Final Technical Report

Best Practice Management of Spot Type Net Blotch in barley and interactions with stubble management and head loss in the Medium Rainfall Zones of Western Australia 2015-2017.

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REPORT SENSITIVITY

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Abstract

Barley is now one of the more profitable crops in the medium rainfall zone and as such there has been large increase in barley plantings. Often barley is planted on barely stubble, which has resulted in increasing levels of Spot Type Net Blotch (*Pyrenophora teres f. maculate).* In the medium rainfall zone it is unclear how economic different management strategies are.

Currently management of STNB has been difficult, especially in retained stubble systems as inoculum is able to persist between seasons and infect new crop. In the medium rainfall zone it is unclear how economic different fungicide strategies are. Single treatments can range from $10/ha including application up to $30/Ha including application with a two-spray strategy. Growers in the medium rainfall zone need to know which strategy to adopt depending on seasonal conditions and disease pressure and the likely economic impact.

The aim of this research was to:

- Investigate the best practice foliar fungicide management for barley on barley rotations and STNB control in barley cv. Scope.
- Better understand the interactions of STNB, stubble and fungicides on the impact of disease, yield and profitability of barley on barley rotations.
- Investigate if higher levels of STNB are associated with head loss pre-harvest.

This research is targeting the medium rainfall zone where yield potential and disease pressure can vary greatly form year to year and there has been limited disease research undertaken in this environment. This trial is part of a series undertaken in 2015, 2016 and 2017

Executive Summary

Throughout the wheatbelt there has been a large increase in barley plantings, which has resulted in increasing levels of Spot Type Net Blotch (STNB; *Pyrenophora teres f. maculata*). In many situations growers are planting barley on barley as it is a very profitable and relatively low risk rotation. However, the current varieties grown in this system (eg. Scope, Hindmarsh, La Trobe and Spartacus) are either susceptible or moderately susceptible to STNB.

Currently management of STNB has been difficult, especially in retained stubble systems as inoculum is able to persist between seasons and infect new crop. In the medium rainfall zone it is unclear how economic different fungicide strategies are. Single treatments can range from $10/ha including application up to $30/Ha including application with a two-spray strategy. Growers in the medium rainfall zone need to know which strategy to adopt depending on seasonal conditions and disease pressure and the likely economic impact.

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Research findings

2015

In 2015 there were multiple rainfall events early in the season that allowed disease pressure top build in the lower canopy, however a dryer finish to the season slowed the progress of the disease in the upper canopy.

In the retained stubble trial, there was 10% yield response to fungicide in a dry finish to the season (190mm GSR, 2.4-2.8 t/ha), significant at $p<0.08$, although when stubble was burnt there was not a yield response to fungicide. There was an economic return ($20-40/ha) under high disease pressure (retained stubble), but not when stubble was burnt (loss of $10 to $30/ha). The trial demonstrated slight differences between fungicide product on leaf infection and also significant difference related to fungicide timing on leaf infection. In both trials, fungicides significantly impacted grain screenings whereby there was fewer screening where a fungicide was applied. Interestingly, the burnt stubble yielded 400kg/ha more than retained stubble irrespective of fungicide treatment.

Head loss was significantly lower at 95% confidence interval when some fungicides were used. This result needs validating to be confident in this result as the % CV for the data set (20) was quite high.

2016

2016 received slightly below average growing season rainfall (250mm) with extended dry periods early in the season that were not conducive to build up disease levels. Disease levels did increase later in the season though this did not cause any differentiation in levels between the burnt and retained areas. The lack of early disease pressure resulted in fungicides applied at stem elongation (Z32) giving little long-term benefit in reducing disease levels.

In 2016 the stubbles were retained around the trial site, this led to the hypothesis that the retention of stubble around the site allowed inoculum levels to remain the same between burnt and retained areas. By flag emergence the disease levels increased to 16% of flag-3 which was the most infected leaf. Two fungicide sprays managed to significantly reduce the disease compared to the untreated control. Late applications of Tilt also gave good control, which were not significantly different to the two-spray strategy.

Treatments which had only an early single spray had infection levels on newly emerged leaves which were not significantly different to the UTC. There were marginally significant benefits on the earlier emerged leaves, however these levels were worse than a single late spray on the equivalent leaves.

Multiple severe frost events at the end of the season severely reduce yield and as a result the trial was not harvested. It was estimated that the paddock would yield <200 kg/ha as a result the remainder of the paddock was cut for hay by the grower.

2017

In 2017 the site received slightly below average growing season rainfall (229 mm) however there were significant summer rainfall events. The start of the growing season was very dry and as a result early disease levels were low at the site (8% average infected leaf area).

Significant control of disease could be achieved with fungicide sprays, however with low levels this had a negligible impact on yield. Following the second application average leaf infection was significantly lower on all plants which received a fungicide compared to the UTC. Those with early sprays were significantly worse at controlling the disease than the late sprays or the two spray approaches.

The two spray approaches (except for 2 x propiconazole) gave a significantly higher yield than the UTC. A late application of Prosaro also returned a significantly higher yield.

Head loss was not influenced by fungicides. The burnt treatments on average returned an additional 325kg/ha over the retained areas however disease levels were not significantly different.

Key Messages and Recommendations

This research highlights how important a tactical approach to STNB management is in the medium rainfall zone. In dry seasons there is lower disease pressure, resulting in a potentially expensive fungicide strategy which can be marginal in returns. Conversely, where there is high disease pressure usually from wet conditions early in the season, then a double spray strategy can improve grain quality, yield and returns to the grower.

Where growing barley on barley, growers should budget for a fungicide spray at Flag-1 every year to protect the top 3 leaves in the canopy. Where conditions are wet early post emergent (especially if stubble is retained) allowing early disease pressure and high yield potential then a fungicide spray at Z31-Z32 can reduce disease pressure and protect the canopy until the Flag-1 spray is applied.

Under high disease pressure situations (wet conditions early post emergent) removing stubble prior to sowing barley on barley can reduce inoculum levels and the build up of early disease pressure. This will also help to reduce the selection pressure for fungicide resistance.

Where there is a dry start to the season and a slow build up of disease then stubble management has minimal impact on the buildup of STNB levels.

Burning barley stubble prior to planting barley on barley has shown to increase yield buy between 325 and 400kg in 2017 and 2015. While removing stubble can reduce early disease pressure, not all the yield increase can be accounted for by disease. Other factors are involved that may require additional work to understand (N mineralization, allelopathic impacts of stubble or improved seed bed). Where erosion risk is low growers should consider burning to remove barley stubble if planting consecutive barley crops.

We feel that there is no further work required to investigate the hypothesized link between STNB levels and pre-harvest head loss.

Growers, advisors and the wider barley industry are the key beneficiaries of this research. Being able to manage disease to maintain grain quality, yield and economic returns to the grower is critical for a competitive barley industry.

Contents

Final Technical Report 2015

Best Practice Management of Spot Type Net Blotch in barley and interactions with stubble management and head loss in the Medium Rainfall Zones of Western Australia 2015.

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Best Practice Management of Spot Type Net Blotch in barley and interactions with stubble management and head loss in the Medium Rainfall Zones of Western Australia.

Project Number: **TAR0006**

Compiling Authors: Ashton Gray (ConsultAg), Geoff Thomas (DAFWA), Andrea Hills (DAFWA), Garren Knell (ConsultAg),

Introduction

Throughout the wheatbelt there has been a large increase in barley planting, which has resulted in increasing levels of Spot Type Net Blotch (STNB). In many situations growers are planting barley on barley as it is a very profitable and relatively low risk rotation. However, the current varieties grown in this system (eg. Scope, Hindmarsh, La Trobe) are either susceptible or moderately susceptible to STNB. Currently management of STNB has been difficult, especially in retained stubble systems. There has been very little new trial data demonstrating the agronomic and economic impact of this disease in medium rainfall zones or the best approach to management.

Objectives

- Investigate the best practice foliar fungicide management in barley on barley for STNB.
- Better understand the interactions of STNB, stubble and fungicides on the impact of disease, yield and profitability of barley on barley rotations.
- Investigate if higher levels of STNB are associated with head loss pre-harvest.

Methods

The trial site was selected North-East of Corrigin (Lat -32.254038^0 Long 117908624^0), Western Australia, in the medium rainfall zone. The site was planted to Scope barley in 2014 and again sown to scope barley in 2015. Half of the paddock was **Burnt (B)** whilst the remaining half of the paddock had stubble **Retained (R)** prior to seeding.

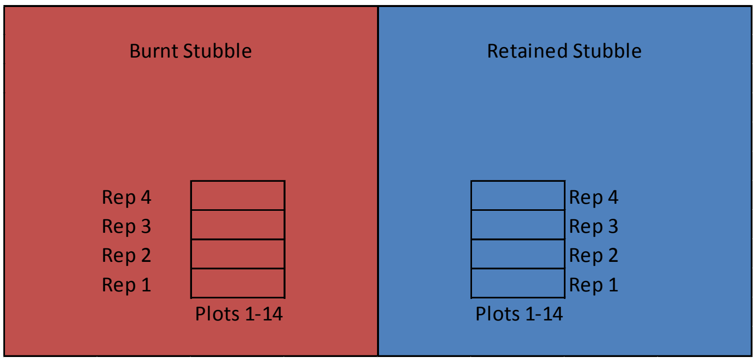
Two trials were replicated on **burnt** and **retained** stubble 50 meters apart. The trial design was completely randomized and replicated 4 times on both the burnt and retained stubble treatments (Figure 1).

Fourteen different fungicide treatments including single and multiple applications of fungicide were applied (Table 1). The fungicides were applied on the:

- 17th July 2015 at growth stage Z31 (first node formed 5.5 leaf).
- And/or the 13th August 2015 at growth stage Z37 (Flag leaf visible).
- Fungicides were applied using a hand boom delivering 100L/ha water through Hardi LD 0.15 nozzles at 2 Bar pressure.

Leaf infection scores (calculated as % leaf area diseased) were conducted three weeks after both fungicide applications to assess the longevity of different fungicide formulations and combinations.

Plots were 12m long and 5m wide and were harvested using a plot harvester and statistical analysis was conducted on yield, grain quality and head loss data. Unharvested strips were left in each plot to look at head loss interaction with fungicide treatments.



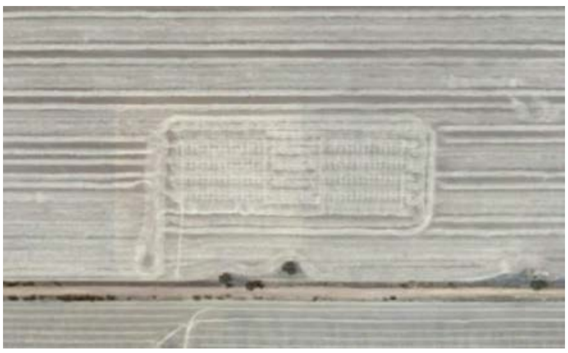


Figure 1. Paddocks and trial layout. Half paddock burnt and half retained stubble.

