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Annual Results Report Template

2020
Annual Results Report

Optimising timing and rate of nitrogen application in waterlogging conditions in the Esperance Port Zone

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Date submitted to GRDC:	19/06/2020

REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	YES/NO	
Results are incomplete	NO (this report contains the results from year 2 of a project that will run 3 years)	
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KEY MESSAGES

- There was no statistically significant difference in Scepter wheat grain yield or protein between the nitrogen application regimes applied at the Jerdacuttup, Speddingup and Condingup demonstration sites, despite there being a difference in the rate of nitrogen and timing of application. Each of these sites experienced below average rainfall in 2019 and no waterlogging occurred. Crops at Jerdacuttup and Speddingup were also affected by frost.
- Despite dry growing conditions and exposure to a significant frost in September, Scepter wheat replicates that received the highest rate of nitrogen were the most profitable at the Jerdacuttup demonstration site. The margin between the most profitable and the least profitable treatment was $79/ha while the difference in nitrogen rate applied between these was 54.9kg/ha.
- The difference between gross income achieved from each of the 4 treatments applied at the Speddingup demonstration site was very small but the variation in input costs did affect profitability. The most profitable treatment was the 'Farmer Practice' treatment as it had the lowest fertiliser input cost with little yield or grain quality penalty. The 'Regular Intervals' treatment was the least profitable of the nitrogen treatments as the input and application costs were highest. Conditions were too dry for the crop to utilize the additional applied nitrogen in this treatment. The difference between these 2 treatments was $72/ha.
- Grain price varied by only $0 to $10/t between nitrogen treatments at the Condingup demonstration site. The most profitable treatment was the 'Playing the Season' treatment, with the highest rate of nitrogen applied and the latest application date when the crop was at growth stage Z24/32-33; just prior to flag leaf emergence. The 'Farmer Practice' treatment was the next most profitable of those applied, the difference being $29/ha, followed by the 'All Up Front' treatment with a margin of $31/ha. The difference between the most profitable and least profitable treatment was $60/ha.

SUMMARY

As cropping systems have intensified there has been an increased reliance on nitrogen (N) fertiliser, now constituting the single largest variable cost for most grain growers. The challenge for growers is supplying the right amount of N at the right time and place to meet crop demand and optimise yield and quality, without over supplying N and reducing profit. The complexity of this decision is added to in waterlogging prone areas by the interaction between waterlogging and N uptake by the crop.

While growers in the Esperance Port Zone are achieving high yields in the higher rainfall parts of the port zone, production is impacted by waterlogging, especially in high decile years. Some growers are using tactics like raised beds, controlled traffic and deep ripping to minimise compaction to ensure better drainage in the paddock, summer cropping and deep drainage to reduce the impact of waterlogging on crop yields. In addition, growers are looking to agronomic options to counter the negative effects of waterlogging on crops.

What often eventuates is a guessing game of how much N to apply, given the associated risks of increasing financial losses with additional input costs. This project aims to enable growers to make timely and efficient nitrogen decisions in the Esperance port zone by having a rule of thumb around the cost/benefit of feeding N to crops on waterlogged soils.

Seasonal conditions at the Jedacuttup, Speddingup and Condingup demonstration sites were drier than average in 2019, and waterlogging did not occur. A significant frost event occurred during early September that affected crops at both the Jerdacuttup and Speddingup demonstration sites.

While the rate of nitrogen applied to Scepter wheat in the treatment replicates at the Jerdacuttup site varied from:

a) 45.2kg/ha applied once at seeding in the 'Playing the Season' treatment to,

b) 91.2kg/ha applied as 45.2kg/ha at seeding followed by 46kg/ha 8 weeks after seeding in the 'Farmer Practice' treatment to,

c) 100.1kg/ha applied as 45.2kg/ha at seeding followed by 54.9kg/ha 5 weeks after seeding in the 'All Up Front' treatment,

this did not translate to a statistically significant difference in grain yield or protein between the three nitrogen application regimes applied. Harvest yield ranged from 2.595 to 2.877 which was below the paddock's 5-year wheat average (up to 2019) of 3.6 t/ha.

There was however a difference in grain quality grade achieved between the treatments with grain from the 'All Up Front' replicates achieving H2 while grain from the 'Farmer Practice' replicates achieved AUH2 and grain from 'Playing the Season' achieved APW1. Once the costs associated with respective nitrogen treatments were factored in to the equation, the 'All Up Front' treatment, which received the highest rate of nitrogen, was the most profitable, followed by 'Farmer Practice', which received the second highest rate of nitrogen followed lastly by 'Playing the Season', which received the lowest rate of nitrogen.

At Jedacuttup, despite dry growing conditions and exposure to a significant frost, the crop that received the highest rate of nitrogen was the most profitable. The margin between the most profitable and the least profitable nitrogen application treatment was $79.43 while the difference in nitrogen rate applied between these was 54.9kg/ha.

Four nitrogen application regimes were implemented at the Speddingup site and there was no statistically significant difference in grain yield between treatments. Average harvest yield ranged from 2.203 to 2.427 t/ha which was below the paddock's 5-year wheat average (up to 2019) of 3.5 t/ha. This result was a product of 2019's drier than average growing conditions coupled with frost in early September.

While the rate of nitrogen applied to the treatment replicates varied from 79kg/ha (Farmer Practice) to 100kg/ha (Playing the Season) and 121kg/ha (All Up Front and Regular Intervals) this did not translate to a significant difference in grain yield. Neither did the timing of nitrogen application. Similarly, while protein varied slightly between treatments (those receiving more nitrogen; regardless of timing, produced grain of higher protein than those receiving less nitrogen) the difference was not enough to affect the H2 grain quality grade achieved from all 4 nitrogen treatments.

Although the difference between gross income achieved from each of the 4 treatments was very small, the variation in input costs did affect profitability. The most profitable treatment was the 'Farmer Practice' treatment as it had the lowest fertiliser input cost with little yield or grain quality penalty. The 'Regular Intervals' treatment was the least profitable of the nitrogen treatments in 2019 as the input and application costs were highest.

The nitrogen application regime implemented at the Condingup site consisted of 3 treatments:

a) 134kg/ha in total applied, 32.2kg/ha at seeding, 55.8kg/ha 7 weeks after seeding and 46kg/ha 11.5 weeks after seeding in the 'Farmer Practice' treatment,

b) 134kg/ha in total applied, 32.2kg/ha at seeding followed by 46kg/ha 5 weeks after seeding and 55.8kg/ha 7 weeks after seeding in the 'All Up Front' treatment, and

c) 143.2kg/ha in total applied, 32.3kg/ha at seeding, 27.6kg/ha 5 weeks after seeding, 55.8kg 7 weeks after seeding and 27.6kg/ha 11.5 weeks after seeding in the 'Playing the Season' treatment.

There was no statistically significant difference in Scepter wheat grain yield or protein between the three nitrogen application regimes applied despite there being a difference in the rate of nitrogen and timing of application. The 'Playing the Season' treatment replicates yielded highest (5.776t/ha), followed by the 'Farmer Practice' replicates (5.660t/ha) which were very closely followed by the 'All Up Front' replicates (5.651t/ha). There was little difference in protein between wheat from the 'Farmer Practice' and 'Playing the Season' replicates though it was lower in wheat from the 'All Up Front' replicates.

Grain price varied by only $0 to $10/t between nitrogen treatments at the Condingup demonstration site. The most profitable treatment was the 'Playing the Season' treatment with the highest rate of nitrogen applied and the latest application date (ie 5th August) when the crop was at growth stage Z24/32-33; just prior to flag leaf emergence. The 'Farmer Practice' treatment was the next most profitable of those applied, the difference being $28.58/ha, followed by the 'All Up Front' treatment with a margin of $31/ha. The difference between the most profitable and least profitable treatment was $60/ha.

1.0 BACKGROUND

Almost two-thirds of the agricultural land in the south-west region has a duplex soil profile with sandy loam surface soils over sandy clay subsoils. These soils are susceptible to waterlogging when the amount of rainfall exceeds the ability of the soil to drain away soil moisture. This susceptibility is increased by the strong texture contrast between sandy topsoils and clay subsoils; infiltration is higher through the topsoil than in the subsoil.

Waterlogging is excess water in the root zone which creates anaerobic conditions. The excess water inhibits gaseous exchange with the atmosphere and biological activity uses up available oxygen in the soil air and water. These conditions affect agricultural plants in several ways including nutrient deficiencies or toxicities, root death, reduced growth or death of the plant.

While growers in the Esperance Port Zone are achieving high yields in the higher rainfall parts of the port zone, production is impacted by waterlogging, especially in high decile years. Some growers are using tactics like raised beds, controlled traffic and deep ripping to minimise compaction to ensure better drainage in the paddock, summer cropping and deep drainage to reduce the impact of waterlogging on crop yields. In addition, growers are looking to agronomic options to counter the negative effects of waterlogging on crops.

When oxygen supply diminishes under waterlogging, N can be lost to the atmosphere largely in the form of either nitrous oxide (N_2O) or nitrogen gas (N_2). The form of N gas is influenced by soil water content; N_2 tends to be lost from highly waterlogged soils, while N_2O from less saturated soil. The rate of gaseous N loss is also driven by soil carbon (C) and soil nitrate (NO_3^-) levels, as well as soil temperature.

In high rainfall areas within the Esperance Port Zone growers say the decile 7+ rainfall years can hurt their profitability more than anything, particularly those with large areas susceptible to waterlogging. Alternatively, in good conditions like those seen in 2017 many growers in the Esperance Port Zone regretted not putting more N on their crops as their high yielding wheat and barley crops experienced

low protein levels. In these parts of the port zone what eventuates often is a guessing game of how much N to apply, given the associated risks of increasing financial losses with additional input costs.

2.0 OBJECTIVES

This project aims to enable growers to make timely and efficient nitrogen decisions in the Esperance port zone by having a rule of thumb around the cost/benefit of feeding N to crops on waterlogged soils.

