Final Technical Report

AGC00005 – Impact of N Placement and timing on crop yield and ryegrass population.

Project code:	**AGC00005**
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Abstract

The need to maximise nitrogen fertiliser uptake is paramount to profitable cropping in the western Riverina. As a result, growers are investing in seeding technology that applies nitrogen under the seed row. Further evidence is needed to show how this approach to nitrogen placement has benefits other than yield, such as increased crop competition and reduced ryegrass seed set.

Two small plot trials, one with no pre-emergent herbicide application and one with a pre-emergent herbicide, were conducted each year for two seasons to compare the impact of nitrogen placement on wheat competitiveness against ryegrass. Each trial consisted of eight nitrogen treatments, all with a total of 50kg nitrogen applied either pre-drilled, split shoot at sowing or topdressed at various stages, and replicated three times. The effects of treatments on yield as well as ryegrass seed set were measured.

Dry seasonal conditions impacted results in both years, making it difficult to draw conclusions in terms of the effect of nitrogen placement, as well as the spreading timing on the ryegrass population at harvest. If nitrogen is to be applied split shoot at sowing, rates need to be low enough not to negatively impact early crop growth and vigour. This trial reinforced the importance of pre-emergent herbicides in reducing ryegrass numbers.

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Executive Summary

Maximising nitrogen fertiliser uptake is paramount to profitable cropping in the western Riverina. Ensuring crops have an advantage over weeds when accessing this nitrogen is an essential component of increasing nitrogen utilisation efficiency. Many growers in the region are investing in seeding technology that applies nitrogen under the seed row. This system has many benefits over top dressing/spreading then incorporating by sowing, and further evidence is needed to show that this approach to nitrogen placement has benefits other than yield, such as increased crop competition and reduced ryegrass seed set. Gaining a better understanding and measuring the effect of N placement on weed numbers would promote further investment into practices that not only lead to higher N utilisation and crop yield, but also lower weed seed set following harvest.

Two small plot trials, one with no pre-emergent herbicide and one with a pre-emergent herbicide, were conducted to gain a better understanding of the effects of applying nitrogen under the seed row versus top dressing or spreading then incorporating by sowing on grain yield and ryegrass seed set. Each trial consisted of eight treatments, all with a total of 50kg nitrogen applied either pre-drilled, split shoot at sowing or topdressed at various stages, and replicated three times over two years. The drilling tines were Dutch double shoot openers, allowing a separation between 2-3cm of seed and fertiliser. Topdressing stages were 1-2 leaf, first node, early tillering and heading.

The trials were conducted over the 2017 and 2018 growing seasons. Both seasons experienced below average growing season rainfall, with 2017 also experiencing prolific frosts in August and 2018 drought conditions persisted. These conditions impacted on crop growth and performance, making it difficult to see any visual differences between the treatments and determine any treatment effects, particularly in 2018.

In 2017 crop establishment and vigour were adversely affected by the split shoot treatments, and as a result, ryegrass populations were higher in these treatments. This demonstrates the importance of placement of seed relative to fertiliser in split shoot systems and ensuring good crop establishment to help compete with weeds. Ensuring good separation of seed and fertiliser in the split shoot treatments will also allow the growers to effectively apply nitrogen fertiliser in a one pass operation at sowing, increasing efficiencies and eliminating another paddock pass. 50kg N/ha split shoot was too high in this trial, and as a result there was less competition for ryegrass. In 2018 there were no obvious treatment differences impacting on establishment and crop vigour, and no significant differences between any of the treatments for ryegrass numbers, grain yield and quality.

The timing of nitrogen application in the western farming system is important. Although in 2018 there were no significant differences between placement and timing of nitrogen, 2017 highlighted the importance of effectively applying nitrogen early in the season. The trial showed topdressing nitrogen fertiliser up to first node increased yield comparable to predrilling and was more important than the method of application in 2017. The lack of effective rain following topdressed nitrogen in 2017 and 2018 impacted on the results, with no significant differences in weed survival and prevalence by applying nitrogen post sowing.

Pre-emergent herbicides are an important part of weed management. The addition of a pre-emergent herbicide in 2017 and 2018 reduced ryegrass numbers and increased grain yield across all treatments compared to where no pre-emergent herbicide was applied. This was expected as early season weed pressure and crop competition is reduced with pre-emergent herbicides.

The observations made throughout the trials have implications to further this research for the benefit of the farming community. If we are able to show the positive effects that nitrogen placement and timing have on not only yield but also on weed seed set, it would encourage growers to invest into more efficient nitrogen application strategies.