Image 1 Satellite Aerial shot of trial site harvest 2015

Table 1 Fungicide treatments applied to crop canopy at Z31 (T1), Z31 & Z37 (T1+T2) and Z37 (T2).

Treatment	Applied @ Z31	Applied @ Flag -1 (Z37)	REP 1	REP2	REP3	REP4
1	Tilt 500ml/ha		106	202	306	411
2	Tilt 500ml/ha	Tilt 500ml/ha	109	211	308	402
3		Tilt 500ml/ha	112	208	301	412
4	Amistar Xtra 600ml/ha		102	206	310	414
5	Amistar Xtra 600ml/ha	Tilt 500ml/ha	111	214	302	406
6	Prosaro 150ml/ha		110	205	313	401
7	Prosaro 150ml/ha	Prosaro 150ml/ha	101	212	307	404
8		Prosaro 150ml/ha	107	204	314	409
9	Prosaro 150ml/ha	Tilt 500ml/ha	103	201	309	405
10	Nil		105	207	311	413
11	Aviator 300ml/ha		108	203	312	407
12	Aviator 300ml/ha	Tilt 500ml/ha	113	209	304	410
13		Aviator 300ml/ha	114	210	303	408
14		Radial 420ml/ha	104	213	305	403

***The replication and layout of the burnt and retained sites is identical**

Tilt (Propiconazole 250 g/L)
Aviator Xpro (Prothioconazole 150 g/L, Bixafen 210 g/L)
Prosaro (Prothioconazole 210 g/L, Tebuconazole 210 g/L)
Amistar Xtra (Azoxystrobin 200 g/L Cyproconazole 80 g/L)
Radial (Azoxystrobin 75 g/L, Epoxiconazole 75 g/L)

Results

Retained stubble trial

Impact of fungicide on leaf area affected by STNB

All fungicide treatments significantly ($P<0.05$) reduced the severity of disease (on F-1, F-2 and F-3) compared to the untreated control when assessed after the Z31 application and again post Z37 fungicide application (Fig. 1). As expected, 3 weeks after Z37 application, treatments containing a double application of fungicide had the lowest levels of leaf infection followed by the single late application. A single application at Z31 still significantly reduced leaf infection at this time, by about half compared to untreated control however disease was able to re-enter the canopy later in the season (Figure 1).

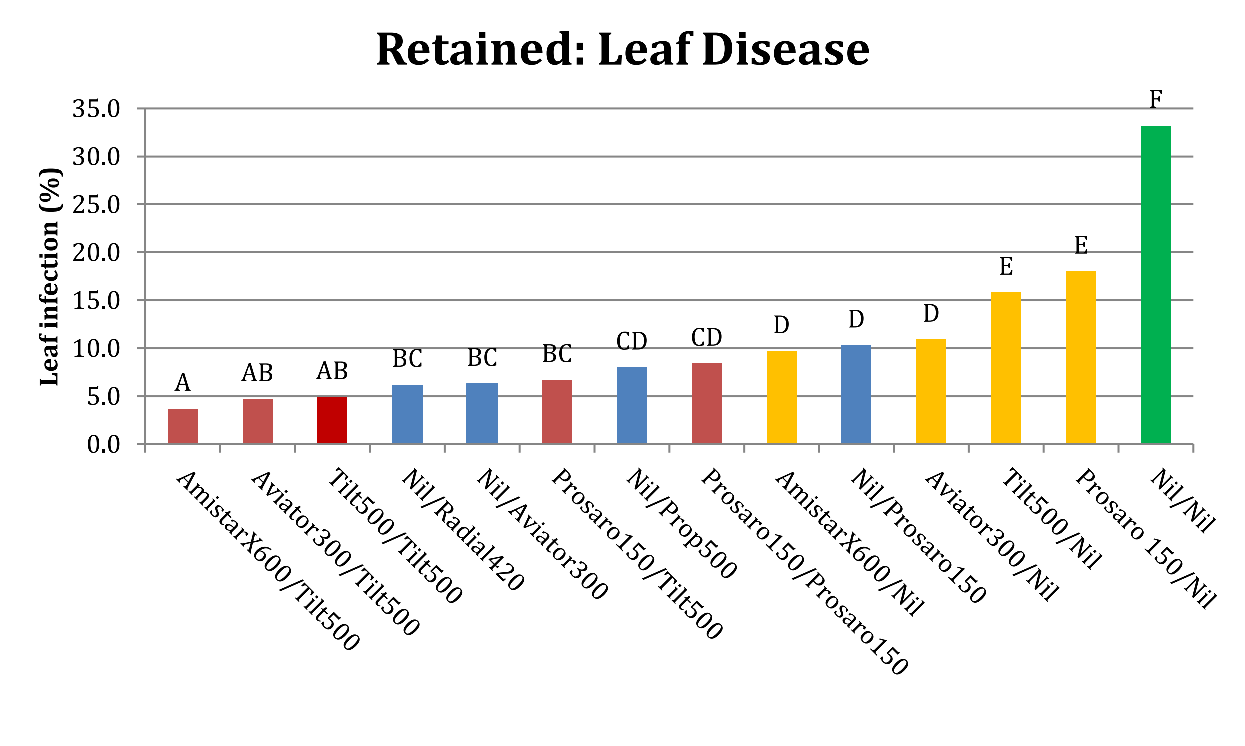


Figure 1: Impact of fungicide timing and product on leaf area affected by spot type net blotch in retained stubble trial, average area affected on Leaf 2-4, assessed 3 weeks after Z37 fungicide application.

Multiple fungicides treatment applied at Z31 & Z37 had significantly lower leaf disease severity than either single application timings. In addition later fungicide applications (Z37) had significantly lower disease levels than a single early fungicide (Z31) (Table 2).

Table 2. Impact of fungicide timing on severity of STNB on top 3 leaves, assessed 3 weeks after Z37 application.

Fungicide timing	% Infection (top 3* leaves)	Log Transformation
T1: Z31	13.6	1.13 a
T2: Z37	7.8	0.86 b
T3: Z31 + Z37	5.6	0.72 c
Average	9.0	
	P-Value	<0.01
	lsd (5%) T2 vs T1/T3	0.12
	T1 vs T3	0.11
	% cv	6.6

Grain Yield

Grain yield had no significant response to fungicide treatments at the 95% confidence level, however at the 92% confidence level there was a significant response to fungicides. All fungicides with the exception of the double Tilt treatment significantly increased yield over the untreated control. The Tilt treatment had significant disease control and so the lack of yield response to this treatment is difficult to explain.

Table 3 Grain Yield Response to fungicide application at Z31, Z37 and Z31&Z37.

Treatment	Applied at Z31	Applied at Z37	Grain yield at 92% CI

9	Prosaro 150ml/ha	Tilt 500ml/ha	2.47 a
12	Aviator 300ml/ha	Tilt 500ml/ha	2.46 a
5	AmistarX 600ml/ha	Tilt 500ml/ha	2.45 a
13	Nil	Aviator 300ml/ha	2.44 a
7	Prosaro 150	Prosaro 150ml/ha	2.44 a
11	Aviator300	Nil	2.43 a
4	AmistarX600	Nil	2.43 a
1	Tilt 500ml/ha	Nil	2.43 a
3	Nil/	Tilt 500ml/ha	2.42 a
8	Nil/	Prosaro150	2.40 ab
14	Nil/	Radial 420	2.37 ab
6	Prosaro 150/	Nil	2.37 ab
2	Tilt 500ml/ha	Tilt 500ml/ha	2.29 bc
10	Nil/	Nil	2.24 c
	P Valve	**P Value**	**0.074**
	LSD	**LSD**	**0.140**
		CV	**2.9**

Fungicide improved grain yield in the retained stubble trial (P<0.08), however there was very little variation between fungicide treatments. When fungicide was analyzed as a combined treatment vs untreated control there was significant response to applying fungicide (P<0.05), there was approximately 10% (175kg/ha) yield advantage gained by applying a fungicide.

Table 4 fungicide response in retained stubble treatments

Treatments	Grain Yield
Nil fungicide	2.240 b
Fungicide	2.417 a
p-Value	<0.001
LSD	0.101
% CV	2.9

Grain Quality

Some Fungicide treatments significantly reduced grain screenings. A single application of Amistar Xtra® 600ml/ha at Z31 resulted in significantly lower screenings than all other treatments. This equated to 20% less screenings than the untreated control. There were no significant differences between fungicide treatments in regards to grain weight and head loss.

Table 5. Screenings response to fungicide application (retained stubble trial).

Treatment	Screenings	
AmistarX/Nil	27.4	a
Prosaro /Prosaro	35.4	b
Nil/Aviator	37.7	bc
Nil/Tilt	39.2	bc
Prosaro/Nil	40.0	bcd
Aviator/Tilt	40.1	bcd
Tilt/Nil	41.8	bcd
Aviator/Nil	42.4	bcd
AmistarX/Tilt	42.5	bcd
Prosaro/Tilt	42.8	bcd
Nil/Radial	44.4	cd
Nil/Nil	44.6	cd
Nil/Prosaro	44.8	cd
Tilt/Tilt	47.6	d
p-value	0.004	
lsd (5%)	7.8	
%cv	14.3	

Burnt stubble trial

Leaf infections

The leaf assessment following the Z31 application and the Z37 application showed fungicide had a significant impact (P<0.05) on the infection severity in both instances; with all treatments significantly reducing severity below the untreated control. While all treatments were effective, as was observed in the Retained trial; later (Z37) and multiple fungicide applications were significantly more effective than the Z31 treatment. However, fungicide application did not impact yield.

