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**

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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.

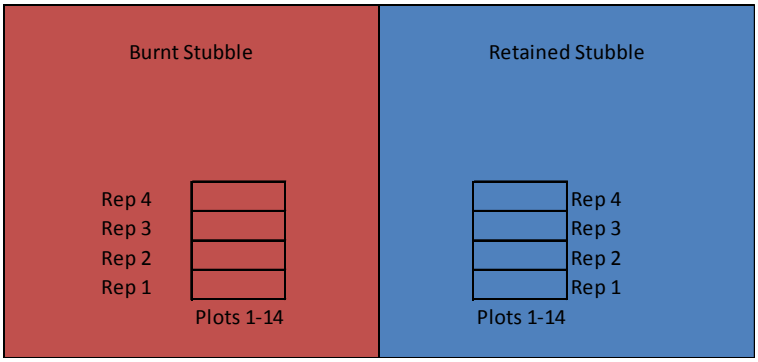

Figure 1. Paddocks and trial layout. Half paddock burnt and half retained stubble. **Image 1 Satellite Aerial shot of trial site harvest 2015**

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).

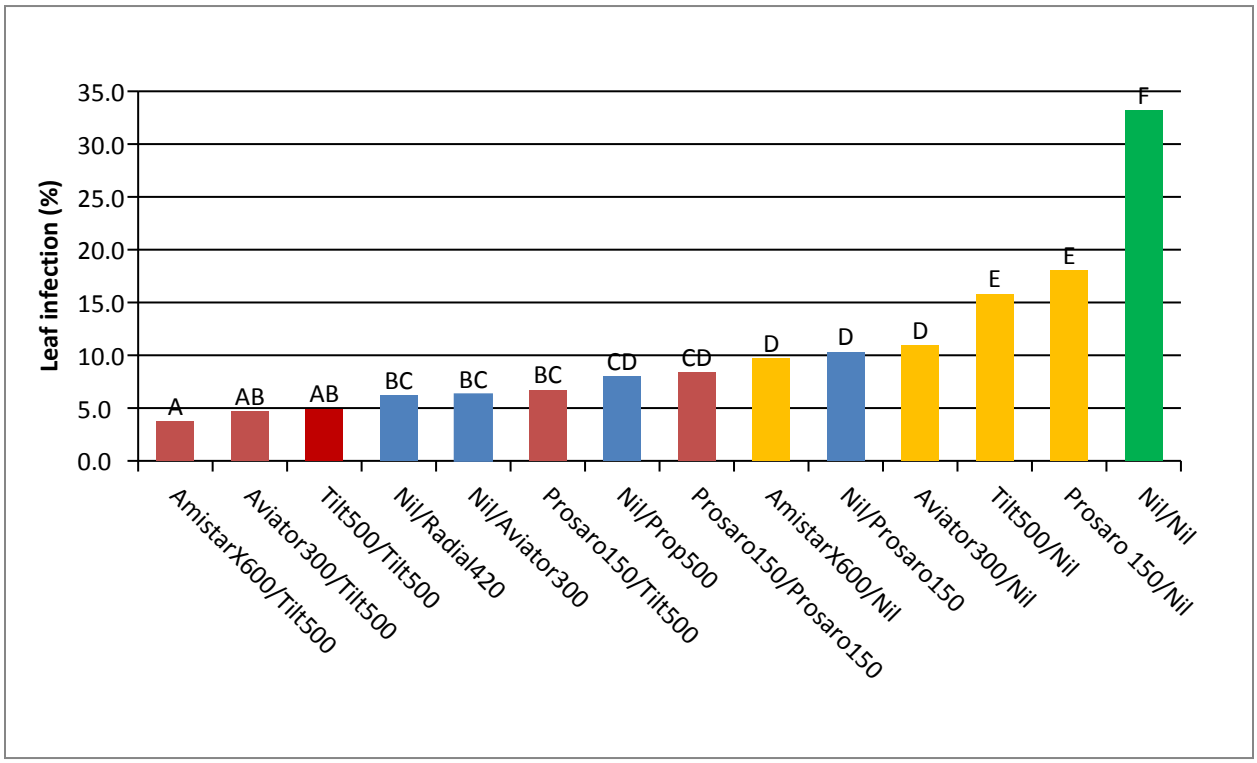

Figure 1: Impact of fungicide timing and product on leaf area affected by spot type net blotch in retained stubble trial, average area affected on Leaf 2-4, assessed 3 weeks after Z37 fungicide application.

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.