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Background

Nitrogen (N) has become one of the major limitations in broadacre farming in SNSW. Approximately 85% of soils sampled in 2017 had less than 35kg N/ha in the top 60cm of topsoil. This has been a similar case over the past 3-5 years, and has led to widespread nitrogen fertiliser use, otherwise uncommon in lower rainfall environments.

Many growers in the region are investing in seeding technology that applies nitrogen under the seed row. This system has many benefits and further evidence is needed to show that this approach to nitrogen placement has benefits other than yield. Increased grain yield and crop competition along with a reduction in ryegrass seed set are all benefits of using nitrogen under the seed row versus top dressing or spreading then Incorporating by Sowing (IBS).

Research by Rohan Rainbow in the late 1990's, as part of the GRDC funded project 'Operation FerTill', looked at optimum fertiliser placement when sowing wheat. Whilst a lot of research exists on nitrogen responses in cereals, there is minimal data on the impact of nitrogen timing and placement on weed survival and subsequent weed seed numbers at harvest. As a result, many growers are now asking the question of the effect of nitrogen timing and placement on weed numbers at harvest, with particular emphasis on ryegrass.

It is well noted that topdressing nitrogen onto weedy paddocks compared to drilling split shoot under the seed increases weed survival and prevalence through to harvest, which leads to higher weed numbers into future rotations. Gaining a better understanding and measuring the effect of N placement on weed numbers would help further investment into practices that not only lead to higher N utilisation and crop yield, but also lower weed seed set following harvest. Similar research has been performed in SA on brome grass, which has been followed with interest by Ag Grow Agronomy staff and our clients, and it is assumed similar outcomes may be applicable for NSW low rainfall farmers for ryegrass.

In 2017, Ag Grow Agronomy conducted trials to investigate the effects of applying nitrogen under the seed row versus top dressing or spreading then IBS on grain yield and ryegrass seed set to answer these questions. Growing conditions in 2017 were not favourable, with severe frosts and well below average growing season rainfall. This impacted on the effectiveness of topdressed nitrogen and crop performance. Results from 2017 showed that 50kg N/ha as urea split shoot at sowing was too high, causing less crop competition against ryegrass and more ryegrass panicles at harvest. It also showed that the addition of a pre-emergent herbicide decreased annual ryegrass. Although the season was tough in 2017 it showed the importance of applying nitrogen early in the season, with yields greater where nitrogen was applied up to the first node stage.

2018 was the second year of the trials, allowing a better understanding of the effect of N placement on weed numbers, over multiple growing seasons. This also allowed us to fine tune best management practices that not only lead to higher N utilisation and crop yield, but also lower weed seed set following harvest.

Project objectives

The aim of the trial was to gain a better understanding of the benefits, in terms of increased yield, increased crop competition and reduced ryegrass seed set when using nitrogen application under the seed row versus top dressing or spreading then Incorporating by Sowing (IBS).

The main objectives of the trials were to assess the effect of nitrogen placement and timing on ryegrass populations at harvest.

The trial consisted of 8 treatments, all of which had a total of 50 kg nitrogen applied either pre-drilled, split shoot at sowing or topdressed

The trial ran over two seasons, both of which had their challenges in terms of unfavourable seasonal conditions.

Methodology

In 2017 and 2018, a set of two trials were established in May of each year at 'Ridge Top' near Beelbangera, 16km NE of Griffith in southern New South Wales.

The first trial had a pre-emergent herbicide applied (1.6L/ha Treflan plus 1.6L/ha Avadex® Xtra) before sowing, and the second trial had no pre-emergent herbicide applied before sowing. This was to ensure an effective comparison between treatments and ryegrass numbers, with both a positive and negative pre-emergent control. 2L/ha of Glyphosate was applied across both trials before sowing. Pest and disease control was undertaken on the trials as needed, and appropriate weed control was undertaken post trial. The management and operations of the trials in 2017 and 2018 are shown in table 1.