3.0 METHODS

Three demonstration sites were established in 2019 in the Esperance Port Zone, one at Jerdacuttup, Speddingup and Condingup in areas prone to waterlogging across a range of decile years.

Three or four Nitrogen application treatments were applied to paddock length strips at each of the trial sites, with either 2 or 3 replicates per treatment, the number of replicates depending on the size of the demonstration site paddock, the size of the site host's equipment and the size of the waterlogging prone area within the paddock. The width of the treatment strips was determined by the width of the site host's equipment.

The first treatment represented usual host 'Farmer Practice' and the second treatment, called 'All Up Front' consisted of total nitrogen application within the first 6 weeks from seeding. The third treatment applied to all three demonstration sites consisted of 'Playing the Season' with the view of maximising yield, grain quality and profitability depending on seasonal conditions at each location and a fourth treatment was applied at the Speddingup site called 'Regular Intervals'. Nitrogen application rates and timing at each location can be found in Tables 2, 9 & 17.

Soil cores were taken at each site prior to seeding in 2019 to establish pre-seeding soil nitrogen levels and during the growing season to measure movement of available nitrogen in the soil profile. One composite soil core per site was taken to 1m depth and analysed at 0-10cm and subsequent depth increments determined by soil horizon changes in the profile.

During the growing season crop establishment counts and Zadok scores were recorded, NDVI was measured and tissue tests were taken and analysed by CSBP's laboratory. Crop agronomic management was implemented and paid for by the site host, in accordance with their usual farm practice, under the advice of their agronomist. The host grower and their agronomist were directly involved in determining nitrogen regimes applied to their demonstration sites.

At harvest, grain yield and quality measurements were recorded per treatment. Harvest yield was measured using header yield maps or a weigh trailer and grain quality was analysed using CBH's Infratec grain analyser. Yield data was analysed using the statistical software package Genstat.

Financial analysis of the respective nitrogen treatments for each location was conducted. Full earnings before tax have not been presented because the cropping program was managed in the same way in all treatment replicates except for nitrogen application. As such the only variable input costs calculated were the cost of the nitrogen applied and the cost of doing so.

4.0 LOCATION

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1	-33.8512626	120.215242
Nearest Town	Hopetoun	

Trial Site #2	-33.322126	121.482887
Nearest Town	Gibson	
Trial Site #3	-33.7017	122.8814
Nearest Town	Condingup	

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	Benefiting GRDC Agro-Ecological Zone:
Experiment Title	Western Region	☒ WA Sandplain

5.0 RESULTS AND DISCUSSION

5.1 Jerdacuttup Demonstration Site

5.1.1 Soil Type

Figure 1: Representative soil core, Jerdacuttup Optimising Nitrogen Demonstration Site, 16/4/19.

Sand over loamy gravel over clay soils prevail at the Jerdacuttup demonstration site (Figure 1). Soil at this demonstration site was mildly acidic (CaCl) from 0 to 10cm depth and then close to neutral throughout the rest of depth profile (Table 1). Soil nitrogen was low throughout the profile, phosphorus was moderate from 0 to 25cm depth and then low to greater depths and potassium was low from 0 to 25cm depth, moderate from 25-60cm and very good at 60-90cm depth. Sulfur was also low from 0-25cm depth and moderate from 25cm depth.

Table 1: Pre-crop soil analysis, Jerdacuttup demonstration site, 16/4/19.

Soil Depth	0-10cm	10-25cm	25-60cm	60-90cm
Colour	GR	GRWH	BR	YWBR
Gravel	0	0	75-80	0
Texture	1	1	1	3
Ammonium Nitrogen	1	< 1	< 1	< 1
Nitrate Nitrogen	12	2	4	4
Phosphorus Colwell	26	21	< 2	< 2
Potassium Colwell	30	26	59	275
Sulfur	5.1	2.8	19.2	30.1
Organic Carbon	0.5	0.14	0.1	0.12
Conductivity	0.046	0.031	0.045	0.123
pH Level (CaCl2)	5.6	6.6	6.4	6.8
pH Level (H2O)	6.3	7.1	6.9	7.7

5.1.2 Rainfall

Total rainfall in 2019 at the Jerdacuttup demonstration site was 306.8mm, well below the 10 year average of 482.4mm (Figure 2). Low summer rainfall meant that subsurface moisture prior to seeding was low and no waterlogging was evident during the growing season. The site experienced a significant frost event on 6th September which was a very unusual occurrence for this location.

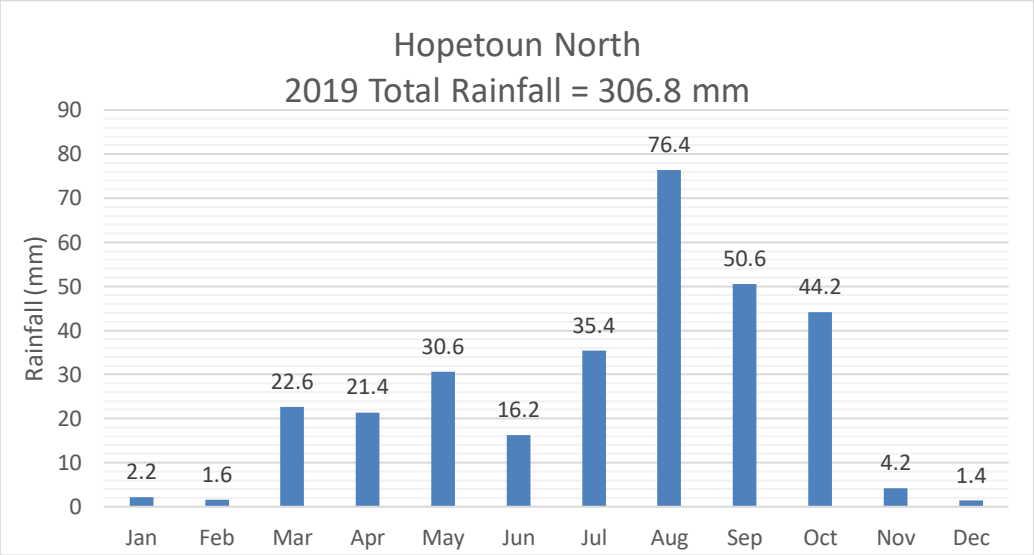


Figure 2: 2019 Annual rainfall, Jerdacuttup.

5.1.3 Treatments Applied to the Demonstration Site

All treatment strips at the demonstration site received 110kg/ha of K-Till Extra and 80L/ha of Flexi N at seeding, on the 30th April 2019, coupled with the post emergent application regime outlined in Table 2 & Figure 3. In total the three 'All Up Front' treatment replicates received the most units of nitrogen during the growing season, followed by the three 'Farmer Practice' replicates and lastly the three 'Playing the Season' replicates.

Table 2: Nitrogen treatment regime applied to replicates at the Jerdacuttup demonstration site.

Treatment	Nitrogen Fertiliser Product Applied (per hectare)	Timing	Total Nitrogen (kg/ha)
All Up Front	80L Flexi N + K-Till Plus 110kg	30/04/19 (Seeding)	45.2
	130L Flexi N	6/06/19	54.9
	TOTAL		**100.1**
Farmer Practice	80L Flexi N + K-Till Plus 110kg	30/04/19 (Seeding)	45.2
	110L Flexi N	27/06/2019	46
	TOTAL		**91.2**
Playing the Season	80L Flexi N + K-Till Plus 110kg	30/04/19 (Seeding)	45.2
	TOTAL		**45.2**

No post emergent nitrogen was applied to the 'Playing the Season' replicates in response to the season's low rainfall; the host grower and his agronomist preferring to pursue a 'shut up shop' strategy. The 'Farmer Practice' treatment received the latest nitrogen application on the 27/6/19.

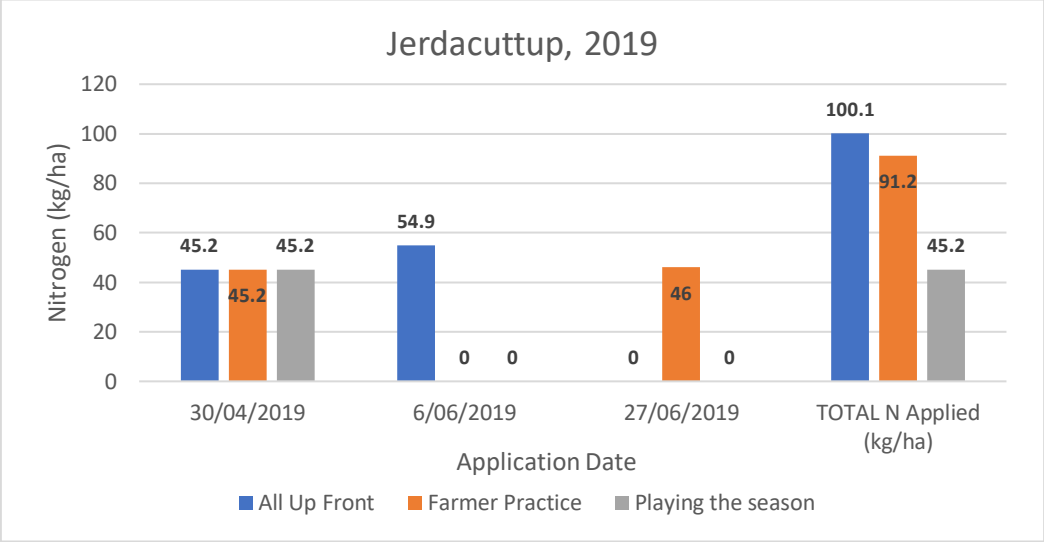


Figure 3: Timing and rates of nitrogen applied to the Jerdacuttup demonstration replicates in 2019.

5.1.4 Growing Season Data

5.1.4.1 Establishment

Scepter wheat plant establishment was within the ideal range of 125-150 plants/m^2 for this area, averaging 143 to 156 plants/m^2 between the treatment replicates (Table 3).