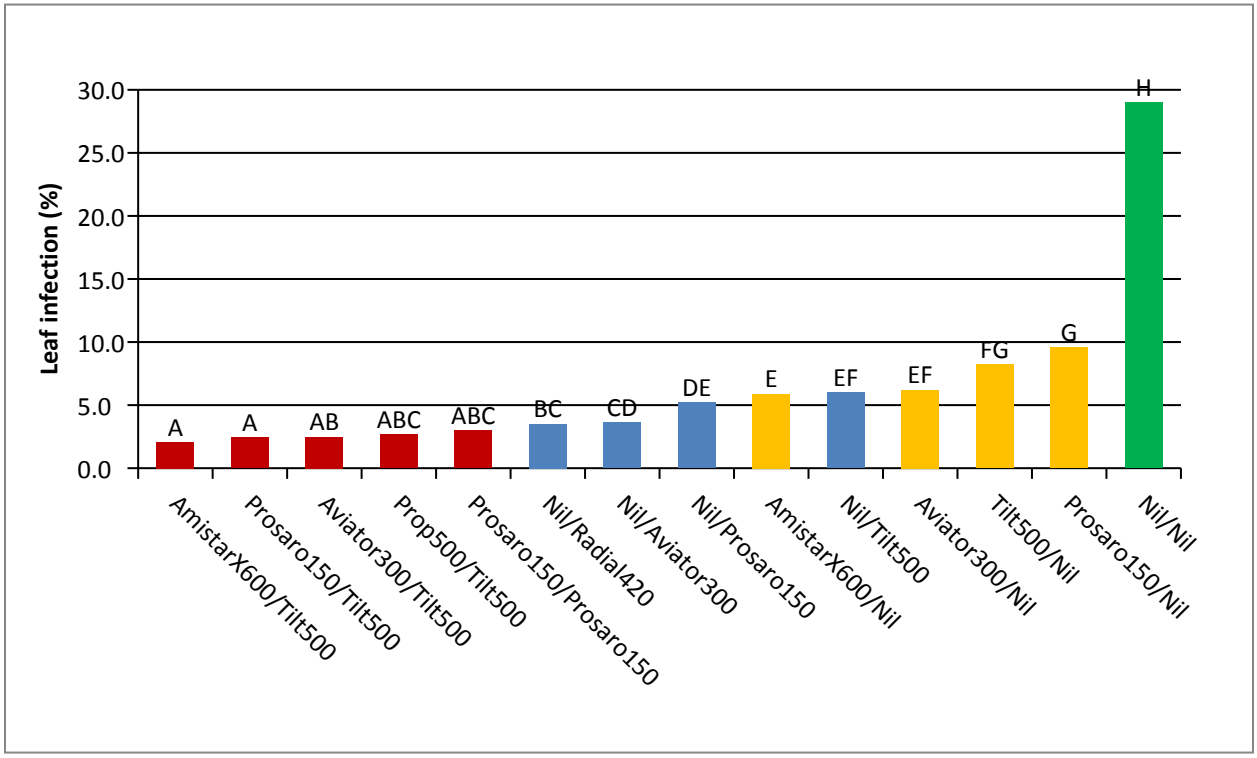

Figure 2: Impact of fungicide timing and product on leaf area affected by spot type net blotch in burnt stubble trial, average area affected on Leaf 2-4, assessed 3 weeks after Z37 fungicide application).

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.