Table 1: 2017 and 2018 Trial Management and Operations

Operations/Management		2017	2018
Soil test data	Soil type	red brown sandy loam	red brown sandy loam
	Organic Matter	1.8%	0.6%
	Total N (0-60cm)	41kg N/ha	83kg N/ha
	pH ($CaCl_2$)	4.9	4.9
	P (Colwell P)	57ppm	69ppm
Sowing details	Date	2nd May	7th May
	Variety	Beckom Wheat	Mustang Wheat
	Sowing Rate	30 kg/ha	35 kg/ha
	Starter Fertiliser	80 kg/ha MAP	80 kg/ha MAP
Harvest		21st November	30th October

Treatments: Both the pre-emergent and no pre-emergent trials compared 8 nitrogen treatments, The treatments were replicated three times, each with their own randomised complete block design. The treatments in each trial were:

1. 50kg N Pre drilled
2. 50kg N Split shoot at sowing
3. 50kg N spread 1-2 leaf
4. 50kg N spread early tiller
5. 50kg N spread 1st node
6. 50kg N spread heading
7. 25kg N Predrilled + 25kg N spread 1st node
8. 25kg N Split shoot + 25kg N spread 1st node

With the split shoot treatments (treatments 2 and 8), the expected separation of the seed and nitrogen fertiliser was between 2-3cm. This is usually slightly more than similar units operating commercially, as small plots are sown at slower speeds. Commercially, separation is closer to 2cm.

Assessments: The assessments carried out on the trials included:

1. A soil test for total soil N
2. Establishment score
3. Ryegrass weed count at first node
4. Ryegrass panicle count at harvest
5. Grain yield and quality data
6. Yield data analysed by biometrician.

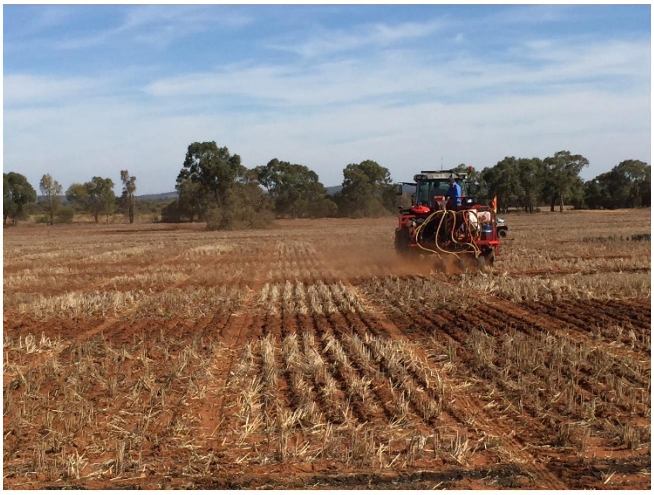

Figure 1: Sowing of the Impact of N Placement and timing on crop yield and ryegrass population trial, 7th May, 2018.

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 "Ridgetop", Beelbangera	-34.189140	146.092010
Nearest Town	Griffith, NSW 2680	
Trial Site #2		
Nearest Town		

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	
Impact of N Placement and timing on crop yield and ryegrass population.	Northern Region 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

Seasonal conditions: The trial was conducted over 2 seasons. Both seasons had their challenges, which impacted on the trial results. Growing season rainfall (1st April to 30th September) was well below average in both years, with 92mm falling in 2017 and 75mm in 2018, table 2. In both years the trial was conducted rain occurred late in the season, benefiting grain fill of later sown crops, unfortunately too late to benefit the trials.

2017 also experienced prolific frosts throughout August, with temperatures as low as -4.7°C on the 20th and -5.2°C on the 28th August in the paddock (data taken from temperature loggers placed at wheat head height in a semi enclosed plastic drum at Rankins Springs). These frost events were 11 hours and 12 hours in duration, respectively. In 2018 Drought conditions were experienced, with the season characterised by high temperatures and low rainfall, with only 221mm rain falling for the year.

Table 2: Monthly Rainfall (mm) - Griffith Airport 2017 and 2018 compared to the long-term average.

Rainfall Data - Griffith Airport			
Month	**2017**	**2018**	**Long Term Average (1958-2018)**
January	18	17.6	33.7
Februray	7.4	2.2	28.5
March	48.8	2.6	35.2
April	21	0.4	27.1
May	28.6	19	35.1
June	2.2	33	35.3
July	13.4	8.2	33.5
August	26.6	6.4	35.2
September	0	8	33
October	55	48.8	38.5
November	23.4	52.8	34
December	100.6	21.8	33.7
TOTAL	345	220.8	397.6

Establishment: Establishment was scored from 0 to 9, with 0 being very poorly established and uneven and 9 being very evenly established.

2018 results - In 2018 the trial took a long time to establish, after a very dry start to the season. Establishment scores were taken 27th June, when the crop was at the 1-3 leaf stage, figure 2. Topdressing at the 1-2 leaf was also undertaken at this time. Both the nil and plus pre-emergent trials established well with establishment scores ranging from 7.8 to 8.7, with no obvious treatment differences at establishment for crop vigour.