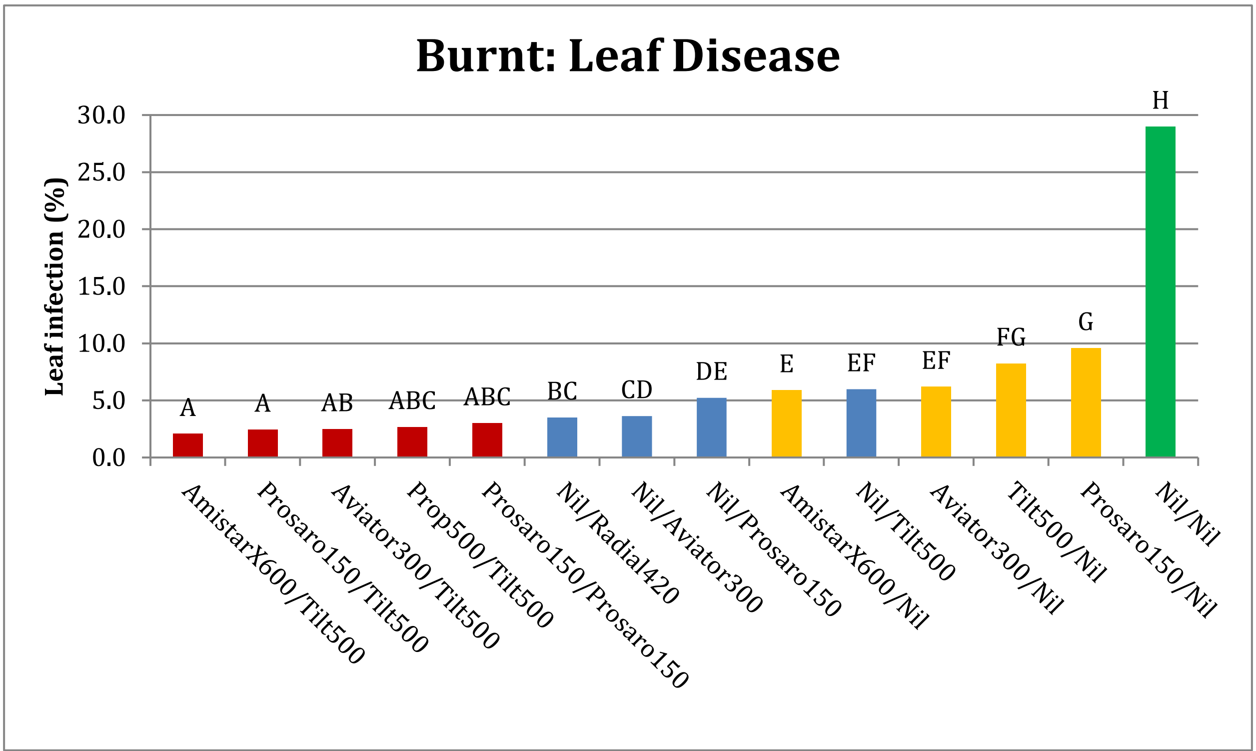


Figure 2: Impact of fungicide timing and product on leaf area affected by spot type net blotch in burnt stubble trial, average area affected on Leaf 2-4, assessed 3 weeks after Z37 fungicide application).

6. Impact of fungicide timing on STNB infection (leaves 2-4, No flag), assessed 3 weeks after Z37 fungicide application (burnt stubble)

Fungicide timing	% Infection (top 3* leaves)	Arc Transformation
T1: Z31	7.5	2.71 a
T2: Z37	4.6	2.18 b
T3: Z31 + Z37	2.5	1.63 c
Average	4.9	
	P-Value	<.001
	lsd (5%) T2 vs T1/T3	0.30
	T1 vs T3	0.29
	% cv	4.9

Grain Yield

While there was a significant impact of fungicide on leaf infection, in the burnt trial there was no significant grain yield response to fungicide application at any timing.

Grain Quality

Fungicide treatments had a significant effect on grain screenings and weight such that some fungicide treatments had significantly lower screenings than the UTC, however there was no particular trend as to which products or timings were most effective.

Table 7. Grain Weight and Screening response to fungicide application in burnt stubble trial.

Treatment	Grain weight	Treatment	Screenings (%)
Nil/Prosaro	39.9 a	Prosaro/Tilt	20.1 a
Tilt/Tilt	39.8 a	Prosaro/Nil	23.3 ab
Tilt/Nil	39.5 ab	Aviator/Nil	24.5 ab
Nil/Aviator	39.3 abc	Nil/ Prosaro	26.7 abc
AmistarX/Nil	39.3 abcd	AmistarX/Nil	27.0 abcd
Nil/Radial	39.2 abcd	Nil/Tilt	27.7 abcd
Aviator/Nil	39.2 abcd	Tilt/Nil	30.0 bcde
Prosaro/Tilt	39.1 abcd	AmistarX/Tilt	31.6 bcde
Prosaro/Nil	38.5 abcde	Nil/Radial	31.7 bcde
AmistarX/Tilt	38.4 abcde	Nil/Aviator	31.8 bcde
Aviator/Tilt	37.8 bcde	Tilt/Tilt	34.0 cde
Nil/Tilt	37.7 cde	Aviator/Tilt	34.7 cde
Nil/Nil	37.6 de	Nil/Nil	36.1 de
Prosaro/Prosaro	36.9 e	Prosaro/Prosaro	36.9 e
p-value	0.024	p-value	0.019
lsd (5%)	1.7	lsd (5%)	9.0
%cv	1.7	%cv	7.6

Head Loss

Head loss was significantly lower at the 95% confidence interval when some fungicides were used (Table 8). This result needs validating over a number of years to be confident in the result as the % CV for the data set (20) is quite high which indicates there was a large amount of variation in the results.

However, a closer analysis into fungicide timing suggests that later timing of fungicide application impacted head loss significantly more than which fungicide was used. Fungicide applied at Z31 & Z37 or at Z37 alone had significantly less head loss than a Z31 application (Table 9).

Table 8 Head loss response to fungicide application in burnt stubble trial.

Treatment	Head loss (kg/ha)
Nil/ Nil	175 a
Prosaro /Nil	168 a
Tilt/Nil	125 ab
Nil/Tilt	118 ab
Aviator/Nil	108 b
Nil/ Prosaro	93 b
Nil/ Aviator	88 b
Prosaro/tilt	83 b
Tilt/Tilt	80 b
Aviator/Tilt	78 b
AmistarX/Nil	73 b
AmistarX/Tilt	73 b
Nil/Radial	73 b
Prosaro/Prosaro	73 b
p-value	0.007
lsd (5%)	60
%cv	20.0

Table 9 Head loss response to fungicide timing.

Fungicide timing		Head loss (head/m²)
T1: Z31		13.0 a
T2: Z37		9.3 b
T3: Z31 + Z37		7.8 b
Average		10.0
p-value		0.002
lsd (5%)	T2 vs T1/T3	3.1
	T1 vs T3	2.9
	%cv	20.1

Overall differences between trials

Grain yield was consistently lower (400kg/ha) on the retained stubble compared to the burnt stubble. Disease occurrence was lower in burnt trial, particularly at early growth stages, and therefore disease may have contributed partially to this difference, however the best disease control treatment in the retained trial (which had minimal disease levels) was still ~400kg less than the Untreated control (Nil) in the Burnt stubble trial (which had significant disease). This suggests that factors other than disease alone contributed to the difference. Therefore while the consistent yield difference between the trials potentially had a component related to very early disease pressure it is likely to be also due to other agronomic factors; potentially water relations, frost or nutrition related to burning / absence of stubble.

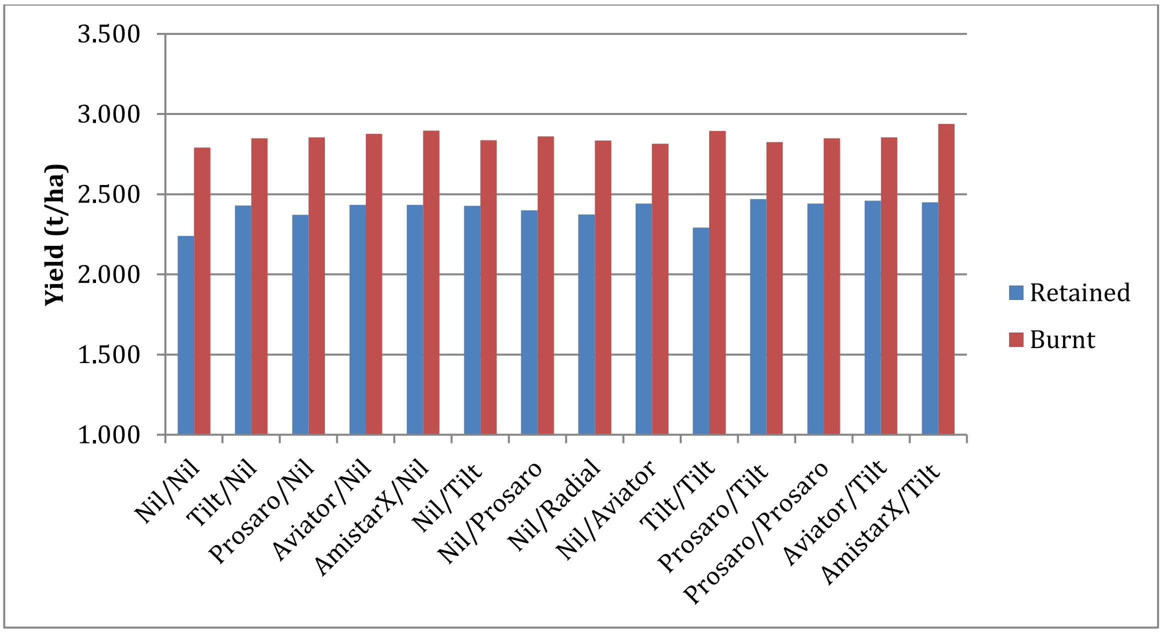


Figure 3. Grain Yield differences between burnt and retained stubble trials.

Another noticeable difference between the trials was that if stubble was burnt, screenings were consistently lower, this is consistent with the higher yield. However in the retained stubble trial some fungicide treatments kept screenings at the same level as the burnt stubble trial (Figure 4), this indicates that disease was a driving factor for yield and grain quality.

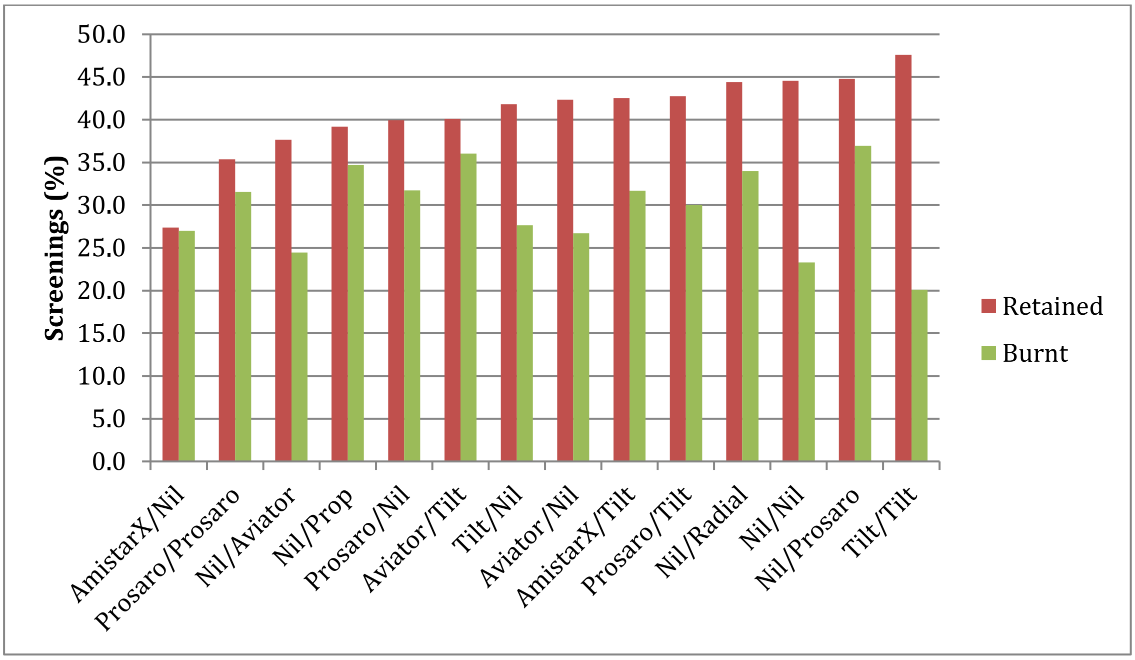


Figure 4. Screenings differences between treatments in burnt and retained stubble trials.