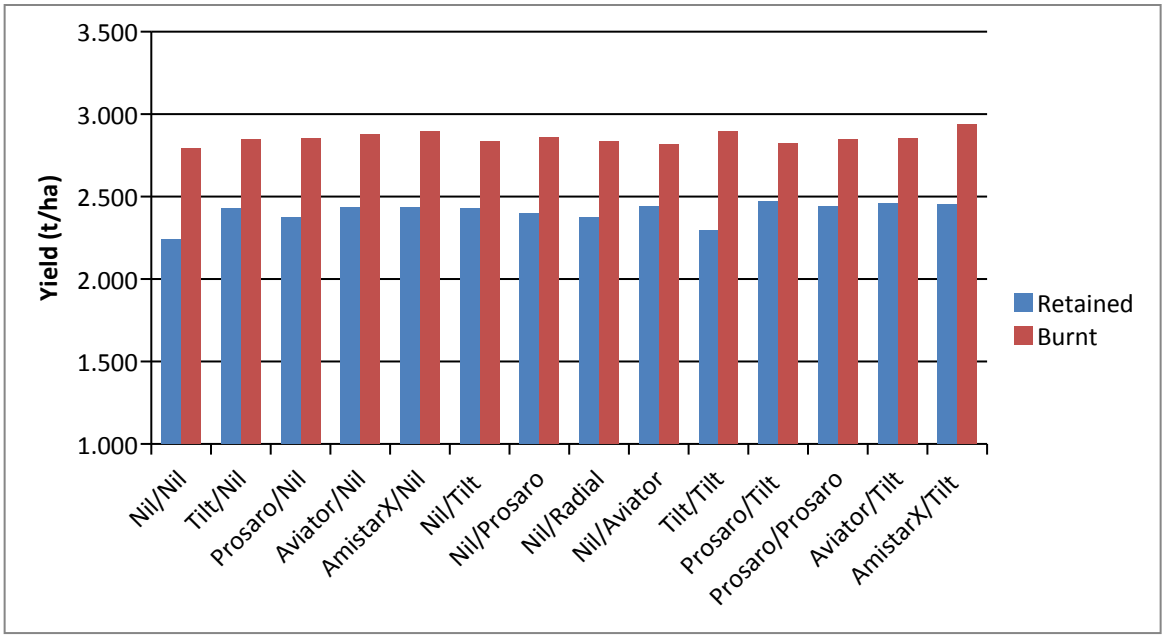

Figure 3. Grain Yield differences between burnt and retained stubble trials.

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.

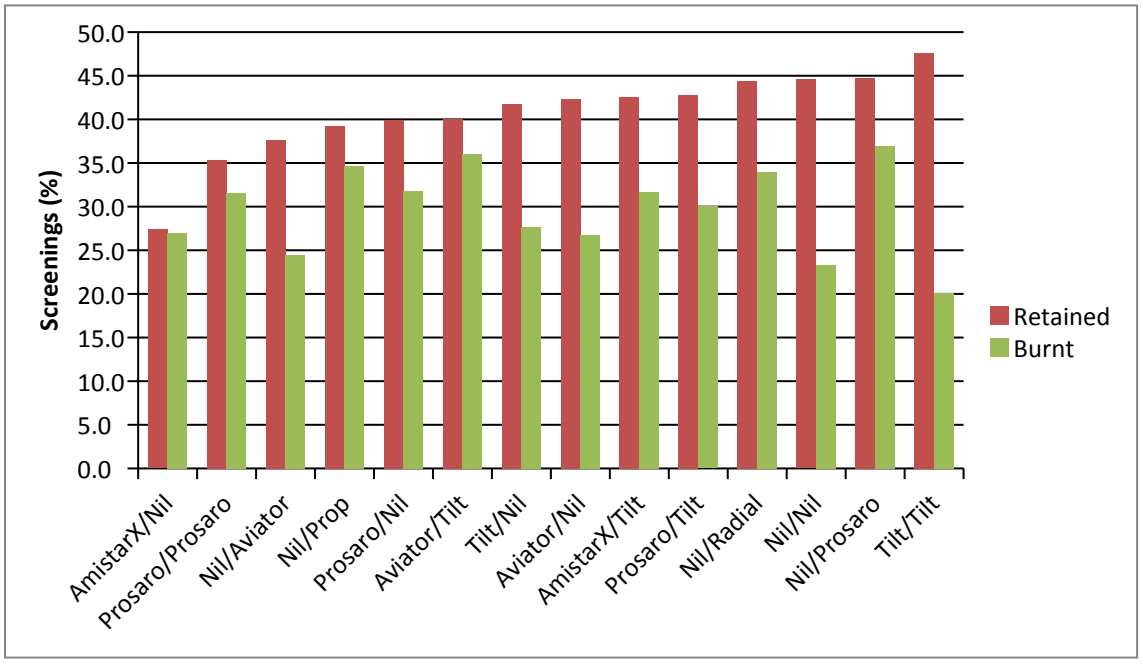

Figure 4. Screenings differences between treatments in burnt and retained stubble trials.

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.