Table 3: Scepter wheat average plants per m^2, Jerdacuttup demonstration site, 6/6/19.

Treatment	Average Plants/m^2
All Up Front	149
Farmer Practice	143
Playing the Season	156

Crop growth was quite even between the treatment replicates In early July (Table 4).

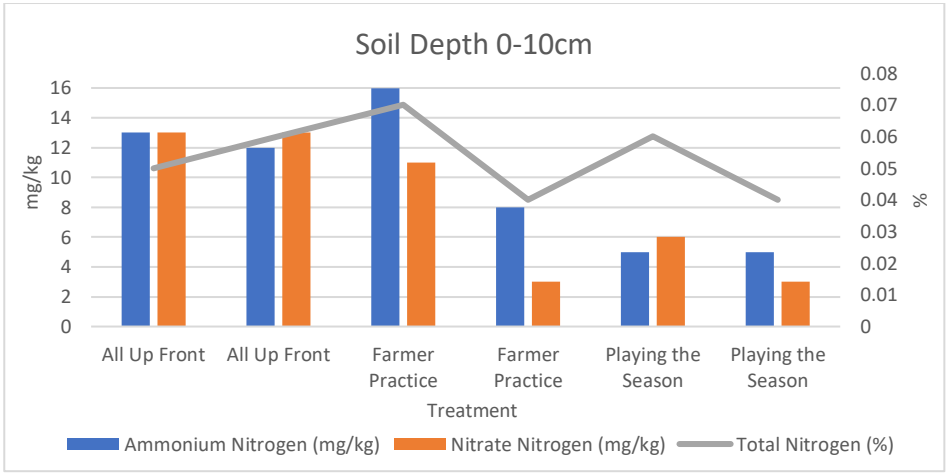
Table 4: Scepter growth stage range per treatment replicates, Jerdacuttup demonstration site, 4/7/19.

Treatment	Zadok Score Range
All Up Front	Z22/32
Farmer Practice	Z21/32
Playing the Season	Z22/32

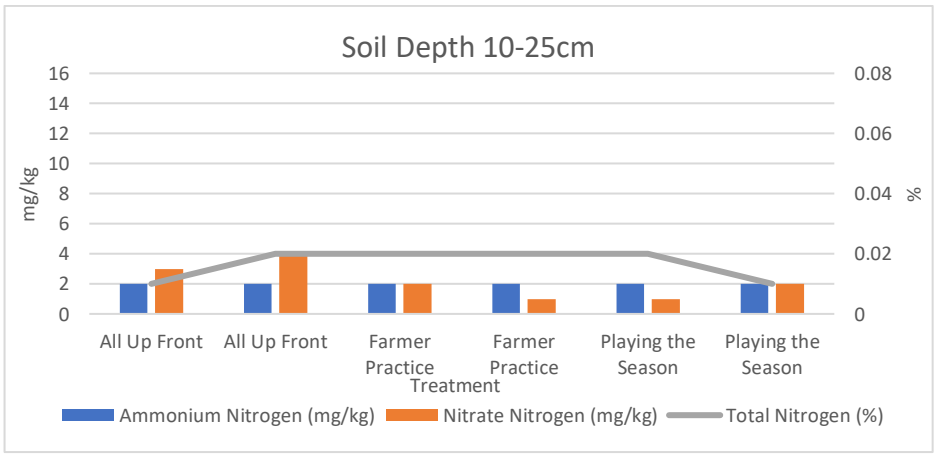
5.1.4.2 In Crop Soil Nitrogen Levels

Soil nitrate levels at 0-10cm depth were satisfactory in the 'All Up Front' replicates sampled and one of the 'Farmer Practice' replicates on the 4th July, 9 weeks after seeding when the crop ranged from Z21/Z32 to Z22/32. Soil nitrate was low in one of the 'Farmer Practice' replicates sampled and low both of the 'Playing the Seaso'n replicates (Figures 4a,b&c). Levels were highest in the 0-10cm layer in all replicates and there was little difference between levels recorded from the 10-25cm horizons and 25-60cm horizons indicating limited leaching had occurred, which is not surprising given the season's dry conditions.

Ammonium nitrogen was good in the 'All Up Front' and 'Farmer Practice' replicates suggesting nitrogen was available for conversion to nitrate if sufficient soil moisture was available. Ammonium levels were low in the 'Playing the Season' replicates suggesting available nitrogen was limited.



a)



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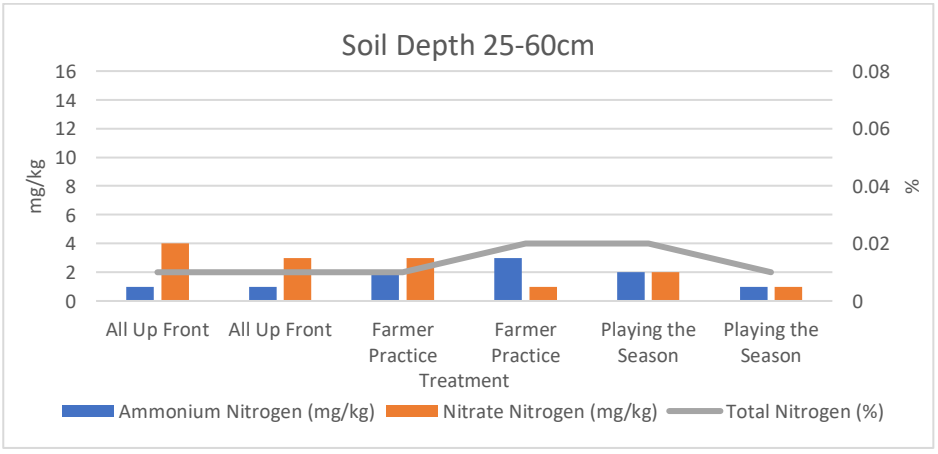


c)

Figure 4a,b&c: Soil nitrogen levels, Jerdacuttup, 4/7/19; 65 days after final nitrogen application to 'Playing the Season' replicates, 28 days after final application to 'All Up Front' replicates and 7 days after application to 'Farmer Practice' replicates.

5.1.4.3 Tissue Testing

Plant tissue testing at growth stage Z59 indicated that total nitrogen levels were at minimum sufficient and phosphorus levels were sufficient, except in 1 replicate (Table 5). Potassium levels were marginal in 5 of the 9 replicates but there was no one treatment regime that had more or less potassium indicating this was a general trend.

Nitrate nitrogen was very low at the time of tissue testing (1/8/19) in all replicates but this was not alarming given the size of the plants at collection, the levels of total nitrogen recorded and the dry growing conditions. What's likely is that the crop had used up readily available soil nitrate in its growth preceding the tissue testing and was unable to covert soil ammonium nitrogen from the soil to nitrate due to the dry conditions. The good rainfall received in August (76.4mm, Figure 2), after tissue testing, would likely have alleviated this. The high to sufficient total nitrogen levels recorded from the crop in all replicates indicate the crop had sufficient nitrogen available.

All other crop tissue nutrients tested for were sufficient or high across all treatment replicates.

Table 5: Scepter Wheat Tissue Nitrogen, Phosphorus and Potassium levels, Jerdacuttup, 1/8/19.

Nutrient	All Up Front	Farmer Practice	Playing the Season	All Up Front	Farmer Practice	Playing the Season	All Up Front	Farmer Practice	Playing the Season
Total N [Leco] (%N) {9G2}	4.71 High	4.73 High	4.49 Sufficient	4.78 High	4.82 High	4.59 Sufficient	4.93 High	5.03 High	4.56 Sufficient
Nitrate-nitrogen (mg N/kg)	37	46	47	39	47	47	38	42	39
P (%P)	0.26 Sufficient	0.26 Sufficient	0.26 Sufficient	0.25 Marginal	0.29 Sufficient	0.29 Sufficient	0.29 Sufficient	0.31 Sufficient	0.27 Sufficient
K (%K)	2.63 Sufficient	2.39 Marginal	2.64 Sufficient	2.48 Marginal	2.77 Sufficient	2.36 Marginal	2.45 Marginal	2.8 Sufficient	2.42 Marginal

5.1.4.4 NDVI

Crop vigour was moderate at the beginning of August, 13 weeks after seeding when plants were at growth stage Z59 (head emergence) (Table 6). NDVI was highest in the 'Usual Farmer Practice' replicates and almost the same in the other two treatment replicates.

Table 6: Scepter Wheat Greenseeker™ NDVI measurements, Jerdacuttup demonstration site, average crop growth stage Z59, 1/8/19.

Treatment	Average NDVI
Farmer Practice	0.548
All Up Front	0.470
Playing the Season	0.472

5.1.5 Harvest Yield and Protein

There was no significant difference in Scepter wheat grain yield or protein between the three nitrogen application regimes applied at the Jerdacuttup demonstration site in 2019 (Table 7, Figures 5 & 6). Harvest yield ranged from 2.595 to 2.877 which was below the paddock's 5-year wheat average (up

to 2019) of 3.6 t/ha. This result was a product of 2019's drier than average growing conditions and the highly unusual frost that occurred in early September.

Table 7: Scepter wheat average grain yield and protein in each nitrogen application regime at the Jerdacuttup demonstration site in 2019.