Early ratings suggested that there was a disparity between the trials in disease pressure, with untreated controls having ~40% less disease in burnt trial compared to retained trial. The retained stubbles had considerably higher pressure than the burnt stubbles due to direct proximity of stubble. Interestingly as the season progressed the variation in infection levels between the burnt and retained trials was small. This indicates that the burn reduced the proximity of emerging plants to stubble borne inoculum and hence early disease onset but over the course of the season spores from stubble and infected plants in the surrounding paddock entered the trial area and infection began to develop.

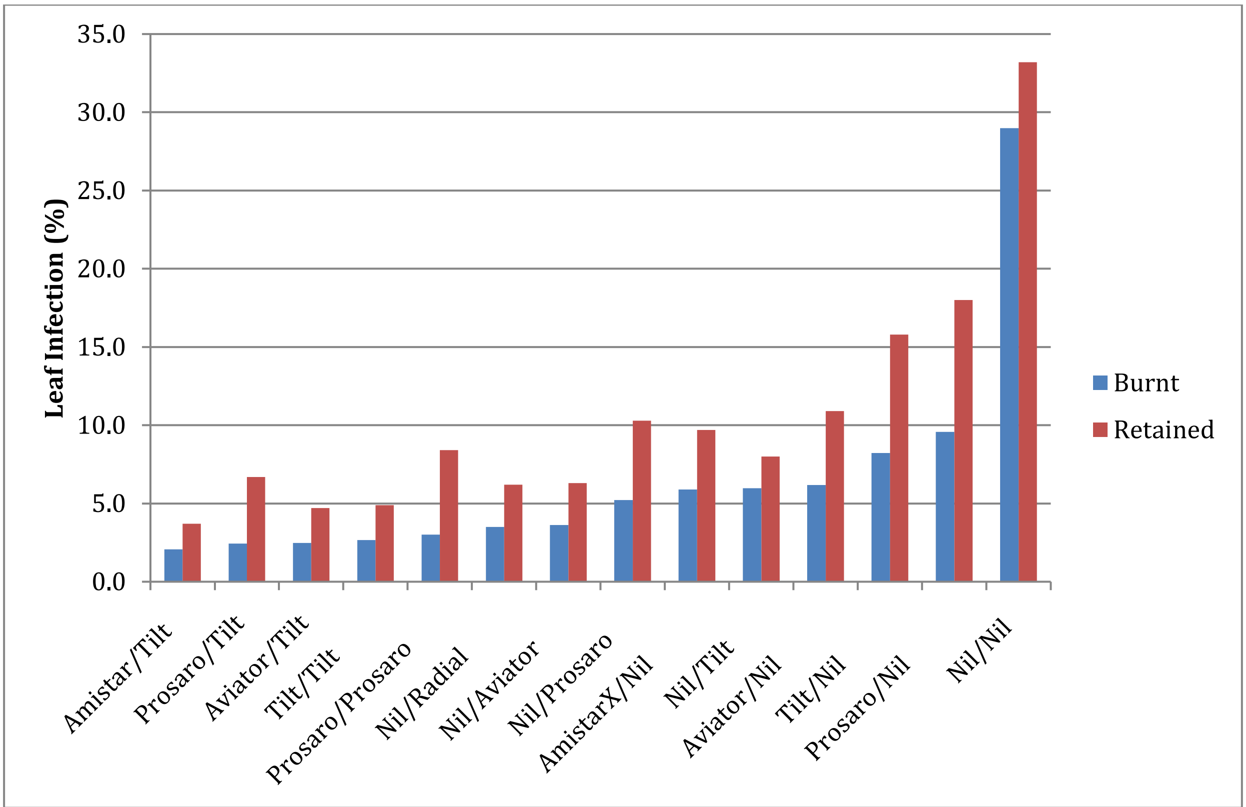


Figure 5. Leaf infection differences between burnt and retained stubble trials. Three weeks after Z37 application

Discussion and conclusions

190mm growing season rainfall (GSR) was experienced at the Corrigin site. This is 90mm below the long term average (GSR 280mm) with a particularly dry spring limiting late season disease development. However there was some out of season rainfall in March, contributing to soil moisture which would have contributed to yield.

The trial concluded a 10% yield response could be achieved by managing STNB even in a low rainfall year under high disease pressure (retained stubble), however when stubble was burnt and hence disease pressure lower there was no yield response.

The responses achieved by fungicide treatments on reducing STNB and retaining green leaf area this season set the crop canopy up for more significant grain yield responses than were achieved. Due to the dry finish to the season the plants didn't require the all the additional green leaf area. We would expect on a softer finishing spring, the fungicides will provide a greater green leaf area to fill grain and achieve even higher grain yield responses to fungicide.

In both trials, fungicides significantly impacted grain screenings, in most instances there was lower screenings where a fungicide was applied. Screenings benefits often occur with yield responses; occasionally screenings benefits occurred in the absence of yield benefit.

There was a significant fungicide response to head loss in the burnt trial but not the retained stubble trial. If anything it would be expected to see a larger response if any under higher disease pressure. This result is unusual and had a large degree of variability in the statistics, this trial would have to be conducted again to have confidence in results.

Economics

Under high disease pressure scenarios (retained stubble) there was an economic benefit from fungicide application. A $20-40/ha benefit was achieved from a fungicide application with a response of 200kg/ha (10%)

(Table 10). On the other hand, there was not a yield response where stubble was burnt and as a result there was $10-30/ha loss associated with fungicide cost and application cost.

Table 10. Economics of applying fungicide. Assuming barley price $250/t, Application cost $4/ha and no wheel track damage as fungicide is added to existing pass

Stubble Method	Fungicide Response	Cost	Cost/Benefit
Retained	200kg/ha ($50/ha)	$10-30/ha	$20-40/ha
Burnt	0 kg/ha	10-30/ha	$-10 to -30/ha

Implications/Key Messages

Retained stubble trial

- In the retained stubble trial, there was a 10% yield response (175 kg/ha) to fungicide in a low rainfall year in the medium rainfall zone (MRZ), significant at $p<0.08$.
- Differences between fungicide products was less than response to fungicide as a whole compared to the untreated
- Fungicide significantly ($P<0.05$) reduced the severity of STNB on the top 4 leaves after the Z31 application and again post Z37 fungicide application.
- Multiple fungicides applied at Z31 & Z37 had significantly lower leaf area affected by STNB than single applications. In addition, later fungicide application Z37 had significantly lower disease level than a single early fungicide (Z31), when assessed at flowering.
- Some Fungicide treatments significantly reduced grain screenings compared to the untreated control.
- There was a marginal economic response ($20-40/ha) to fungicide under high disease pressure (retained stubble) in a low rainfall year in MRZ.

Burnt Stubble trial

- Fungicide applications at both Z31 and Z37 significantly reduced STNB severity on leaves, however no fungicide timing or product had a significant impact on yield.
- Fungicide treatments had a significant effect on grain screenings and weight such that some fungicide treatments had significantly lower screenings than the untreated control
- Head loss was significantly lower at the 95% confidence interval when some fungicides were used, with the later timing having greatest impact. This result needs validating over a number of years to be confident in the result.
- There was no economic response to fungicide under low disease pressure (burnt stubble) in a low rainfall year in MRZ

Overall Differences between trials

- Grain yield was consistently lower on the retained stubble and the use of fungicides did not affect this result (400kg/ha).
- If stubble was burnt, screenings were consistently lower; however in the retained stubble some fungicides kept screenings at the same level as the burnt stubble trial.
- There was lower leaf infection in the burnt trial which demonstrates that the burn reduced early infection levels

Recommendations

- Growers should adopt a single or double fungicide strategy when growing barley in a high pressure scenarios (retained stubble), even in a low rainfall season in MRZ as this should return an economic response.
- When stubble was burnt there was not an economical reason to apply a fungicide for Spot Type Nett Blotch control in a low rainfall season in MRZ.
- Pre-harvest head loss was slightly correlated to disease management technique (in burnt trial only) however more research need to be done to validate this result.
- Burning Stubble returned a 400kg/ha yield response compared to treatments where stubble was retained irrespective of fungicide strategy. Grower should consider burning stubble if planting barley on barley in some scenarios.

Appendix

Extension Activities

18th September 2015 - Corrigin Farm improvement Group (CFIG) visited the trial during a spring field walk in late September. Here, approximately 30 growers and industry personnel were shown the different fungicide timings, combinations and interactions with and without stubble.

24th September 2015 - The GRDC Western Panel visited the trial site in late September as a part of their spring tour.

The results from this trail have been compiled with a number of other net blotch trials across WA in 2015 and a collaborative paper of these trials has been submitted to the GRDC 2016 crop Updates (Andrea Hills, DAFWA).

In addition, these results will be presented at CFIG autumn updates.

The results of this study will be involved in DAFWA extension programs along with ConsultAg extension program with grower seminars in autumn.