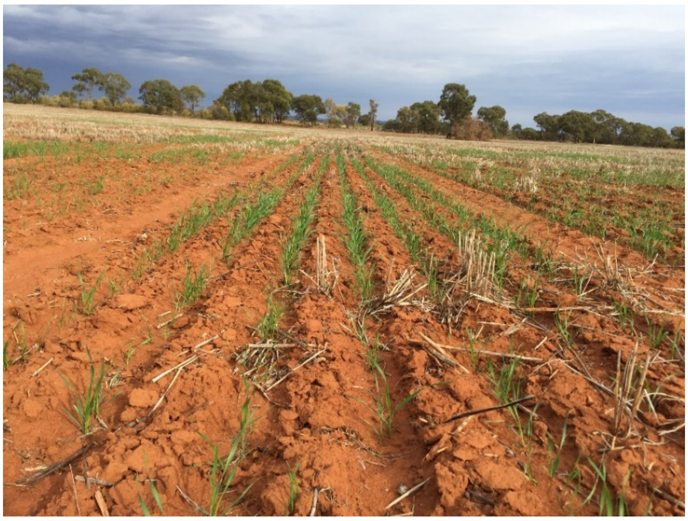

Figure 2: Establishment of the Impact of N Placement and timing on crop yield and ryegrass population trial, 27th June, 2018.

2017 results - Establishment scores were taken 31st May, when the crop was at the 3-5 leaf stage. There were minor visual differences between treatments at establishment. The split shoot application treatments had some fertiliser burn, however the differences were minimal. The average establishment score of the plus pre-emergent trial was 5.7 and the average establishment score of the nil pre-emergent trial was 6.3. Establishment scores ranged from 5 for the 50kg N split shoot at sowing treatment to 7 for the 50kg N pre-drilled treatment. Table 3 shows the Establishment scores of the plus pre-emergent and nil pre-emergent trials in 2017. For crop vigour results see appendix A.

Table 3: Establishment scores of the plus pre-emergent and nil pre-emergent trials, 31st May 2017 at 3-5 leaf stage.

TREATMENT	Establishment Score	
	Plus Pre-emergent	**Minus Pre-emergent**
PreDrill_50	5.7	7.3
Split_Pre_25_Node1_25	6	6
Split_Shoot_25_Node1_25	5.3	5.7
Split_ShootSow_50	5.7	5
Spread_50_2leaf	6	6.3
Spread_50_Etill	5.7	6.3
Spread_50_Head	5.3	6.7
Spread_50_Node1	6	7
Mean	5.7	6.3
LSD (p=0.05)	n.s	1.17

Ryegrass numbers: Ryegrass density was assessed in both trials at first node and again before harvest. As well as a ryegrass count, a weed density score (0-9) was also taken on each plot, with 0 having no weeds and 9 full of weeds. Ryegrass populations were higher both years where no pre-emergent herbicide was applied.

2018 results - Figure 3 shows the ryegrass density at the first node stage in both the plus and nil pre-emergent trials and figure 4 shows the density before harvest in both the plus and nil pre-emergent trials.

Figure 3: Ryegrass density at first node plus pre-emergent (left) & nil pre-emergent (right)

 

Figure 4: Ryegrass density before harvest plus pre-emergent (left) & nil pre-emergent (right)

Table 4 shows the ryegrass density scores at first node and at harvest, and Table 5 shows the ryegrass population at the first node stage and again at harvest, with ryegrass panicles counted, for the plus pre-emergent and nil pre-emergent trials.

Table 4: Ryegrass density scores for the plus and nil pre-emergent trials for 2018 at first node (28.08.2018) and at harvest (30.10.2018).

TREATMENTS		Plus Pre-emergent		Nil Pre-emergent	
		First Node Ryegrass Density Score	Harvest Ryegrass Density Score	First Node Ryegrass Density Score	Harvest Ryegrass Density Score
Trt1	50kg N Pre drilled	1	1	4	5
Trt2	50kg N Split shoot at sowing	1	2	2	6
Trt3	50kg N spread 1-2 leaf	1	2	2	5
Trt4	50kg N spread early tiller	1	2	2	4
Trt5	50kg N spread 1st node	1	2	2	4
Trt6	50kg N spread heading	1	2	2	4
Trt7	25kg N Predrilled + 25kg N spread 1st node	1	2	2	4
Trt8	25kg N Split shoot + 25kg N spread 1st node	1	2	3	5
	Average	***1***	***2***	***2***	***5***

Table 5: Ryegrass numbers and panicle counts for the plus and nil pre-emergent trials for 2018 at first node (28.08.2018) and at harvest (30.10.2018).