Treatment	Nitrogen Applied (kg/ha)			TOTAL N (kg/ha)	Average Yield (t/ha)	Average Grain protein (%)
	Seeding	Post Emergent	Post Emergent			
	30/04/2019	6/06/2019	27/06/2019			
All Up Front	45.2	54.9	0	100.1	2.877	11.7
Farmer Practice	45.2	0	46	91.2	2.782	11.6
Playing the season	45.2	0	0	45.2	2.595	11.1

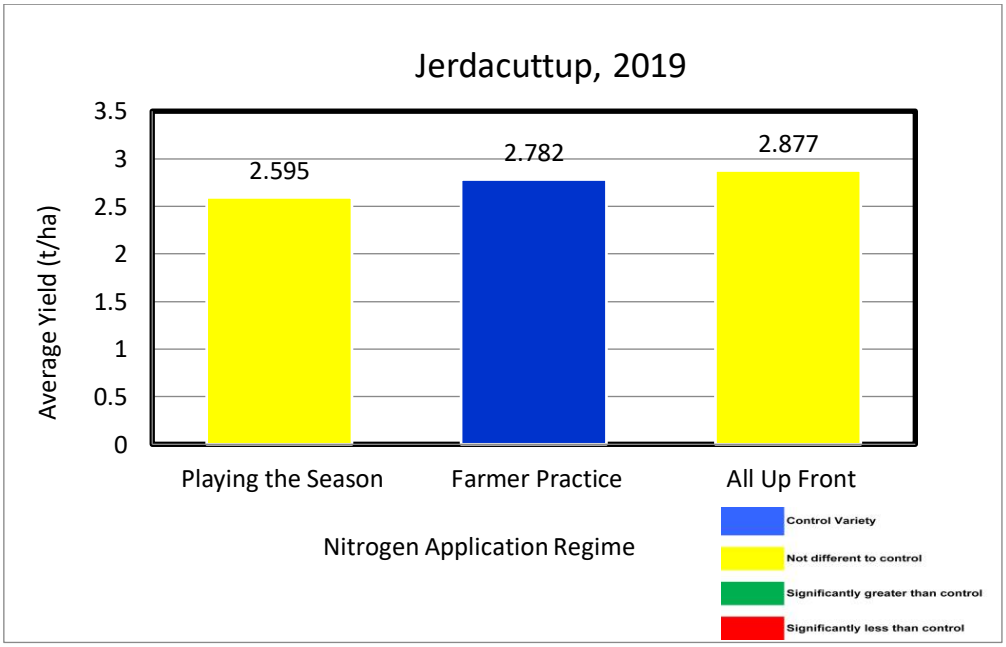


Figure 5: Average 2019 Scepter wheat yield per nitrogen application treatment at the Jerdacuttup demonstration site, 2019 where the LSD between treatments = 0.361 t/ha at p = 0.229.

While the quantity of nitrogen applied to the treatment replicates varied from 45.2kg/ha to 91.2kg/ha and 100.1kg/ha this did not translate to a statistically significant difference in grain yield or protein.

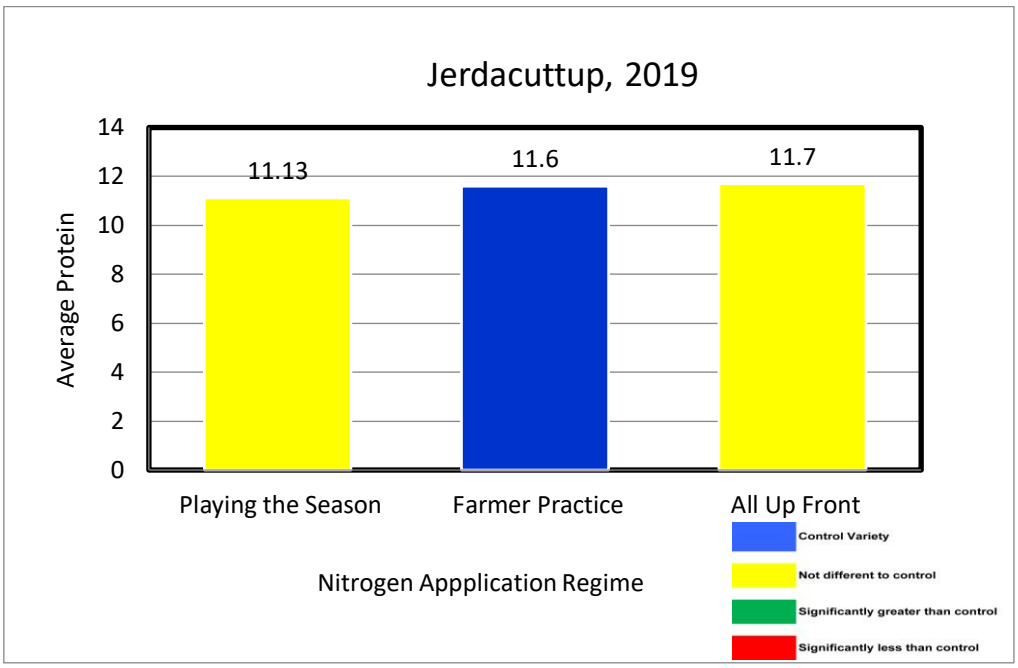


Figure 6: Average 2019 Scepter wheat grain protein per nitrogen application treatment at the Jerdacuttup demonstration site where the LSD between treatments = 0.67 at p = 0.165.

There was however a difference in grain quality grade achieved between the treatments with grain from 'All Up Front' achieving H2, grain from 'Farmer Practice' achieving AUH2 and grain from 'Playing the Season' achieving APW1 (Table 8).

Table 8: Scepter wheat average gross income in each nitrogen application treatment, Jerdacuttup demonstration site, 2019.

Nitrogen Application Treatment	Average Yield (t/ha)	Average Grade	Average Price	Average Gross Income ($/ha)	N Product Cost ($/ha)	N Application Cost ($/ha)	Gross Income - N Cost ($/ha)
All Up Front	2.9	H2	$355	$1,029.50	$130.13	$20.00	$879.37
Farmer Practice	2.806	AUH2	$346	$970.88	$118.56	$20.00	$832.32
Playing the Season	2.482	APW1	$350	$868.70	$58.76	$10.00	$799.94

Once the costs associated with the respective nitrogen treatments were factored in to the equation the 'All Up Front' treatment proved to be the most profitable, followed by 'Farmer Practice'; with a difference of $47.05/ha, followed by 'Playing the Season'.

5.2 Speddingup Demonstration Site

5.2.1 Soil Type

Figure 7: Representative soil core, Speddingup Optimising Nitrogen Demonstration Site, 9/5/19.

Soils at the Speddingup demonstration site were a sand over clay duplex consisting of 40cm of acidic sand over neutral clay (Figure 7, Table 9). Potassium levels were low in the sand to 40cm depth but high in the clay. Mild salinity persisted from 40cm depth.

Table 9: Pre-crop soil analysis, Speddingup demonstration site, 9/5/19.

Soil Depth	Unit	O-10cm	10-40cm	40-90cm
Colour		GRWH	GRWH	BRGR
Gravel	%	0	0	5
Texture		1.0	1.0	3.5
Ammonium Nitrogen	mg/kg	7	1	< 1
Nitrate Nitrogen	mg/kg	5	2	5
Phosphorus Colwell	mg/kg	13	17	< 2
Potassium Colwell	mg/kg	31	19	390
Sulfur	mg/kg	10.3	4.6	10.8
Organic Carbon	%	0.79	0.26	0.25
Conductivity	dS/m	0.104	0.077	0.172
pH Level (CaCl2)		5.1	5.4	6.7
pH Level (H2O)		6.1	6.3	8.1
DTPA Copper	mg/kg	0.52	0.52	0.28
DTPA Iron	mg/kg	52.87	106.44	30.63
DTPA Manganese	mg/kg	3.20	0.38	0.02
DTPA Zinc	mg/kg	1.45	0.50	0.22
Exc. Aluminium	meq/100g	0.080	0.139	0.210
Exc. Calcium	meq/100g	1.60	0.42	2.63
Exc. Magnesium	meq/100g	0.26	0.11	5.30
Exc. Potassium	meq/100g	0.08	0.03	0.97
Exc. Sodium	meq/100g	0.40	0.33	4.16
Boron Hot CaCl2	mg/kg	0.33	0.24	6.34

5.2.2 Rainfall

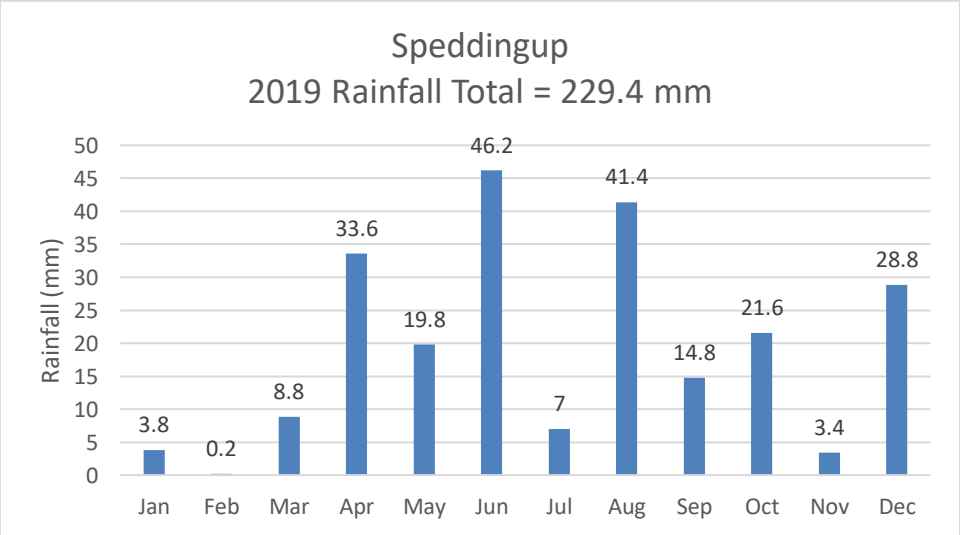


Figure 8: Monthly rainfall totals received close to (5km east) the Speddingup demonstration site.

Total rainfall in 2019 was 229.4mm and growing season rainfall (April to October) was 184.4mm (Figure 8) at the Speddingup demonstration site. Annual rainfall was well below the 10-year average from a weather station 15km to the south of the site of 504.5mm and waterlogging was not recorded. The site experienced a moderate frost on 6th September.