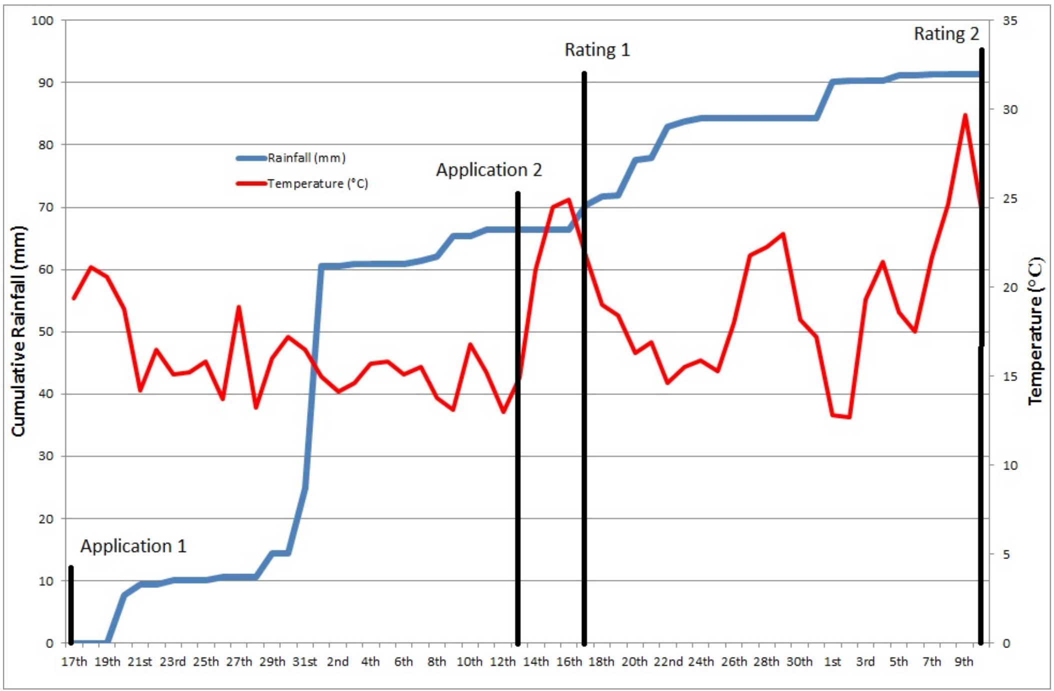


Figure 6. Rainfall and temperature in Corrigin 2015. Dates of fungicides application and leaf score ratings.

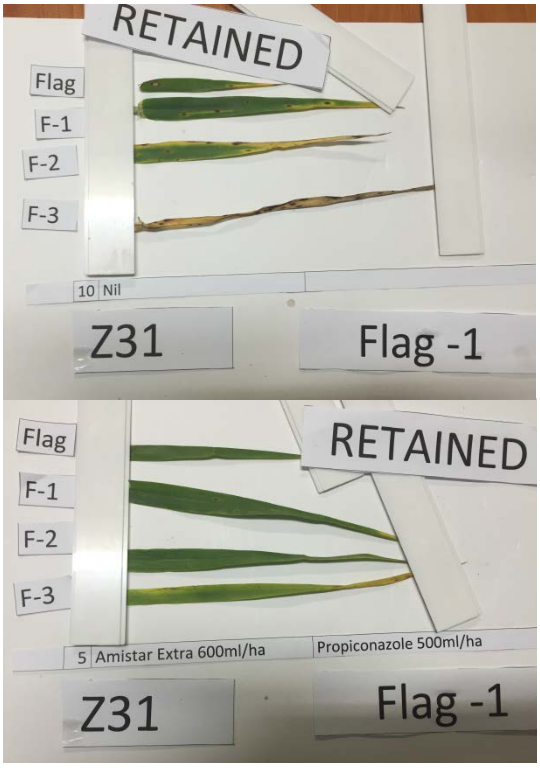


Figure 7A. Visual Images comparing leaf scores

Final Technical Report 2016

Best Practice Management of Spot Type Net Blotch in barley and interactions with stubble management and head loss in the Medium Rainfall Zones of Western Australia 2016.

Project code: TAR00007-A

Prepared by: Trent Butcher

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REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	YES/NO
Results are incomplete	YES/NO
Commercial/IP concerns	YES/NO
Embargo date	YES/NO

KEY MESSAGES

- The site was severely frosted overriding any treatment effects on yield or head loss. However there was useful information gained from leaf assessments.
- Early disease levels were low even on a tight barley on barley rotation
- Burnt areas provided no additional reduction in early disease levels
- Early fungicides applications were likely to have not resulted in a positive economic response

SUMMARY

Spot type net blotch (STNB) is a growing concern in medium rainfall areas as the increase of barley plantings and intensive barley rotations puts pressure on the commonly grown varieties which are either susceptible or moderately susceptible to the disease. Growers are looking to fungicide as well as cultural practices such as burning to reduce the prevalence of the disease. This is the second year of a trial series exploring the impact of burning stubbles and different fungicide products and timings of applications.

Good early rainfall events prior to sowing and a continuous barley on barley rotation (>5 years) were presumed to be ideal conditions for an early infection of STNB. However disease levels were low at the start of the season in both areas with retained and burnt stubble. Rainfall overall was slightly below average for the growing season and the levels of disease post flag leaf emergence were still lower than anticipated.

Late applications of fungicide provided the greatest level of control as the disease levels started to increase. Two spray strategies gave the greatest control but the economics of this approach was unable to be determined. A period of repetitive frosts during the flowering and grain fill stage destroyed yield potential and prevented any clear economical conclusions from being made.

BACKGROUND

Throughout the wheatbelt there has been a large increase in barley plantings, which has resulted in increasing levels of Spot Type Net Blotch (STNB). In many situations growers are planting barley on barley as it is a very profitable and relatively low risk rotation. However, the current varieties grown in this system (eg. Scope, Hindmarsh, La Trobe and Spartacus) are either susceptible or moderately susceptible to STNB. Currently management of STNB has been difficult, especially in retained stubble systems. There has been very little new trial data demonstrating the agronomic and economic impact of this disease in medium rainfall zones or the best approach to management.

This is the 2nd year of trials analysing the impact of cultural and agronomic approaches to reducing STNB.

OBJECTIVES

- Investigate the best practice foliar fungicide management for barley on barley rotations and STNB control.
- Better understand the interactions of STNB, stubble and fungicides on the impact of disease, yield and profitability of barley on barley rotations.
- Investigate if higher levels of STNB are associated with head loss pre-harvest.

METHODS

The trial site was selected North-East of Corrigin, Western Australia, in the medium rainfall zone. The site was planted to Scope barley in 2015 and sown to Latrobe barley in 2016. Half of the plots were **Burnt (B)** whilst the remaining half of the plots had stubble **Retained (R)** prior to seeding.

Each replicate had half of the plots with **burnt** stubble and the other half with **retained** stubble. The trial design was completely randomized and replicated 4 times on both the burnt and retained stubble treatments (Figure 1).

Two untreated controls and eight different fungicide treatments were applied including single and multiple applications (Table 1). The fungicides were applied on the:

- 7th July 2016 at growth stage Z32 (first node formed 5.5 leaf).
- And/or the 10th August 2016 at growth stage Z37 (Flag leaf visible).
- Fungicides were applied using a hand boom delivering 100L/ha water through Hardi LD 0.15 nozzles at 2 Bar pressure.

Leaf infection scores (calculated as % leaf area diseased) were conducted four to five weeks after both fungicide applications to assess the effectiveness and longevity of different fungicide formulations and combinations. Assistance from Geoff Thomas from the Department of Agriculture and food was employed to ensure rigour and consistency of assessments to match standard practices.

Plots were 12m long and 3m wide and were assessed for STNB control. The intention was to harvest plots using a plot harvester and to conduct statistical analysis on yield, grain quality and head loss data. However due to severe frost damage it was concluded that there would be no merit in harvesting the trials.

9	2	1	3	6	4	8	7	5	10	Rep 4
801	802	803	804	805	806	807	808	809	810	
9	2	1	3	6	4	8	7	5	10	
701	702	703	704	705	706	707	708	709	710	
4	5	9	7	2	8	10	1	6	3	Rep 3
601	602	603	604	605	606	607	608	609	610	
4	5	9	7	2	8	10	1	6	3	
501	502	503	504	505	506	507	508	509	510	
10	2	6	3	5	9	7	4	1	8	Rep 2
401	402	403	404	405	406	407	408	409	410	
10	2	6	3	5	9	7	4	1	8	
301	302	303	304	305	306	307	308	309	310	
3	8	10	6	1	5	4	7	9	2	Rep 1
201	202	203	204	205	206	207	208	209	210	
3	8	10	6	1	5	4	7	9	2	
101	102	103	104	105	106	107	108	109	110	

Figure 8. Paddocks and trial layout. Shaded areas indicate burnt stubble and unshaded indicate retained stubble.

Table 11 Fungicide treatments applied to crop canopy at Z31 (T1), Z31 & Z37 (T1+T2) and Z37 (T2).

	Treatment	
	Z32	Z37 (Flag -1)
1	Tilt (450ml)	
2		Tilt (450ml)
3	Tilt (450ml)	Tilt (450ml)
4	Prosaro (200ml)	
5		Prosaro (200ml)
6	Prosaro (200ml)	Tilt (450ml)
7	Amistar (400ml)	
8	Amistar (400ml)	Tilt (450ml)
9	Untreated Control	
10	Untreated Control	

Tilt (Propiconazole 250 g/L) (label rate 250ml-500ml)
Prosaro (Prothioconazole 210 g/L, Tebuconazole 210 g/L) (label rate 150ml-300ml)
Amistar Xtra (Azoxystrobin 200 g/L Cyproconazole 80 g/L) (label rate 200ml-800ml)

LOCATION

NOTE: Where field trials have been conducted please include location details: Latitude and Longitude, or nearest town, using the table below (please add additional rows as required):

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1	-32.297607^{0}	117.995351^{0}
Nearest Town	Corrigin	

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or GRDC 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	Choose an item. Choose an item. Choose an item.	☐ Qld Central ☐ NSW NE/Qld SE ☐ NSW Vic Slopes ☐ Tas Grain ☐ SA Midnorth-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

Corrigin received significant rainfall in January of 2016 meant that there was a large amount of stored soil moisture present early in the season. In season rainfall events however were lower than average, with many crops able to grow on the back of early falls. As a result the rainfall for the year was above average at the end of October. Growing season rainfall (GSR) was 250.3mm (April-October) in 2016 which was slightly below the long term average of 288mm (GSR). A long term history of barley on barley rotation (>5 years) coupled with strong early rainfall events provided a good potential for disease to thrive during the growing season. However, the substantial rainfall events early in the year appeared to do little in allowing the disease to spread rapidly. It's likely the dry start to the growing season reduced the disease spreading. This is in contrast to 2015 where there was lots of early disease and a dry finish which lowered the amount of disease at the timing of the second application.

The low disease levels at the site early in the growing season were observed in both the unburnt and burnt areas. As a result there was little variation observed between the burnt and unburnt areas in early ratings. The levels of infection did increase as the season progressed but in general disease levels were low.

Table 2: Cumulative growing season rainfall for the 2016 season vs the long term average.

	April	May	June	July	August	September	October
Long Term Average	78	125	184.5	244	291.5	321.3	342.7
2016 Rainfall	162.1	208.9	232.3	270.5	331.4	359.2	368.2

The best strategies for reducing the amount of overall leaf infection was a two spray strategy of either a Z31 application of Tilt, Prosaro or Amistar followed by a flag-1 application of Tilt or a single application of Tilt at the flag-1 stage. All of the aforementioned combinations significantly reduced the amount of disease present compared to the untreated control. There was no significant difference between Amistar, Tilt of Prosaro in reducing leaf infection when the early spray of these products was followed by a late spray of Tilt. Though differences were observed, overall the disease level in all treatments was low (flag-3 on utc >20% infected).