TREATMENT		Nil Pre-emergent		Plus Pre-emergent	
		Weed Count first node (weeds/m2)	Ryegrass Panicle count (panicles/m2)	Weed Count first node (weeds/m2)	Ryegrass Panicle count (panicles/m2)
Trt1	50kg N Pre drilled	50.5	61.7	4.4	3.5
Trt2	50kg N Split shoot at sowing	45.3	62.6	4.3	18.3
Trt3	50kg N spread 1-2 leaf	47.2	60.0	8.4	15.2
Trt4	50kg N spread early tiller	42.8	64.3	3.3	13.9
Trt5	50kg N spread 1st node	32.8	44.2	7.4	19.5
Trt6	50kg N spread heading	41.0	64.4	10.5	16.5
Trt7	25kg N Predrilled + 25kg N spread 1st node	45.5	53.2	8.6	7.6
Trt8	25kg N Split shoot + 25kg N spread 1st node	46.6	77.9	5.1	7.2
	mean	***44.0***	***61.0***	***6.5***	***12.7***
	lsd (p=0.05)	***ns***	***ns***	***ns***	***ns***

There were no significant differences between treatments for ryegrass numbers at the first node stage or at harvest in both the nil pre-emergent and plus pre-emergent trials. At the first node stage, the average ryegrass population in the plus pre-emergent trial was 7 ryegrass plants/m^2 and the average weed density score was 1. At harvest, the average ryegrass panicles were 13 panicles/m^2.

Without the addition of a pre-emergent herbicide, the average ryegrass population at the first node stage was 44 ryegrass plants/m^2, and the average weed density score was 2. At harvest, the average ryegrass panicles/m^2 were 61 panicles/m^2.

2017 results - Ryegrass populations were significantly higher in the nil pre-emergent trial. Table 6 shows the ryegrass numbers at first node and at harvest.

Table 6: Ryegrass numbers, density scores and panicle counts for the plus and nil pre-emergent trials in 2017 at first node and at harvest

Treatments		Plus Pre-emergent			Nil Pre-emergent		
		Weed Count first node (weeds/m2)	Density Score first node	Ryegrass Panicle count (panicles/m2)	Weed Count first node (weeds/m2)	Density Score first node	Ryegrass Panicle count (panicles/m2)
Trt1	50kg N Pre drilled	27	2.7	28	113	5.7	56
Trt2	50kg N Split shoot at sowing	51	4	63	221	8.7	135
Trt3	50kg N spread 1-2 leaf	21	3	42	96	5	43
Trt4	50kg N spread early tiller	29	3.3	42	85	4.7	52
Trt5	50kg N spread 1st node	26	2.7	20	120	5.7	82
Trt6	50kg N spread heading	21	1.7	20	164	7	65
Trt7	25kg N Predrilled + 25kg N spread 1st node	28	2.7	41	119	7.3	50
Trt8	25kg N Split shoot + 25kg N spread 1st node	42	3	32	190	8.3	140
	mean	***31***	***2.9***	***36***	***139***	***6.5***	***78***
	LSD (p=0.05)	***ns***	***ns***	***ns***	***ns***	***2.79***	***56.4***

There were no significant differences between treatments for ryegrass numbers at the first node stage or at harvest in the plus pre-emergent trial. At the first node stage the average ryegrass population was 31 ryegrass plants/m2 and the average weed density score was 2.9. At harvest the average ryegrass panicles were 36 panicles/m2.

Without the addition of a pre-emergent herbicide, the average ryegrass population at the first node stage was 139 ryegrass plants/m2, with 50kg N split shoot at sowing (treatment 2) and 25kg N split shoot + 25kg N spread at 1st node (treatment 8) having the highest populations with 221 and 190 ryegrass plants/m2 respectively. The average weed density score at the first node was 6.54, with the same 2 treatments also having the highest weed density scores. At harvest the average ryegrass panicles/m2 were 78 panicles/m2, with treatments 8 (25kg N split shoot + 25kg N spread at 1st node) and treatment 2 (50kg N split shoot at sowing) again having the highest amount ryegrass.

Grain Yield & Quality

2018 – The 2018 trial was harvested on 30th October. The trial suffered from the effects of moisture stress from below average growing season rainfall. Table 7 shows the grain yield and quality data from the plus pre-emergent and nil pre-emergent trials.