5.2.3 Treatments Applied to the Demonstration Site

All treatment strips at the demonstration site received 100kg/ha of K-Till Xtra and 50L/ha of Flexi N at seeding, on the 15th June 2019, coupled with the post emergent application regime outlined in Table 9. In total the two 'All Up Front' and 'Regular Intervals' treatment replicates received the most units of nitrogen during the growing season, followed by the two 'Playing the Season' replicates and lastly the two 'Farmer Practice' replicates (Table 10, Figure 9).

At the start of the growing season it was intended that an additional 50L/ha Flexi N (ie 21 kg/ha N) would be applied to the 'Farmer Practice' replicates on 2nd September but the dry seasonal conditions meant that this was no longer usual practice so this did not occur. The 'Regular Intervals' treatment received the latest nitrogen application.

Table 10: Nitrogen treatment regime applied to replicates at the Speddingup demonstration site, 2019.

2019 Treatment	Nitrogen Fertiliser Product	Timing	Total Nitrogen (kg/ha)
Farmer Practice	50L/ha Flexi N + K-Till Xtra 100 kg/ha	15/6/19 (Seeding)	33
	130kg/ha of Urea/Mop blend	10/07/2019	46
	TOTAL		**79**
All Up Front	50L/ha Flexi N + K-Till Xtra 100 kg/ha	15/6/19 (Seeding)	33
	100L/ha Flexi-N with stream Jets	9/07/2019	42
	130kg/ha of Urea/Mop blend	10/07/2019	46
	TOTAL		**121**
Playing the Season	50L/ha Flexi N + K-Till Xtra 100 kg/ha	15/6/19 (Seeding)	33
	130kg/ha of Urea/Mop blend	10/07/2019	46
	50L/ha Flexi-N with stream Jets	2/09/2019	21
	TOTAL		**100**
Regular Intervals	50L/ha Flexi N + K-Till Xtra 100 kg/ha	15/6/19 (Seeding)	33
	130kg/ha of Urea/Mop blend	10/07/2019	46
	50L/ha Flexi-N with stream Jets	10/08/2019	21
	50L/ha Flexi-N with stream jets	2/09/2019	21
	TOTAL		**121**

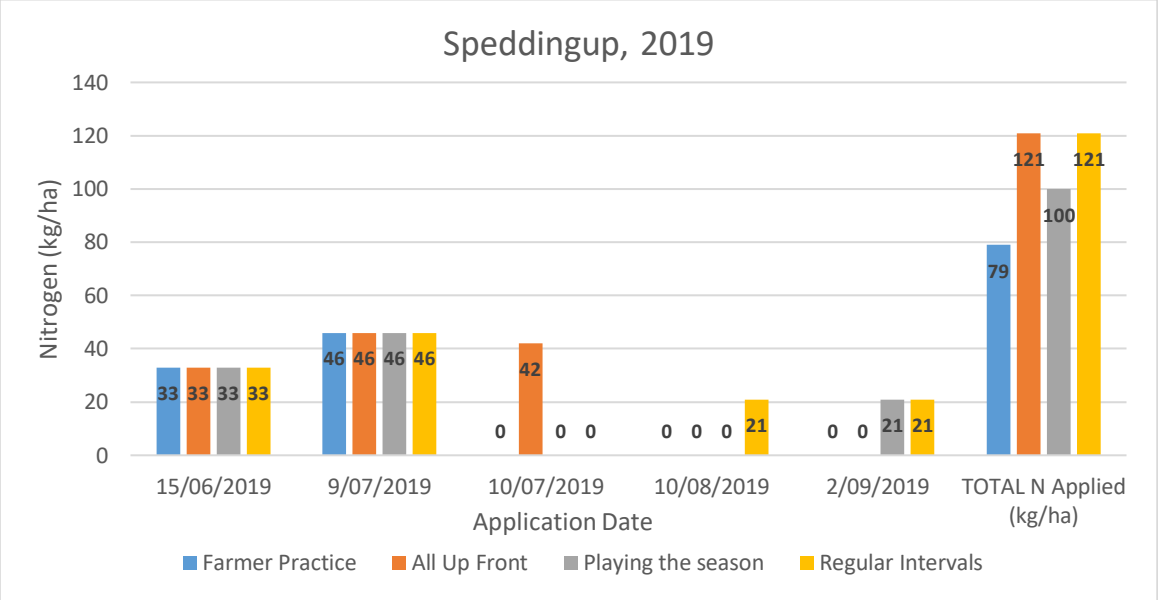


Figure 9: Timing and rates of nitrogen applied to the Speddingup demonstration replicates in 2019.

5.2.4 Growing Season Data

5.2.4.1 Establishment

Crop establishment was quite good, despite the dry start, at the Speddingup demonstration site with plant density ranging from 104 to 123 plants/m^2 in the treatment replicates (Table 11). Target plant density for this area is 120 plants/m^2. Zadock score was relatively even across the replicates on 28/8/19, ranging from Z32-Z33, indicating germination was quite even.

Table 11: Scepter wheat average plants per m^2, Speddingup demonstration site, 28/8/19.

	Plot	Plot Treatment	Plants/m2
Replicate 1	**1**	Farmer Practice	119
	2	All Up front	102
	3	Playing the Season	118
	4	Regular intervals	123
Replicate 2	**5**	Playing the Season	104
	6	All Up front	106
	7	Farmer Practice	111
	8	Regular intervals	106

5.2.4.2 Tissue Testing

Analysis of the tissue test samples collected on 28th August 2019, when the crop was at growth stage Z31-33, reveal a general trend suggesting the crop required top-up nitrogen to be applied in all replicates except 'All Up Front' (Table 12). The soil testing results reported in section 5.2.4.3 below however indicate that sufficient soil nitrogen was available in the form of ammonium but the season's low rainfall was impeding conversion of ammonium to the nitrate required for crop growth. As such, while the tissue test results suggest the crop required more fertiliser in all but the 'All Up Front' treatments this would have been unnecessary expenditure as the underlying issue was lack of soil moisture.

All other nutrients tested for were sufficient or high across all treatment replicates.

Table 12: Scepter wheat nitrogen tissue test results from each of the nitrogen application treatments, Speddingup, 28th August 2019.

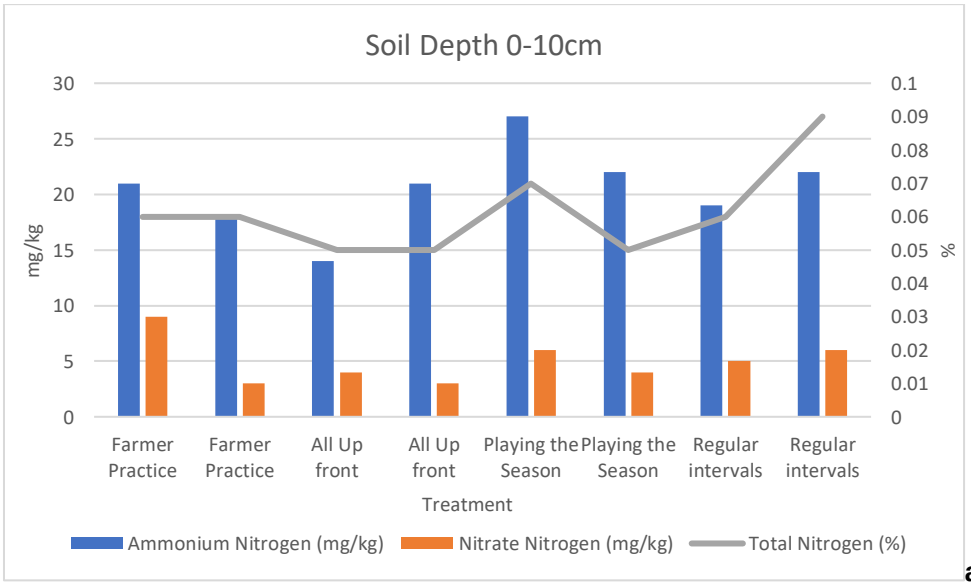
Nutrient	Farmer Practice	Farmer Practice	All Up Front	All Up Front	Playing the Season	Playing the Season	Regular Intervals	Regular Intervals
Total N [Leco] (%N) {9G2}	3.12 Marginal	3.95 Marginal	3.64 Sufficient	3.75 Sufficient	3.29 Marginal	3.55 Sufficient	3.59 Marginal	4.01 Sufficient
Nitrate-nitrogen (mg N/kg)	255 Sufficient	106 Low	250 High	223 Sufficient	95 Low	209 Sufficient	175 Low	228 Low

5.2.4.3 In Crop Soil Nitrogen

Soil ammonium nitrogen levels were good and nitrate nitrogen levels were low in all treatment replicates, at 0-10cm depth, on the 3rd September, 11 weeks after seeding (Figures 10a,b&c). This suggests that at the time soil cores were collected the crop had used available nitrates but had sufficient ammonium available to convert to nitrate if sufficient soil moisture was present.

Soil nitrogen was highest in the 0-10cm layer in all replicates followed by the 10-40cm horizon and then the 40-80cm horizon. The levels recorded indicate there was some leaching of nitrate in the sandy top 40cm of the soil profile whereas the less mobile ammonium nitrogen was much higher in the 0-10cm than either of the deeper soil horizons.

Soil nitrogen did not vary much between the nitrogen application treatments from which the soil cores were taken.