Table 3: Leaf infection observed on the top four leaves observed on the 12th of September 2016

			Flag		Flag-1		Flag-2		Flag-3	
1	Tilt (450ml)		2.521	ab	5.7	bc	8.426	b	9.93	cd
2		Tilt (450ml)	1.563	a	2.813	a	4.237	a	6.881	ab
3	Tilt (450ml)	Tilt (450ml)	1.34	a	1.85	a	3.137	a	5.066	a
4	Prosaro (200ml)		3.789	bc	7.338	d	11.575	c	12.348	d
5		Prosaro (200ml)	2.438	ab	4.663	b	7.725	b	9.379	bc
6	Prosaro (200ml)	Tilt (450ml)	1.706	a	2.063	a	3.938	a	5.576	a
7	Amistar (400ml)		3.625	b	6.138	cd	8.537	b	11.168	cd
8	Amistar (400ml)	Tilt (450ml)	1.413	a	2.675	a	3.537	a	5.316	a
9	Untreated Control		4.988	c	8.475	e	12.412	c	16.208	e

Standalone Z31 sprays of Tilt, Amistar and Prosaro gave a lower amount of control than the later spray of tilt on flag -1, -2 and -3 leaves. However the difference between the standalone early sprays (Z31) and the late spray of Prosaro showed less variation between reductions of disease on leaves. The early application of tilt generally provided the best degree of control however it was not significantly better than the control given by Amistar. There was significantly greater control given by Amistar than the untreated control on all leaves except the flag leaf, whereas tilt provided superior control over all leaves.

The early application of Prosaro gave the poorest level of control compared to the untreated only providing significantly more control on F-3. However the control from Prosaro was not significantly different from that supplied from Amistar on the flag, f-1 and f-3 leaves.

Table 4: Comparison of the three tested products when applied early with no follow up spray against the untreated control

	Flag		flag-1		Flag-2		Flag-3	
Tilt	2.5	a	5.7	a	8.4	a	11.2	a
Amistar	3.6	ab	6.1	ab	8.5	a	9.9	a
Prosaro	3.8	ab	7.3	bc	11.6	b	12.4	a
UTC	5.0	b	8.5	c	12.4	b	16.2	b

Frost Damage

The impact of frost on this site was substantial. Early flowering frosts limited grain production and much of the grain that was able to form was severely distorted by a grain fill frost. The damage throughout the paddock in which the trial was located was extensive enough that the grower warranted cutting the remainder of the paddock for hay as it had an expected yield of less than 200kg/ha (figure 6). For this reason the trial was not harvested as any results that could be attained would be largely influenced by the confounding frost factor. The lack of grain in the heads of the plants also meant that head loss levels were very low as the weight wasn't there. Measurements for head loss were not taken as a result.

There was a propensity for temperatures to be lower (0.2-0.4°C) and remain lower for longer in the retained stubble areas compared to the burnt areas (figure 3). This result reflects other work looking at stubble loads and their impact on increasing the severity and duration of frost events at head height.

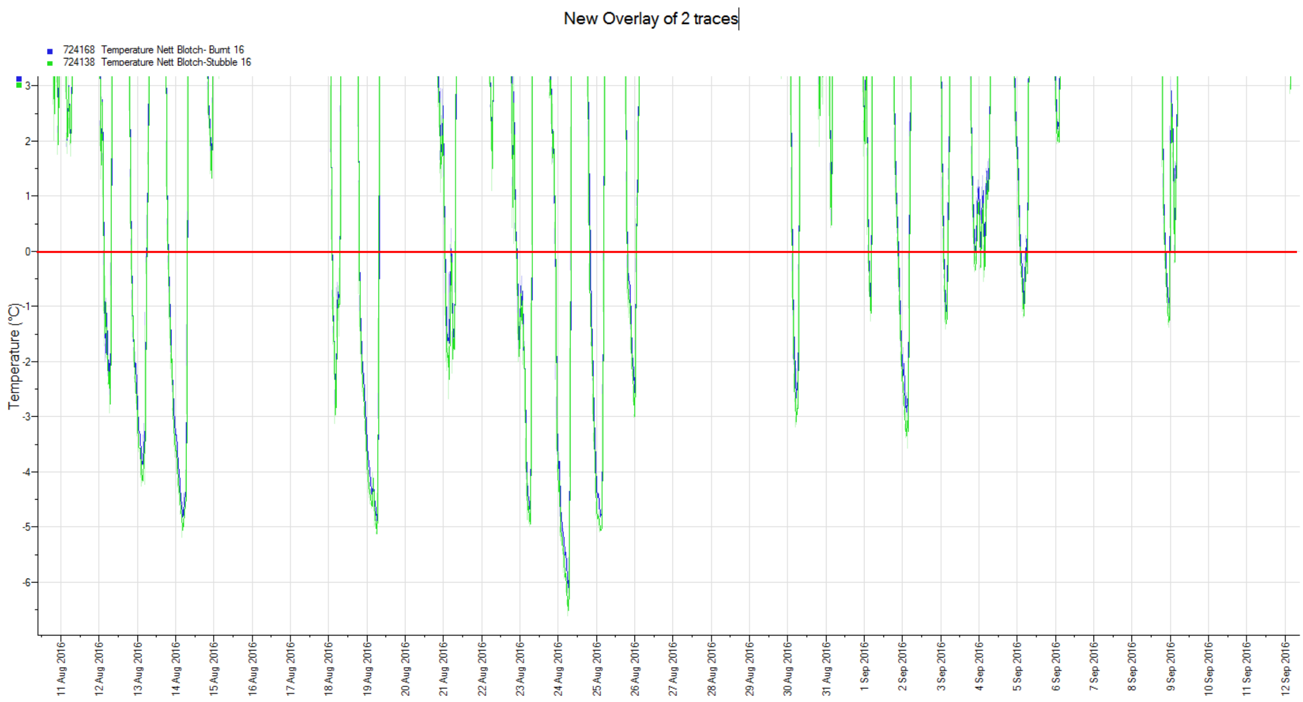

Figure 3: Recorded minimum temperatures throughout the growing season (higher resolution graph attached.

CONCLUSIONS

The low disease levels throughout the trial early in the season were surprising given the amount pre-growing season rainfall. When the disease did enter the crop later into the season there was no significant difference observed between the burnt and unburnt areas. There are two potential reasons for this lack of difference.

1. The lack of disease early in the season meant that the amount of inoculum in the previous year's stubbles was lower than predicted and that the early fungicides were not required.

2. The small burnt patches into a large paddock were not enough of a buffer zone to reduce the exposure to the disease. Ideally the whole paddock would've been burnt to allow for the buffer areas to be larger reducing the chance of inoculum reaching the burnt areas. The large amounts of pre-growing season rainfall made this unachievable (this has been amended for the 2017 trial)

The lack of reduction in disease from the early spray was a good demonstration of the limitation of prophylactic spraying in reducing the spread of STNB. For example an early application of Prosaro only provided superior control to the untreated control on the flag-1 and flag-3 leaves. Whereas a single late application (Z39) application of tilt provided significantly better control than both the untreated and the early application of Prosaro on all of its leaves. These results indicate the importance of "playing the season" in the medium to low rainfall zones.

Unfortunately the severe frost events throughout the season resulted in a significant reduction in the yield potential of the crop. The confounding effect of frost would have reduced the power and accuracy of any yield measurements made when trying to determine the influence of disease. The economics of applications as a result were unable to be determined which makes it difficult to identify which products and timings made a positive financial contribution.

Head loss was also unable to be determined as the frost severely distorted and reduced grain size which caused heads not to fall as they were light in weight. It is likely from observation however that an early spray would have been uneconomical if the trial was not frosted.

Over two very different growing seasons it is becoming apparent that the timing of fungicides in the lower rainfall areas is very important. Disease may establish itself early or late and the value of applying fungicides at this time, though reducing the amount of disease may not have a positive economic interaction. Further exploration on timings and products will help to better establish the appropriate thresholds and timings for a drier growing environment.

Figure 4: The burnt areas within the stubble paddock (wet stubble made burning difficult).

Figure 5: STNB infection levels in untreated areas at the time of rating (12/9/2016)

Figure 6: Hay stacked from the cut barley.

Final Technical Report 2017

Best Practice Management of Spot Type Net Blotch in barley and interactions with stubble management and head loss in the Medium Rainfall Zones of Western Australia 2017.

Project code:	TAR00007-A
Prepared by:	Trent Butcher
	tb@consultag.com.au gk@consultag.com.au
	Consultag
	Garren Knell

REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	YES/NO
Results are incomplete	YES/NO
Commercial/IP concerns	YES/NO
Embargo date	YES/NO

Background

Throughout the wheatbelt there has been a large increase in barley plantings, which has resulted in increasing levels of Spot Type Net Blotch (STNB; *Pyrenophora teres f. maculata*). In many situations growers are planting barley on barley as it is a very profitable and relatively low risk rotation. However, the current varieties grown in this system (eg. Scope, Hindmarsh, La Trobe and Spartacus) are either susceptible or moderately susceptible to STNB. Currently management of STNB has been difficult, especially in retained stubble systems as inoculum is able to persist between seasons and infect new crop.

There has been very little new trial data demonstrating the agronomic and economic impact of this disease in medium rainfall zones or the best approach to management.

This is the 3rd year of trials analysing the impact of cultural and agronomic approaches to reducing STNB.

Project objectives

The main objectives of this trial are to:

- Investigate the best practice foliar fungicide management for barley on barley rotations and STNB control in barley cv. Scope.
- Better understand the interactions of STNB, stubble and fungicides on the impact of disease, yield and profitability of barley on barley rotations.
- Investigate if higher levels of STNB are associated with head loss pre-harvest.

Methodology

The trial site was selected North-East of Corrigin, Western Australia, in the medium rainfall zone. The site was planted to Scope barley in 2016 and sown to Scope barley on the 20th of May 2017. Burning treatments were carried out prior to sowing on the 7th of April.

The trial had a strip plot design with four replicates. Each replicate included a **Burnt (B)** and **Retained (R)** stubble strips with fungicide treatments applied across each strip (Figure 1).

Two untreated controls and eight different fungicide treatments were applied including single and multiple times of applications (TOA) (Table 1). The fungicides were applied on the:

- 27th July 2017 at growth stage Z32 (TOA1) to a crop under heavy dew
- And/or the 21st August 2016 at growth stage Z37 (Flag leaf emerging on some plants) (TOA2).
- Fungicides were applied using a 2.5m hand boom delivering 100L/ha water through Hardi LD 0.15 nozzles at 2 Bar pressure.