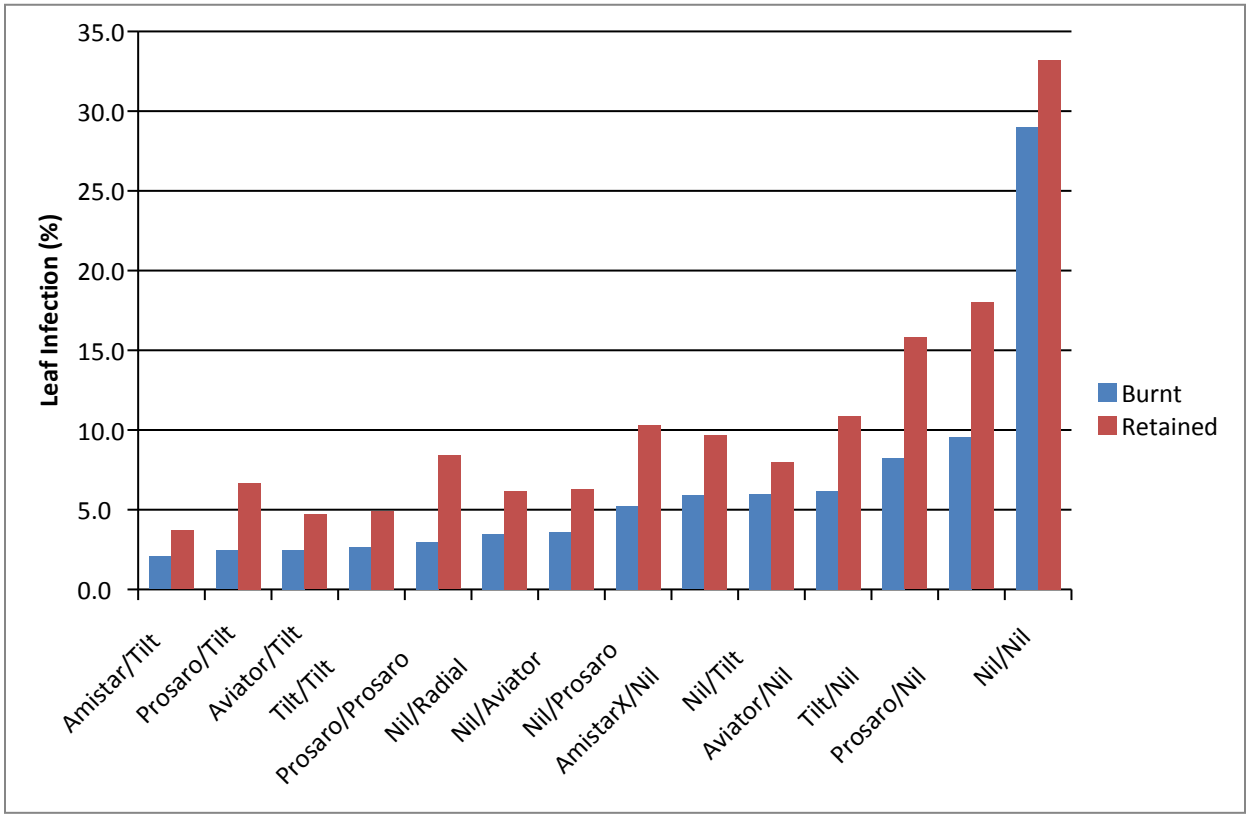

Figure 5. Leaf infection differences between burnt and retained stubble trials. Three weeks after Z37 application

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.

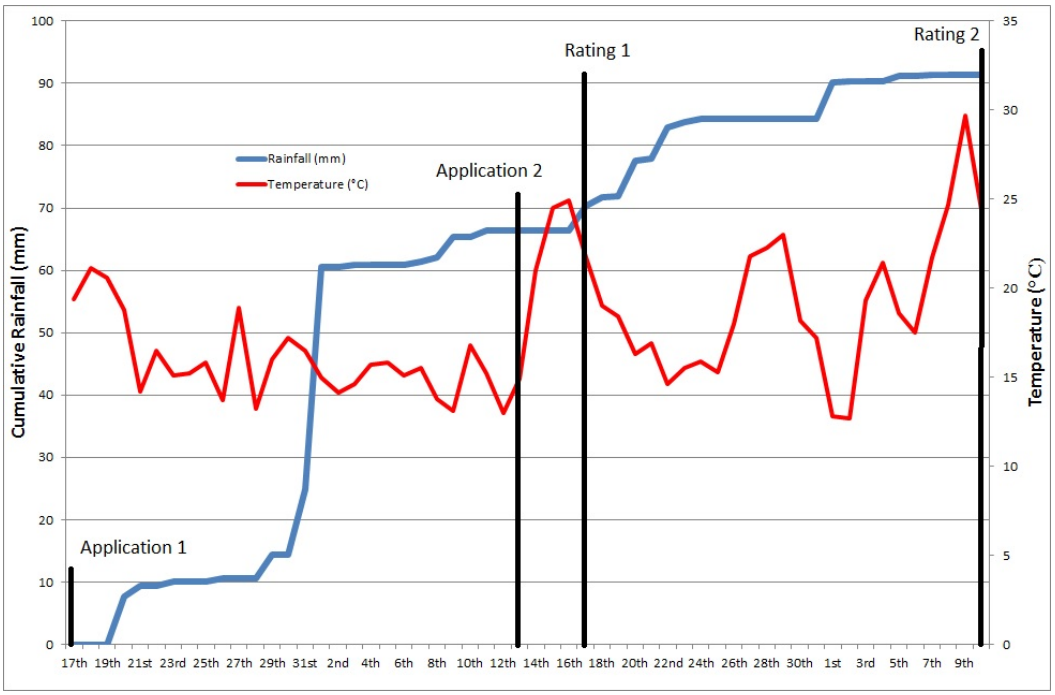

Figure 6. Rainfall and temperature in Corrigin 2015. Dates of fungicides application and leaf score ratings.

Figure 7A. Visual Images comparing leaf scores