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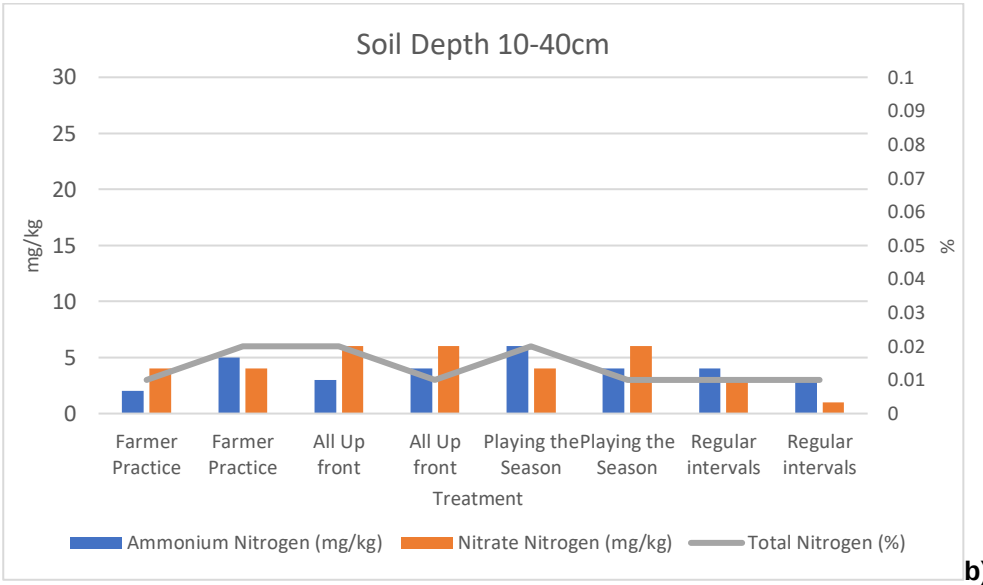

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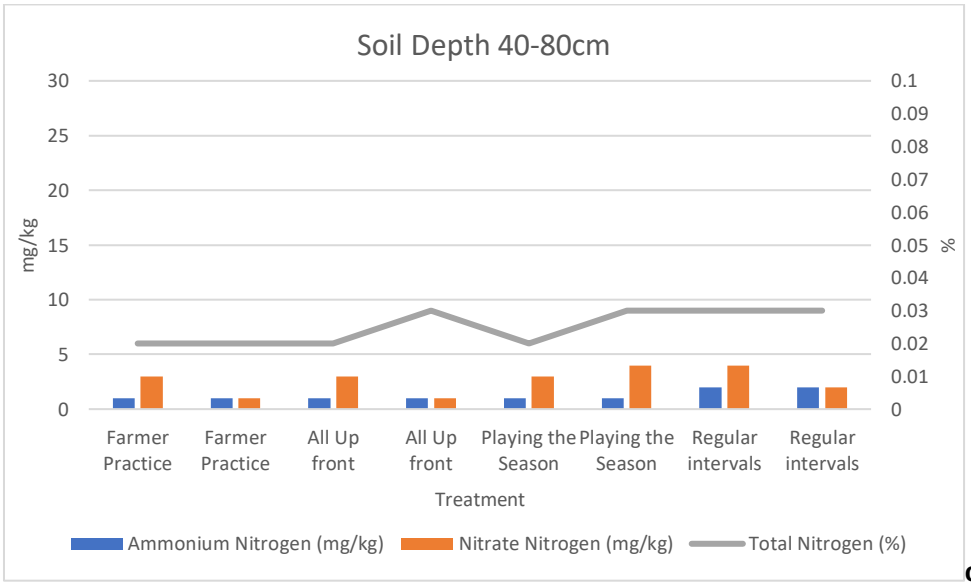


c)

Figure 10 a,b&c: Soil nitrogen levels in nitrogen treatment replicates, Speddingup demonstration site, 3/9/19.

5.2.4.4 NDVI

Crop vigour was relatively low in early October indicating the crop was not thriving (Table 13). NDVI did not vary between nitrogen application treatments.

Table 13: Scepter Wheat Greenseeker™ NDVI measurements, Speddingup demonstration site, 7/10/19.

Treatment	Average NDVI
Farmer Practice	0.37
All Up Front	0.36
Playing the Season	0.38
Regular Intervals	0.37

5.2.4.5 Harvest Yield and Protein

There was no significant difference in Scepter wheat grain yield between the four nitrogen application regimes applied at the Speddingup demonstration site in 2019 (Table 14, Figure 11). Average harvest yield ranged from 2.203 to 2.427 t/ha which was below the paddock's 5-year wheat average (up to 2019) of 3.5 t/ha. This result was a product of 2019's drier than average growing conditions coupled with the frost that occurred in early September.

Table 14: Scepter wheat average grain yield and protein in each nitrogen application regime at the Speddingup demonstration site in 2019.

Treatment	Nitrogen Applied (kg/ha)					TOTAL N (kg/ha)	Average Yield (t/ha)	Average Grain Protein (%)
	15/06/2019 (Seeding)	9/07/2019	10/07/2019	10/08/2019	2/09/2019			
Farmer Practice	33	46	0	0	0	79	2.394	11.85
All Up Front	33	46	42	0	0	121	2.440	12.65
Playing the Season	33	46	0	0	21	100	2.427	12.05
Regular Intervals	33	46	0	21	21	121	2.203	12.55

While the rate of nitrogen applied to the treatment replicates varied from 79kg/ha to 100kg/ha and 121kg/ha this did not translate to a significant difference in grain yield. Similarly, while protein varied slightly between treatments (those receiving more nitrogen; regardless of timing, produced grain of higher protein than those receiving less nitrogen) the difference was not enough to affect the H2 grain quality grade achieved from all 4 nitrogen treatments.

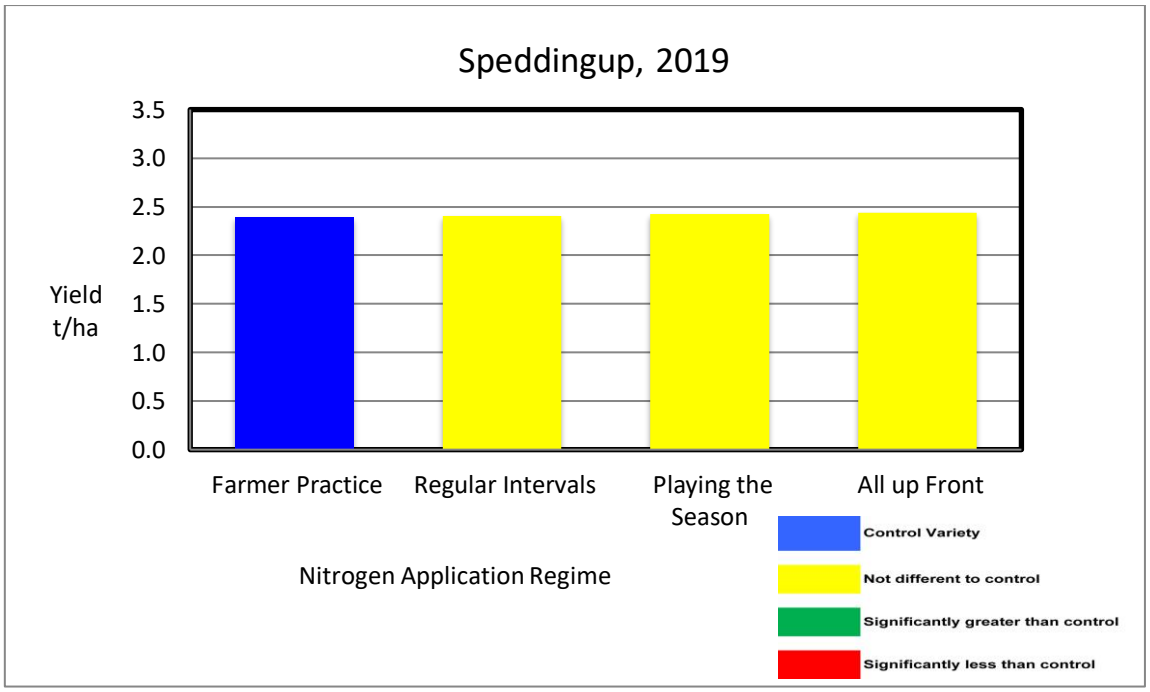


Figure 11: Average 2019 Scepter wheat yield per nitrogen application treatment at the Speddingup demonstration site, 2019 where the LSD between treatments = 0.1618 t/ha at p = 0.849.

Although the difference between gross income achieved from each of the 4 treatments was very small, the variation in input costs did affect profitability (Table 15). The most profitable treatment was the 'Farmer Practice' treatment as it had the lowest fertiliser input cost with little yield or grain quality penalty. The 'Regular Intervals' treatment was the least profitable of the nitrogen treatments in 2019 aas the input costs were highest. As the soil and tissue test results indicate, the season was too dry for the extra nitrogen applied to be utilised by the crop.

Table 15: Scepter wheat average gross income in each nitrogen application treatment, Speddingup demonstration site, 2019.

Nitrogen Application Treatment	Average Yield (t/ha)	Average Grade	Average Price	Average Gross Income ($/ha)	N Product Cost ($/ha)	N Application Cost ($/ha)	Gross Income - Nitrogen Cost ($/ha)
Farmer Practice	2.394	H2	$355	$849.88	$102.70	$20.00	$727.18
All Up Front	2.440	H2	$355	$866.12	$157.30	$30.00	$678.82
Playing the Season	2.427	H2	$355	$861.48	$130.00	$20.00	$711.48
Regular Intervals	2.402	H2	$355	$852.86	$157.30	$40.00	$655.56

5.3 Condingup Demonstration Site

5.3.1 Soil Type

Soil at the Condingup demonstration site was a very shallow sand over clay duplex (Figure 12).

Figure 12: A soil core taken from the Condingup demonstration site, 10th May 2019.

Phosphorus and sulphur levels were moderate at 0-10cm depth and low below 10cm while potassium levels were very good throughout the soil profile (Table 16). Organic carbon levels were low throughout the soil profile and pH (CaCl) the soil was acidic from 0-10cm depth, close to neutral from 10-30cm depth and alkaline from 30-90cm depth.

Table 16: Pre-crop soil analysis at the Condingup demonstration site, 10th May 2019.