Conditions at Application		
	TOA 1 (Z32)	TOA2 (Z37)
Wind speed (km/h)	12.5	6.2
Wind Direction	NNW	SW
Temperature (°C)	12.4	17
Humidity (%)	81	35
Delta t	2	7

Leaf infection severity scores were calculated as % leaf area infected by STNB of each individual leaf. This involved assessment of the top four emerged leaves post TOA1 and the top three leaves post TOA2. Assessments were conducted four to five weeks after both fungicide applications to assess the effectiveness and longevity of different fungicide formulations and combinations (Assessment 1, 24th August (Z33), Assessment 2, 6th September (Z61)). Methodology for leaf assessments was consistent with those used by the Department of Primary Industries and Regional Development (DPIRD).

Plots were 12 m long and 5m wide (cut back to 10m prior to harvest) and STNB assessments were taken randomly from whole plots. Individual plants were assessed for infection levels with 8 replicates taken post TOA1 and 6 replicates post TOA2. Yields were determined by plot harvester on the 12th of December 2018, taking a single width cut (1.8m) from mid-section of each plot. Statistical analysis by Anova (Genstat 18th Edition) was applied to disease assessment, yield and grain quality data. Head loss data was recorded after harvest in both the harvested and harvested areas.

9	2	1	3	6	4	8	7	5	10	Rep 4
801	802	803	804	805	806	807	808	809	810	
9	2	1	3	6	4	8	7	5	10	
701	702	703	704	705	706	707	708	709	710	
4	5	9	7	2	8	10	1	6	3	Rep 3
601	602	603	604	605	606	607	608	609	610	
4	5	9	7	2	8	10	1	6	3	
501	502	503	504	505	506	507	508	509	510	
10	2	6	3	5	9	7	4	1	8	Rep 2
401	402	403	404	405	406	407	408	409	410	
10	2	6	3	5	9	7	4	1	8	
301	302	303	304	305	306	307	308	309	310	
3	8	10	6	1	5	4	7	9	2	Rep 1
201	202	203	204	205	206	207	208	209	210	
3	8	10	6	1	5	4	7	9	2	
101	102	103	104	105	106	107	108	109	110	

Figure 9. Paddocks and trial layout. Shaded areas indicate burnt stubble and unshaded indicate retained stubble.

Table 12 Fungicide treatments applied to crop canopy at Z31 (T1), Z31 & Z37 (T1+T2) and Z37 (T2).

	Treatment	
	Z32	Z37 (Flag -1)
1	Tilt (450ml)	
2		Tilt (450ml)
3	Tilt (450ml)	Tilt (450ml)
4	Prosaro (200ml)	
5		Prosaro (200ml)
6	Prosaro (200ml)	Tilt (450ml)
7	Amistar (400ml)	
8	Amistar (400ml)	Tilt (450ml)
9	Untreated Control	
10	Untreated Control	

Tilt (Propiconazole 250 g/L) (label rate 250ml-500ml)
Prosaro (Prothioconazole 210 g/L, Tebuconazole 210 g/L) (label rate 150ml-300ml)
Amistar Xtra (Azoxystrobin 200 g/L Cyproconazole 80 g/L) (label rate 200ml-800ml)

Location

NOTE: Where field trials have been conducted please include location details: Latitude and Longitude, or nearest town, using the table below (please add additional rows as required):

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1	-32.277765	117.957348
Nearest Town	Corrigin	

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	Choose an item.	☐ Qld Central	☐ NSW Central
	Choose an item.	☐ NSW NE/Qld SE	☐ NSW NW/Qld SW
	Choose an item.	☐ NSW Vic Slopes	☐ Vic High Rainfall
		☐ Tas Grain	☐ SA Vic Mallee
		☐ SA Midnorth-Lower Yorke Eyre	☐ SA Vic Bordertown-Wimmera
		☐ WA Northern	☒ WA Central
		☒ WA Eastern	☐ WA Sandplain

☐ WA Mallee

Results

Seasonal Conditions

Corrigin received significant rainfall in January and February of 2017 which meant that there was a large amount of stored soil moisture present early in the season. In season rainfall events however were lower than average at the break of the season, with many crops relying on stored moisture to emerge. May and June were very dry (41mm) and provided few germination opportunities or early growth potential. Growing season rainfall (GSR) was 229mm (April-October) in 2017 which was slightly below the long term average of 287mm (GSR) (table 2). Rainfall for the year however was above average by the end of October due to significant rainfall events from July to October as well as the summer falls.

Table 2: Monthly and Cumulative growing season rainfall for the 2017 season vs the long term average.

	April	May	June	July	August	September	October
Long Term Average	23.1	46.7	59.2	59.4	47.6	29.8	21.5
2017	6.4	13.6	27.4	47	59.8	36.2	38.6
Cumulative Long Term Average	69	116	175	234	282	312	333
Cumulative 2017 Rainfall	216	229.6	257	304	364	400	439

Disease and Control

Despite sowing onto barley stubble, the very dry conditions following sowing and during seedling and tillering growth stages did not promote early disease proliferation. Rainfall events later into the season provided a good potential for disease to develop at the back of the growing season, however given the slow early disease onset and relatively late sowing time, disease severity did not reach extreme levels. This was a similar situation to the 2016 season where substantial rainfall events early in the year prior to sowing appear to do little in allowing the disease to spread rapidly. It’s likely the dry start to the growing season reduced the disease spreading. Both 2017 and 2016 are in contrast to 2015 where there was lots of early disease and a dry finish which lowered the amount of disease at the timing of the second application. The impact of STNB has been shown to be strongly related to disease favourable conditions during spring (Hills et al 2015).

Lower than expected disease severity early in the growing season were observed in both the retained and burnt areas. There was no significant difference in disease pressure between the burnt and retained areas at both assessment timings.

Assessments on disease severity following the application of fungicides at Z32 showed a significant reduction in disease when Tilt and Amistar were applied Prosaro did not significantly reduce disease compared to the UTC. However, it should be noted that although the differences in control were significant the total leaf affected by disease in the UTC was <3% which is considered to be minimal and unlikely to affect yield (table 3).

Table 3: Relationship between fungicide strategies and total assessed leaf infection following TOA1

	Average Leaf Infection (mean % leaf area infected)
Tilt Z31	1.094 a
Ami Z31	1.125 a
Pros Z31	1.984 ab
UTC	2.772 b
L.S.D	1.192
C.V	9.7
F-value	0.012

TOA: timing of application

Means followed by the same letter are not significant different (P = 0.05, LSD)

Table 4: Relationship between fungicide strategies and leaf infection on Flag-2 following TOA2

TOA1 (Z32)	TOA2 (Z37)	Average Leaf Infection (mean % leaf area infected)
Amistar	Tilt	1.3 a
Tilt	Tilt	1.7 a
Prosaro	Tilt	1.7 a
	Tilt	1.9 a
	Prosaro	2.7 ab
Tilt		4.1 bc
Amistar		4.3 c
Prosaro		5.2 c
UTC		8 d
L.S.D		1.358
C.V		7
F-value		<0.001

TOA: timing of application

Means followed by the same letter are not significant different (P = 0.05, LSD)

Even though disease severity was low (8%), applying a fungicide at Z32, Z37 or a multiple fungicide approach at both growth stages significant reduced SFNB disease severity compared to the UTC (table 4). There was no significant difference between mixed treatments or between the treatments at individual application timings for disease severity. Single applications of Prosaro, Amistar and Tilt applied at Z32 were significantly inferior at reducing STNB disease severity compared to late single applications of Tilt and Prosaro. The addition of Tilt to these applications at Z37 was also significantly superior to these early, single treatments. There was no significant difference between fungicide applications at Z37 of Tilt or Prosaro for disease severity compared to a multiple fungicide application approach. There was no observable response between burnt and retained treatments (table 5).

Table 5: Relationship between burning and retaining stubble on leaf infection of Flag-2 following TOA2

	Average leaf infection (mean % leaf area infected)
Burnt	4.06
Unburnt	3.74
L.S.D	1.568
C.V	5.5
F-value	0.2

Grain Yield

There was a significant grain yield response to burning. Burnt areas yielded on average 325kg/ha more than the retained areas (table 6). Though not reflected in early plant counts it was apparent that establishment was poorer in retained plots and the impact of root disease on growth also appeared to be worse however this observation was not quantified.

Table 6. Yield responses between burnt and unburnt treatments.

	Yield t/ha
Burnt	2.838
Unburnt	2.513
L.S.D	0.2496
C.V	4.6
f value	0.034

There was no burning and fungicide interaction however there were significant yield increases from the application of fungicide over the untreated control (table 7). The yield increases tended to correspond to the increase in disease control however it was not true for all treatments. Amistar followed by Tilt, Prosaro followed by Tilt and a late Prosaro all yielded more than the untreated control returning 223-392kg/ha (8.8-15.5%) more.

Table 7. Yield responses of fungicide strategies compared to the untreated control.

TOA1 (Z32)	TOA2 (Z37)	Average Leaf Infection (t/ha)
Amistar	**Tilt**	2.833
Tilt	**Tilt**	2.667
Prosaro	**Tilt**	2.917
	Tilt	2.622
	Prosaro	2.748
Tilt		2.683
Amistar		2.547
Prosaro		2.685
UTC		2.525
L.S.D		0.2161
C.V		8.4
F-value		0.025

Grain Quality

Grain protein was on average 0.51% higher in the retained plots over the burnt plots (8.8% vs 8.3%) (table 8) which was statistically significant. There was no fungicide interaction on grain protein. Screenings through a 2.5mm screen were significantly lower in all fungicide treatments compared to the untreated control, there was no difference between product or fungicide strategy. Screenings were 2.5-4.2% lower in fungicide treatments than in the untreated control.

Table 8: Grain quality and fungicide treatment interactions

TOA1	TOA2	Screenings (2.5mm)	Protein
Amistar	Tilt	4.57	8.49
Tilt	Tilt	4.67	8.40
Prosaro	Tilt	3.71	8.31
	Tilt	4.98	8.19
	Prosaro	4.56	8.39
Tilt		5.40	8.91
Amistar		5.01	8.52
Prosaro		5.34	8.74
UTC		7.92	8.71
L.S.D		**1.741**	**0.61**
C.V		**9.8**	**2.4**
F-value		**<0.001**	**0.04**

Barley Head Loss

Harvested areas and unharvested areas were located side by side and head loss was assessed post-harvest on the 5th January. There was no significant difference between burnt and retained areas in total head loss (Table 9). Subsequently there was no significant difference in head loss numbers in the unharvested areas between any treatment and the untreated control. Head loss numbers were still relatively high, however no treatment effect was able to reduce the total numbers. A late Prosaro spray was found to significantly reduce the amount of head loss in the harvested treatments. Potentially there is some degree of interaction happening as head loss in the unharvested plots was lower in the late Prosaro treatment (though not significantly).