There were no significant differences for grain yield and quality between any of the treatments for both the nil pre-emergent and the plus pre-emergent trials. The average grain yield with a pre-emergent herbicide was 892 kg/ha, with yields ranging from 630 for treatment 7 (25kg N pre-drilled + 25kg N spread first node) to 1145 kg/ha for treatment 6 (50kg N spread at heading). The average grain protein of the plus pre-emergent herbicide trial was 12.5%.

Without a pre-emergent herbicide, the average grain yield of the trial was 684 kg/ha. Yields ranged from 602 kg/ha for the 50kg N pre-drilled (treatment 1) to 772 kg/ha for the 50kg N split shoot at sowing treatment. The average grain protein of the nil pre-emergent herbicide trial was 12.4%.

Table 7: Grain yield and grain quality data from the ryegrass plus pre-emergent and nil pre-emergent trials 2018

TREATMENT		Nil Pre-emergent				Plus Pre-emergent			
		Grain yield (kg/ha)	Protein %	Screenings %	Test Weight kg/HL	Grain yield (kg/ha)	Protein %	Screenings %	Test Weight kg/HL
Trt1	50kg N Pre drilled	602	12.7	1.3	78.1	842	12.9	1.1	78.9
Trt2	50kg N Split shoot at sowing	772	12.0	1.1	78.2	1002	12.5	1.1	78.1
Trt3	50kg N spread 1-2 leaf	673	12.2	1.2	78.5	894	12.5	0.8	77.7
Trt4	50kg N spread early tiller	727	11.6	1.2	78.5	923	12.2	0.9	78.3
Trt5	50kg N spread 1st node	618	11.8	1.2	78.8	884	12.5	1.0	77.8
Trt6	50kg N spread heading	718	12.8	1.0	79.2	1145	12.5	0.8	79.3
Trt7	25kg N Predrilled + 25kg N spread 1st node	606	14.4	1.3	78.5	630	12.4	1.1	80.1
Trt8	25kg N Split shoot + 25kg N spread 1st node	756	11.4	1.2	78.9	819	12.6	1.1	79.1
	mean	***684***	***12.4***	***1.2***	***78.6***	***892***	***12.5***	***1.0***	***78.7***
	lsd (p=0.05)	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***	***ns***

2017 - The 2017 trial was harvested on 21st November. The trial suffered from the effects of frost as well as moisture stress from below average growing season rainfall. Table 8 shows the grain yield and quality data from the plus pre-emergent and nil pre-emergent trials.

Table 8: Grain yield and grain quality data from the ryegrass plus pre-emergent and nil pre-emergent trials 2017

Ttreatments		Plus Pre-emergent		Nil Pre-emergent	
		Grain yield (kg/ha)	Protein %	Grain yield (kg/ha)	Protein %
Trt1	50kg N Pre drilled	1098	15.7	800	16.1
Trt2	50kg N Split shoot at sowing	920	15.7	675	16.1
Trt3	50kg N spread 1-2 leaf	901	15.5	843	16.1
Trt4	50kg N spread early tiller	908	15.3	812	15.4
Trt5	50kg N spread 1st node	905	16	808	15.8
Trt6	50kg N spread heading	1015	15.8	564	15.8
Trt7	25kg N Predrilled + 25kg N spread 1st node	827	15.9	803	16.2
Trt8	25kg N Split shoot + 25kg N spread 1st node	946	15.8	744	16
	mean	***940***	***15.7***	***756***	***15.9***
	LSD (p=0.05)	***ns***	***ns***	***134.5***	***0.48***

Given the season, with the addition of a pre-emergent herbicide there were no significant differences for grain yield and quality between treatments. The average grain yield with a pre-emergent herbicide was 940 kg/ha, with yields ranging from 827 for treatment 7 (25kg N pre-drilled + 25kg N spread first node) to 1098kg/ha for treatment 1 (50kg N pre-drilled). The average grain protein of the plus pre-emergent herbicide trial was 15.7%, with proteins ranging from 15.3% for 50kg N spread early tillering (treatment 4) to 16.0% for 50kg N spread at first node (treatment 5).

Without a pre-emergent herbicide the average grain yield of the trial was 756 kg/ha. Yields ranged from 564 kg/ha for the 50kg N spread at heading (treatment 3) to 843 kg/ha for the 50kg N spread at 2 leaf (treatment 6). Treatment 3 was significantly lower than all other treatments except treatment 2 (50kg N split shoot at sowing). The average grain protein of the nil pre-emergent herbicide trial was 15.9%. Proteins ranged from 15.4% for 50kg N spread early tillering (treatment 4) to 16.2% for 25kg N pre + 25kg N at first node (treatment 7).