Parameter	Unit	Depth (cm)		
		0-10	10-30	30-90
Colour		GRBR	BRWH	YWGR
Gravel	**%**	0	0	0
Texture		2.5	3.0	3.0
Ammonium Nitrogen	**mg/kg**	6	< 1	< 1
Nitrate Nitrogen	**mg/kg**	14	4	2
Phosphorus Colwell	**mg/kg**	18	5	3
Potassium Colwell	**mg/kg**	297	260	347
Sulfur	**mg/kg**	12.9	5.5	4.0
Organic Carbon	**%**	1.04	0.48	0.30
Conductivity	**dS/m**	0.134	0.146	0.186
pH Level (CaCl2)		5.9	7.6	8.1
pH Level (H2O)		6.5	8.3	9.3

5.3.2 Rainfall

Total rainfall in 2019 at the Condingup demonstration site was 427mm, well below the 3-year average of 570.2mm (Figure 13). Summer rainfall was low and while 372.4mm fell during the growing season (April to October) no waterlogging was evident.

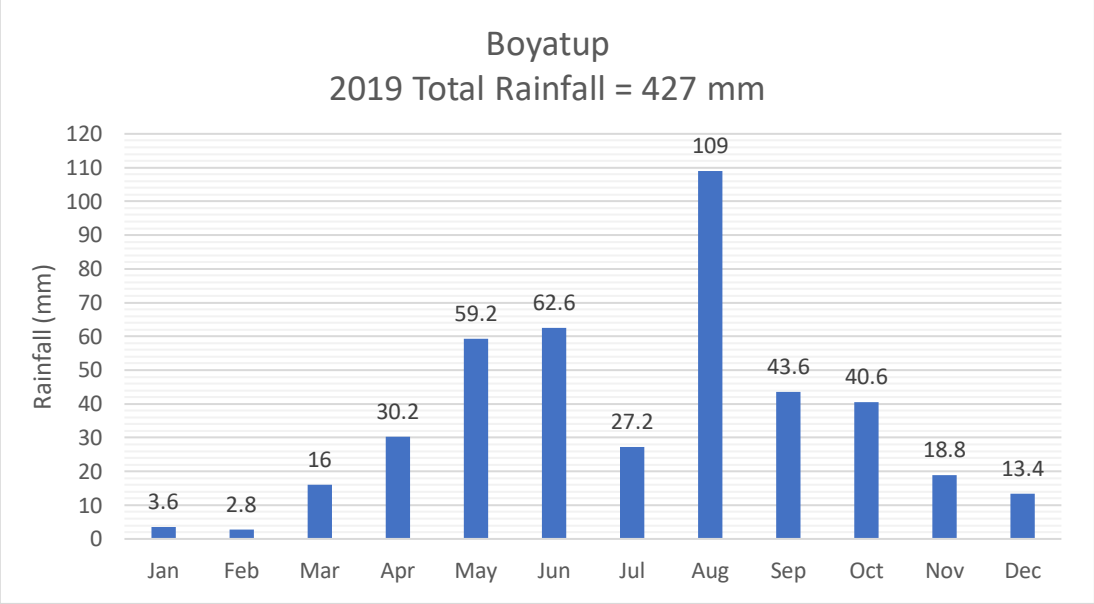


Figure 13: Monthly rainfall totals received at the Condingup demonstration site, 2019.

5.3.3 Treatments Applied to the Demonstration Site

All treatment strips at the demonstration site received 100kg/ha of MAP and 50L/ha of UAN at seeding, on the 17th May 2019, coupled with the post emergent application regime outlined in Table 17. In total the three 'Playing the Season' treatment replicates received the most nitrogen during the growing season, followed by both the three 'Playing the Season' replicates and the three 'All Up Front' replicates which each received the same rate of nitrogen but at different times (Table 17, Figure 14).

Table 17: Nitrogen treatment regime applied to replicates at the Condingup demonstration site, 2019.

2019 Treatment	Nitrogen Fertiliser Product	Timing	Total Nitrogen (kg/ha)
Farmer Practice	100 kg/ha MAP + 50 L/ha UAN	(Seeding) 17/5/2019	32.2
	Nil	20/06/2019	0
	150 kg/ha Urea Plus	4/07/2019	55.8
	100 kg/ha Urea	5/08/2019	46
	TOTAL		**134**
All Up Front	100 kg/ha MAP + 50 L/ha UAN	(Seeding) 17/5/2019	32.2
	100 kg/ha Urea	20/06/2019	46
	150 kg/ha Urea Plus	4/07/2019	55.8
	Nil	5/08/2019	0
	TOTAL		**134**
Playing the Season	100 kg/ha MAP + 50 L/ha UAN	(Seeding) 17/5/2019	32.2
	60 kg/ha Urea	20/06/2019	27.6
	150 kg/ha Urea Plus	4/07/2019	55.8
	60 kg/ha Urea	5/08/2019	27.6
	TOTAL		**143.2**

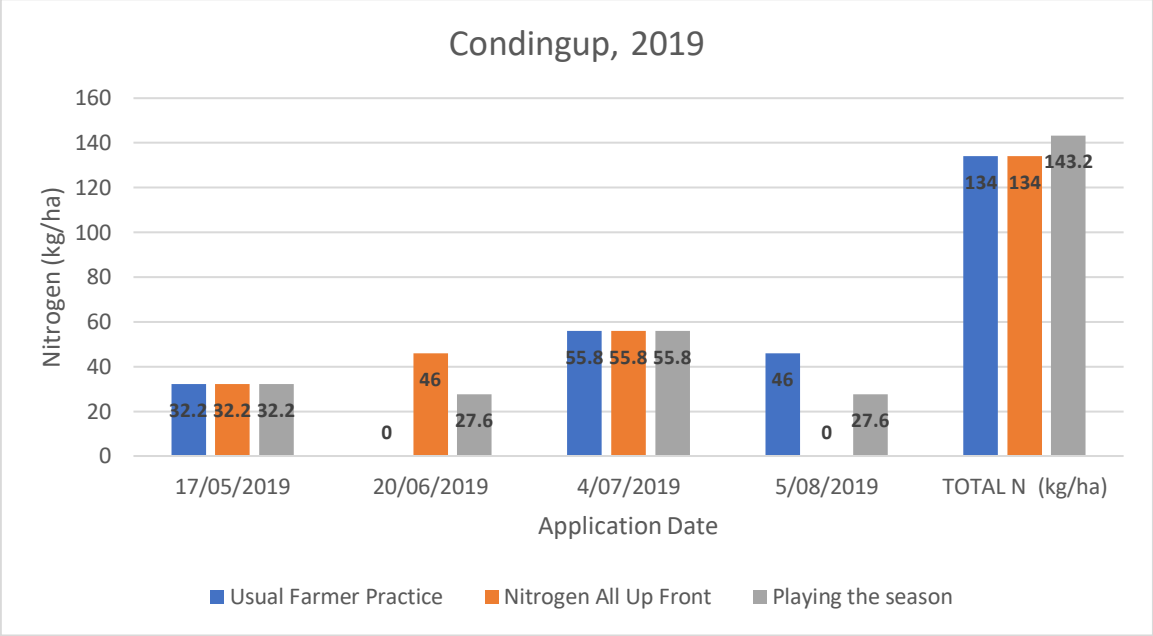


Figure 14: Timing and rates of nitrogen applied to the Condingup demonstration replicates in 2019.

5.3.4 Growing Season Data

5.3.4.1 Establishment

Scepter wheat plant establishment was slightly lower than the ideal range of 150-170 plants/m^2 for this area and variable, ranging from 119 to 172 plants/m^2 between the treatment replicates 3.5 weeks after seeding on the 17th May (Figure 15). The crop was at growth stage Z13 on this date. By the 11th July 2019 the crop was even between the replicates and at growth stage Z24/31.

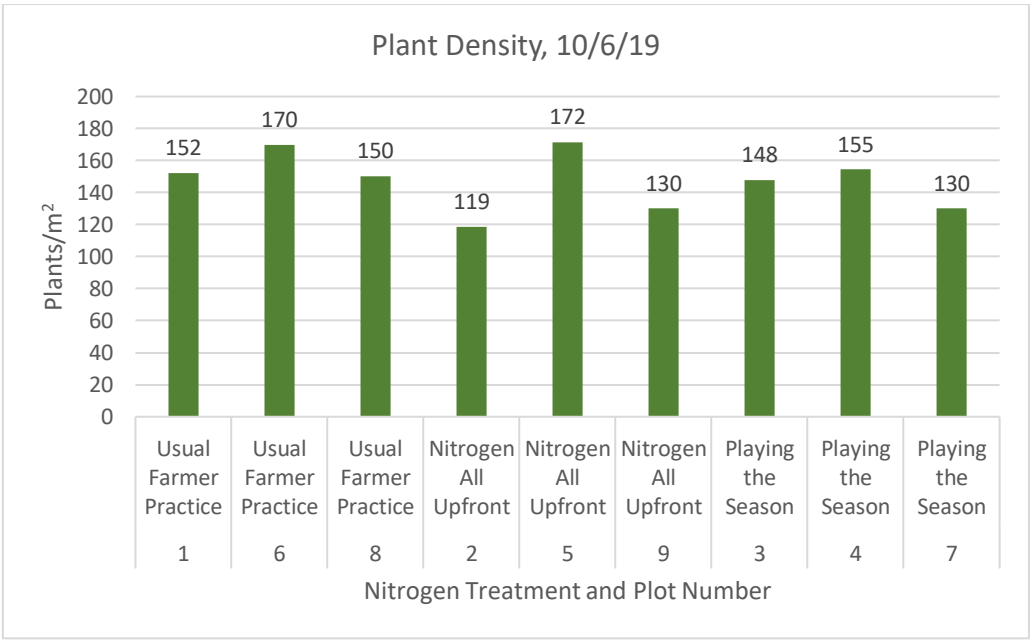
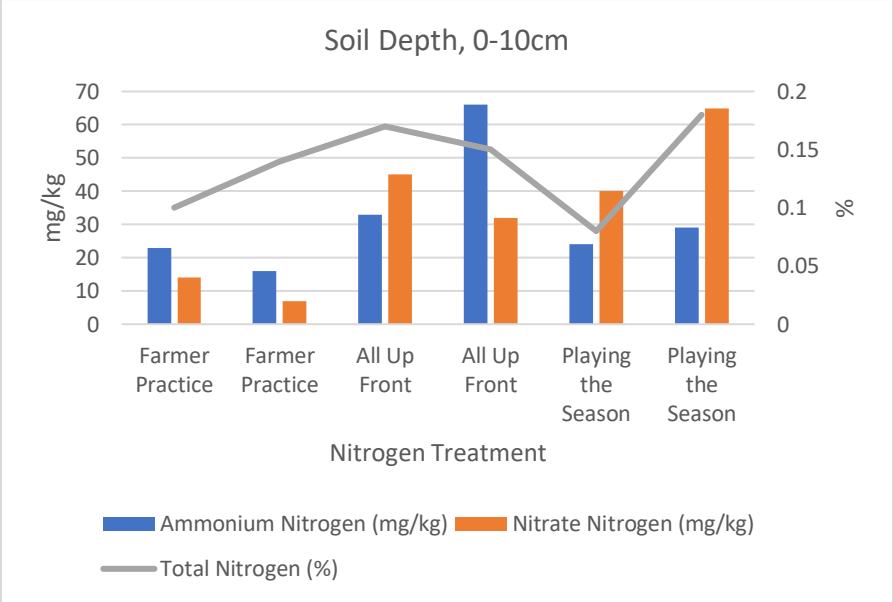