Table 9: Average number of heads in a metre row recorded in the harvested and unharvest section of trial plots on the 5th of January 2018

TOA1	TOA2	Harvested Head Loss (head/m row)	Unharvested Head Loss (head/m row)
Amistar	Tilt	8.8	11.0
Tilt	Tilt	9.2	13.5
Prosaro	Tilt	8.0	15.3
	Tilt	8.3	14.6
	Prosaro	5.5	9.7
Tilt		7.8	11.5
Amistar		7.7	12.9
Prosaro		7.8	14.4
UTC		9.2	13.8
L.S.D		**2.1**	**4.8**
C.V		**14.1**	**17.9**
F value		**0.07**	**0.5**

Economics

All treatments aside from a single early application (Z32) of Amistar gave a higher economic return than the UTC (table 10). The top three performers were those that yielded significantly higher than the untreated control and resultantly gave a higher economic return. The best performing treatment of an early Prosaro followed by a late Tilt returned an additional $62/ha over the UTC. Burning again gave an economic advantage over retained stubble returning an additional $75/ha more than the retained stubble areas.

Assumptions for the economic analysis are an application cost of $5/ha and a price of $70/L for Prosaro, $38/L for Amistar xtra and $12/L for Tilt. Wheel track damage was not taken into account in this analysis but can be considered to be around 2.5% (machine dependant). The price of feed barley averaged $233/t for the year FIS in Kwinana.

Table 10: Economic returns from various fungicide strategies

TOA1	TOA2	Gross Return ($/ha)	Cost ($/ha)	Net Return ($/ha)
Prosaro	Tilt	679.7	29.4	650.3
Amistar	Tilt	660.1	30.6	629.5
	Prosaro	640.3	19.0	621.3
Tilt		625.1	10.4	614.7
Prosaro		625.6	19.0	606.6
Tilt	Tilt	621.4	20.8	600.6
	Tilt	610.9	10.4	600.5
UTC		588.3	0.0	588.3
Amistar		593.5	20.2	573.3

Discussion of Results

Despite being a barley on barley crop low disease levels were present throughout the trial early even after significant amounts of pre-growing season rainfall. Unlike the 2016 season, in 2017 the whole paddock was burnt aside from the retained plots in the trial in an attempt to differentiate the disease pressure between the retained and burnt stubble without outside inoculum sources from the rest of the paddock.

No significant differences were observed in total disease infection between burnt and retained areas again throughout the 2017 season. It appears that the disease incidence and severity was too low to allow for a difference. It is possible that significant summer and autumn rainfall caused formation and release of spores on stubble, possibly diminishing inoculum for the growing season. For the 2017 season, the dry conditions post emergence limited inoculum production and infection opportunities, limiting disease development at seedling and tillering growth stages. Total disease was low at the site, 3% total leaf infection following time of application one (TOA1) and 6% total leaf infection following time of application two (TOA2). Prophylactic spraying for STNB was shown not to be beneficial to final control levels. Though significant reductions in disease severity were observed from the spraying at Z32, the lack of disease early meant that these sprays did little to reduce the spread of the disease in the crop. Sprays at flag-1 (Z37) were more effective at reducing disease and provided a significant reduction in disease when either a single spray was applied at flag-1 or the flag-1 spray was applied following a Z32 spray. On the most infected leaf (flag-2) this resulted in a reduction from 8% to <3%.

Despite low disease pressure, significant yield and quality responses were achieved by managing disease with fungicide. Amistar and Prosaro with the addition of a later application of Tilt or a late single application of Prosaro were the only combinations which returned a yield significantly greater than the UTC. Surprisingly the late spray of Tilt and the two sprays of Tilt did not significantly increase the yield but controlled disease to a similar level as the aforementioned combinations. Burnt areas yielded on average 325 kg/ha more than the retained areas. It is unlikely that this difference was driven by leaf disease as levels were similar across the site.

Grain quality was influenced by spraying, all fungicides reduced the level of screenings to a similar extent and a yield dilution from burnt areas resulted in lower protein. None of the quality differences however had any impact on the receival grade of the grain. Head loss was not influenced by the application of fungicides or the burning of stubbles.

Controlling disease did provide a positive economic response even though infection levels were low. Prosaro followed by Tilt and Amistar followed by Tilt gave the best economic responses with returns of an additional $62/ha and $41/ha compared to the untreated control. The two spray approach with Tilt did not give a significant economic response though disease control was similar to the other products, potentially some additional green leaf retention from the premium products may have contributed to this difference. This suggests that an approach incorporating a single application at flag-1 to flag emergence (Z37-39) under low disease pressure or a 2-spray approach with greater early season disease pressure can be effective and economically viable.

The greatest response in the trial was to burning stubble which delivered additional yield gain and an economic response of $75/ha. There was no clear interaction between burning and disease. The yield was likely gained from other interactions. The utilisation of burning is a recognised approach to reducing stubble borne disease inoculum and can reduce disease pressure, however with susceptible varieties and in favourable environments it is unlikely to totally remove requirement for fungicide but will contribute to reducing the number of sprays required.

These are important messages given the recent detections of fungicide resistant STNB and NTNB in WA highlighting the need to maximise response to fungicide application and to utilise rotation of fungicide products where possible. Given the relatively lesser yield response of propiconazole (Tilt) in 2017, consideration of which product should be utilised at which spray timing in medium to lower rainfall environments should continue to be explored.

Conclusion

Growers, advisors and the wider barley industry are the key beneficiaries of this research. Being able to manage disease to maintain grain quality, yield and economic returns to the grower is critical for a competitive barley industry.

In seasons with below average rainfall early post emergent, the buildup of disease is slower in the crop canopy. This trial found that early disease levels were low even on a tight barley on barley rotation. In seasons with low early disease pressure there is less likely to be an economic response an early fungicide spray at Z32.

As the season progressed the disease levels increased in response to a wet spring infecting the top 3 leaves of the crop canopy (Flag, F-1 and F-2) however it was still low overall (6% total infection in the UTC). Fungicides applied at F-1 and two spray approaches incorporating this timing with an application 3 weeks earlier gave the greatest economic response ($25-$60/ha). In 2017 STNB management was all about protecting the top 3 leaves of the crop canopy.

In the medium rainfall zone it is important to be tactical in the management of STNB. The strategies used in wet seasons where inoculum levels are high will be different to the most profitable strategy in low disease pressure seasons.

With the dry conditions early in the season we found that burning stubble provided no additional reduction in early disease levels. However, the barley yielded an additional 325kg where the stubble was burnt vs retained, similar results were also observed in 2015. Given that there was little difference in leaf disease pressure this yield response must be due to other factors (eg, mineralised N, soil water relations or improved seed bed).

In 2017 we found that there was no interaction with barley head loss and disease pressure either with fungicide strategy or stubble management.

Implications

In the medium rainfall zone it is important to be tactical in the management of STNB. The strategies used in wet seasons where inoculum levels are high will be different to the most profitable strategy in low disease pressure seasons.

Disease management strategies vary from nil to a single treatments of $10/ha including application up to $30/Ha including application with a two spray strategy. Growers in the medium rainfall zone need to know which strategy to adopt depending on seasonal conditions and disease pressure and the likely economic impact.

Our research has shown that by protecting yield potential through good management of STNB an additional $65/Ha can be made, and this was in a low disease pressure season. In high disease pressure seasons the benefit of good disease management to growers and industry is likely to be significant.

Our research has also shown that there is no link between disease pressure and fungicide strategy on pre-harvest head loss in barley. Anecdotally growers thought there may have been a link, however this research highlights that other management tools are required to limit pre-harvest head loss.

Recommendations

This research highlights how important a tactical approach to STNB management is in the medium rainfall zone. In dry seasons there is lower disease pressure, resulting in a potentially expensive fungicide strategy which can be marginal in returns. Conversely, where there is high disease pressure usually from wet conditions early in the season, then a double spray strategy can improve grain quality, yield and returns to the grower.

Where growing barley on barley, growers should budget for a fungicide spray at Flag-1 every year to protect the top 3 leaves in the canopy. Where conditions are wet early post emergent (especially if stubble is retained) allowing early disease pressure and high yield potential then a fungicide spray at Z31-Z32 can reduce disease pressure and protect the canopy until the Flag-1 spray is applied.

Burning barley stubble prior to planting barley on barley has shown to increase yield buy between 325 and 400 kg in 2017 and 2015. While removing stubble can reduce early disease pressure, not all of the yield increase can be accounted for by disease. Other factors are involved that may require additional work to understand (N mineralization, allelopathic impacts of stubble or improved seed bed). Where erosion risk is low growers should consider burning to remove barley stubble if planting consecutive barley crops. Burning stubble will also help to reduce the selection pressure for fungicide resistance.

We feel that there is no further work required to investigate the hypothesized link between STNB levels and pre-harvest head loss.

Glossary and Acronyms

Below is a sample Abbreviations and Acronyms list. Be sure to include on this page all abbreviations and acronyms that appear in the report

DAFWA	Department of Agriculture and Food, Western Australia
DAP	di ammonium phosphate
DArT	Diversity Arrays Technology
DAT	days after treatment
Db	bulk density
DAFWA	Department of Agriculture and Food, Western Australia

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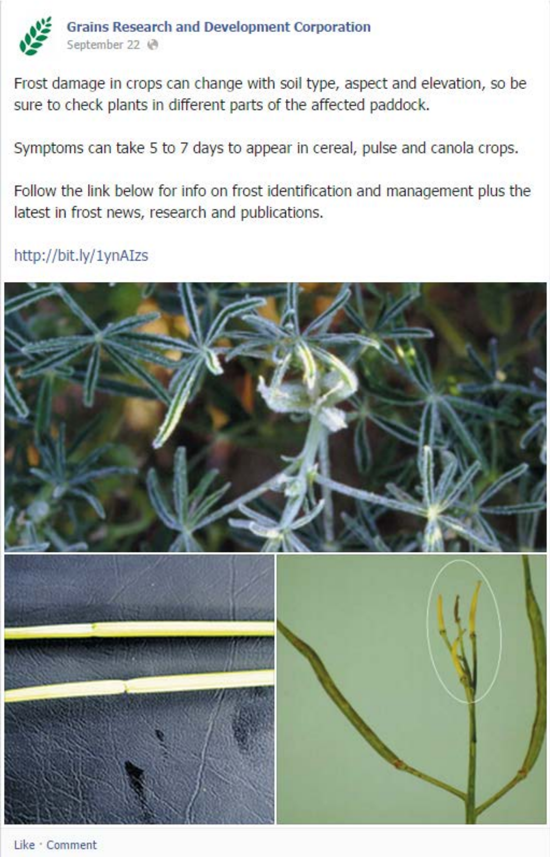

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