Discussion of Results

2018 - Results in 2018 were affected by the dry seasonal conditions, with growing season rainfall well below the long-term average. Crop growth and overall crop performance were adversely impacted by the drought-like conditions experienced. This made it difficult to see any visual differences between the treatments and determine any treatment effects.

Due to the variability of the trial, there were no significant differences measured between any of the treatments for ryegrass numbers, grain yield and quality for both the nil pre-emergent and the plus pre-emergent trial.

The effectiveness of topdressed nitrogen treatments was also impacted, as it was uncommon for predicted rain to fall after topdressing, with some topdressing timings applied later than ideal. There was no significant differences in weed survival and prevalence by applying nitrogen post sowing.

The addition of a pre-emergent herbicide showed similar results to 2017. By adding a pre-emergent herbicide, annual ryegrass numbers were reduced and grain yield was higher across all treatments compared to the trial where no pre-emergent herbicide was applied.

2017 - Results in 2017 were affected by seasonal conditions, with the dry start and finish, coupled with severe frosts, impacting on results.

Given the season and the effect on establishment and vigour of the split shoot treatments, the crop was unable to recover and provide competition for the weeds, so ryegrass populations were higher in these treatments. This showed that care needs to be taken with the placement of seed relative to fertiliser, as many factors can contribute to crop damage, including soil type and environmental conditions as well as fertiliser rate and degree of separation. If nitrogen is to be applied split shoot at sowing, the rates need to be low enough not to have a negative impact on early crop vigour. In this trial 50kg N/ha split shoot was too high, and as a result caused less competition against ryegrass and resulted in more ryegrass panicles at harvest.

The lack of effective rain, following topdressed nitrogen, also impacted on the results. There was no significant differences in weed survival and prevalence by applying nitrogen post sowing. Applying nitrogen early, treatments where nitrogen was either pre-drilled nitrogen or top dressing up to 1st node stage, provided the biggest increase in yield as a result of getting the nitrogen into the system earlier and allowing the plant access to it before it suffered moisture stress.

Conclusion

Seasonal conditions in 2017 and 2018 impacted upon the overall trial results. Both seasons were characterised by below average growing season rainfall, with only 221mm falling for the year in 2018. The 2018 season characterised by high temperatures and low rainfall/drought-like conditions. In 2017, significant frost events and below average growing season rainfall made for another difficult season.

Both seasons impacted on crop performance. As such, it was hard to draw conclusions from the trials in terms of the effect of nitrogen placement on ryegrass population at harvest, and the effect of nitrogen timing on ryegrass population at harvest.

Despite the dry seasonal conditions in both years the trials showed, as expected, the importance of applying a pre-emergent herbicide in reducing ryegrass numbers. Ryegrass numbers were higher across all treatments in the trial which did not have a pre-emergent herbicide.

Lessons from 2017 showed that care needs to be taken with the placement of seed relative to fertiliser, as many factors can contribute to crop damage, including soil type and environmental conditions as well as fertiliser rate and degree of separation. If nitrogen is to be applied split shoot at sowing, the rates need to be low enough not to have a negative impact on early crop vigour. In this trial 50kg N/ha split shoot was too high, and as a result caused less competition against ryegrass and resulted in more ryegrass panicles at harvest.

2017 also showed the importance of applying nitrogen early in the season. Treatments involving pre-drilled nitrogen and topdressing up to 1st node stage provided the biggest increase in yield. This allowed plant uptake of nitrogen to occur earlier, before they suffered moisture stress. Although split shoot application induced some fertiliser burn, these treatments still yielded significantly higher than the 50kg at heading treatment. This further highlights the need for early, effective nitrogen application in the western farming system.

Implications

The observations made in 2017 have implications to further this research for the benefit of the farming community. If we are able to show the positive effects that nitrogen placement and timing have on not only yield but also on weed seed set, it would encourage growers to invest into more efficient nitrogen application strategies.

Good crop establishment is important to reduce weed competition. In 2017, where establishment was affected by the lack of separation of seed and fertiliser, the ryegrass population was higher. Ensuring good separation of seed and fertiliser in split shoot treatments will allow growers to effectively apply nitrogen fertiliser in a one pass operation at sowing, increasing efficiencies and eliminating another paddock pass. Although dependant on soil type, commercially we have found no more than 40kg N/ha can be added split shoot at sowing before crop vigour is affected. On sandier soils this is closer to 30kgN/ha. This shows the relatively low safety margin that exists when considering split shoot application of nitrogen especially when marginal soil moisture conditions are experienced.

The two dry seasons experienced highlighted the importance of applying nitrogen early in low rainfall areas. In 2017 in particular, treatments involving pre-drilled nitrogen and topdressing up to the 1st node stage provided the biggest increase in yield. This was a direct of getting the nitrogen into the system earlier and allowing the plant access to it before it suffered moisture stress.

Recommendations

The two seasons the trials were conducted were very challenging, although still provided valuable information we can build upon with future research. These trials highlighted the importance of applying a pre-emergent herbicide in reducing weed numbers, regardless of nitrogen timing and placement.

These trials also highlighted the importance of early nitrogen applications in our low rainfall environment in maximising yield potential, with nitrogen applied up to the first node stage having higher yields.

It is important to have good separation of seed and fertiliser in split shoot systems to reduce the impact on crop establishment and vigour from fertiliser burn. Good separation of seed and fertiliser in split shoot treatments allows nitrogen to be applied effectively in a one pass operation at sowing. Commercially, in our environment, we have found no more than 40kg N/ha can be added split shoot at sowing before crop vigour is affected. On sandier soils this is closer to 30kgN/ha.

In the future, if similar trials are run in more favourable seasons, it will build on the information gained over the past few seasons. It will also allow us to gain a better understanding of the effect of N placement on weed numbers, over various growing seasons. This in turn will further grower confidence and investment into best management practices that not only lead to higher N utilisation and crop yield, but also lower weed seed set following harvest.

Appendix A.
2017 Crop Vigour Results

2017 Crop Vigour Results

A crop vigour score was also taken at establishment, and again on 3rd July, when the crop was at the late tillering to the first node stage.

This included any visual crop effects such as colour and overall plant health, with vigour scored from 0 to 9 (0 having no vigour and 9 vigorous).

Plus pre-emergent: Vigour scores at establishment averaged 6.04, with the two lowest treatments being the 50kg N split shoot at sowing (treatment 2) and the 25kg N split shoot + 25kg N spread at 1st node (treatment 8), table 1.

Table 1: Plus pre-emergent trial vigour scores May & July 2017.

Treatment	Vigour Score	
	31.05.2017	03.07.2017
PreDrill_50	6.67	9
Split_Pre_25_Node1_25	6.33	9
Split_Shoot_25_Node1_25	5	7.67
Split_ShootSow_50	4.67	6.33
Spread_50_2leaf	6.33	8.67
Spread_50_Etill	6.33	8.33
Spread_50_Head	6.33	7.67
Spread_50_Node1	6.67	8.67
Mean	6.04	8.17
LSD (p=0.05)	*1.002*	*0.865*

Vigour improved at the second assessment with an average vigour score of 8.17, with the 50kg N split shoot at sowing (treatment 2) again having the lowest vigour.

Nil pre-emergent: Vigour scores at establishment averaged 6.124, with the two lowest treatments again the 50kg N split shoot at sowing (treatment 2) and the 25kg N split shoot + 25kg N spread at 1st node (treatment 8), table 2.

Table 2: Nil pre-emergent trial vigour scores May & July 2017.

Treatment	Vigour Score	
	31.05.2017	03.07.2017
PreDrill_50	7.333	8.67
Split_Pre_25_Node1_25	6.333	8.33
Split_Shoot_25_Node1_25	5.667	7.67
Split_ShootSow_50	5	5.67
Spread_50_2leaf	6.333	7.67
Spread_50_Etill	6	7.33
Spread_50_Head	6.333	8
Spread_50_Node1	6	8.33
Mean	*6.125*	*7.71*
LSD (p=0.05)	*0.7523*	*0.974*

The second vigour assessment followed the same trends as the plus pre-emergent treatment, which saw an improvement in average vigour score with 7.71 and with treatment 2, 50kg N split shoot at sowing, having significantly lower vigour.

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

IBS	Incorporated by Sowing
GSR	Growing Season Rainfall
MAP	Mono-Ammonium Phosphate
N	Nitrogen

References

This section provides the information a reader would need to locate the articles, journals, and/or other publications referred to in the report.

Christie, R (1998). Operation FerTill – Achievements at Birchip in 1998.

Rainbow, R. Seedbed Utilisation (SBU) – Calculating safe urea N fertilizer rates.