Figure 15: Scepter wheat average plants per m^2, Condingup demonstration site, 10/6/19.

5.3.4.2 In Crop Soil Nitrogen

Soil nitrate and ammonium levels were good at 0-10cm depth in both the 'All Up Front' and 'Playing the Season' replicates, 10 weeks after seeding, when the crop was at growth stage Z24/32 and 24 days after nitrogen application to all three treatments (Figures 16a,b&c). Soil nitrate and ammonium was moderate to low at 0-10cm depth in the 'Farmer Practice' replicates indicating the crop would likely benefit from the application of more nitrogen; hence the application of 46kg/ha of nitrogen on the 5th August was well timed (Figure 14).

Ammonium and nitrate levels were much lower in the 10-30cm and 30-80cm horizons than in the 0-10cm layer in all replicates and there was little difference between nitrate levels recorded from these deeper horizons indicating limited leaching had occurred.



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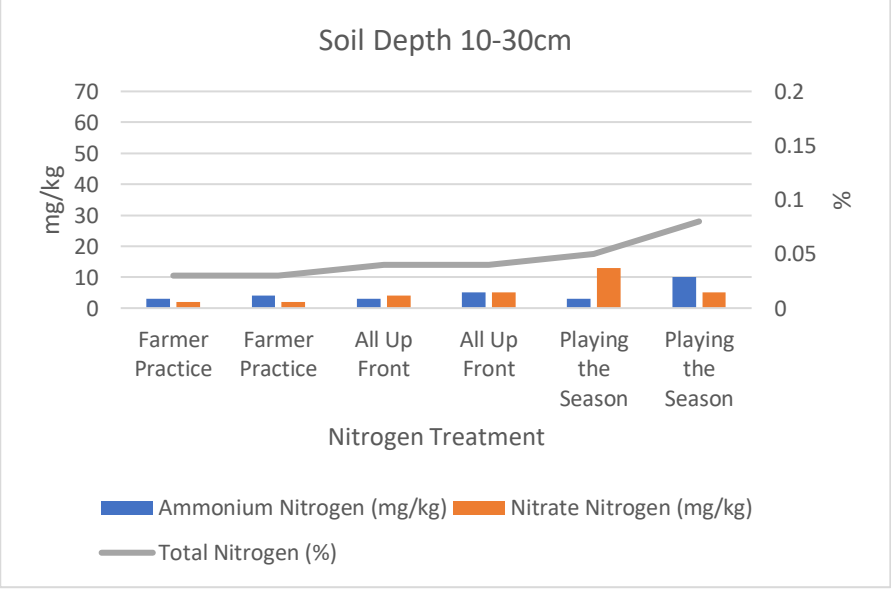

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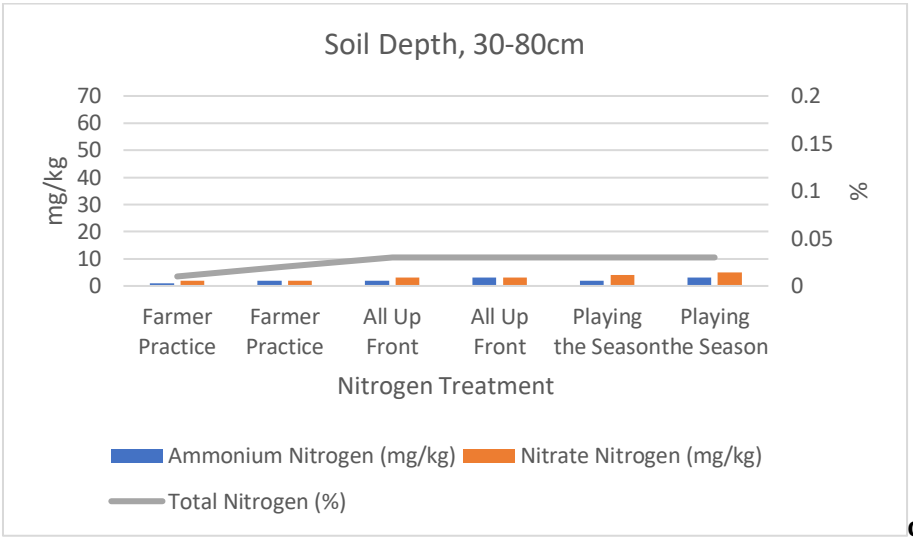

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Figure 16 a,b&c: Soil nitrogen levels in nitrogen treatment replicates, Condingup demonstration site, 25/7/19.

5.3.4.3 Tissue Testing

Tissue test results from crop samples collected from each treatment on 25th July 2019, when the crop was at growth stage Z24/32, indicated that the crop was not nutrient deficient. All nutrients analysed for were present at sufficient or high levels.

5.3.4.4 NDVI

Crop vigour was relatively high in late July (Table 18). Crop NDVI did not vary between nitrogen application treatments.

Table 18: Scepter Wheat Greenseeker™ NDVI measurements, Condingup demonstration site, 25/7/19.

Treatment	Average NDVI
Farmer Practice	0.717
All Up Front	0.728
Playing the Season	0.724

5.3.4.5 Harvest Yield and Protein

The rate of nitrogen and timing of application to the treatment replicates varied but there was no statistically significant difference in Scepter wheat grain yield or protein between the three nitrogen application regimes applied at the Condingup demonstration site in 2019 (Figures 17 & 18 and Table 19).

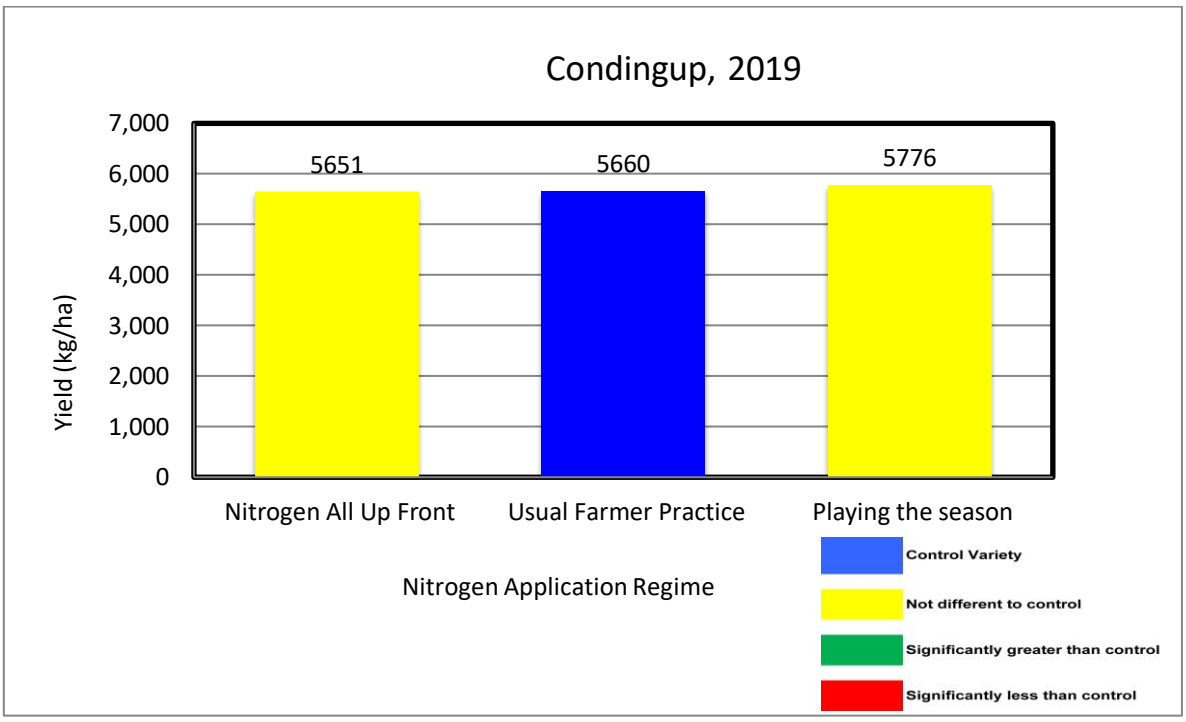

Figure 17: Average 2019 Scepter wheat yield per nitrogen application treatment at the Condingup demonstration site, 2019 where the LSD between treatments = 428 kg/ha, at p = 0.74.

The 'Playing the Season' treatment replicates yielded highest (5.776t/ha), followed by the 'Farmer Practice' replicates (5.660t/ha) which were very closely followed by the 'All Up Front' replicates (5.651t/ha).

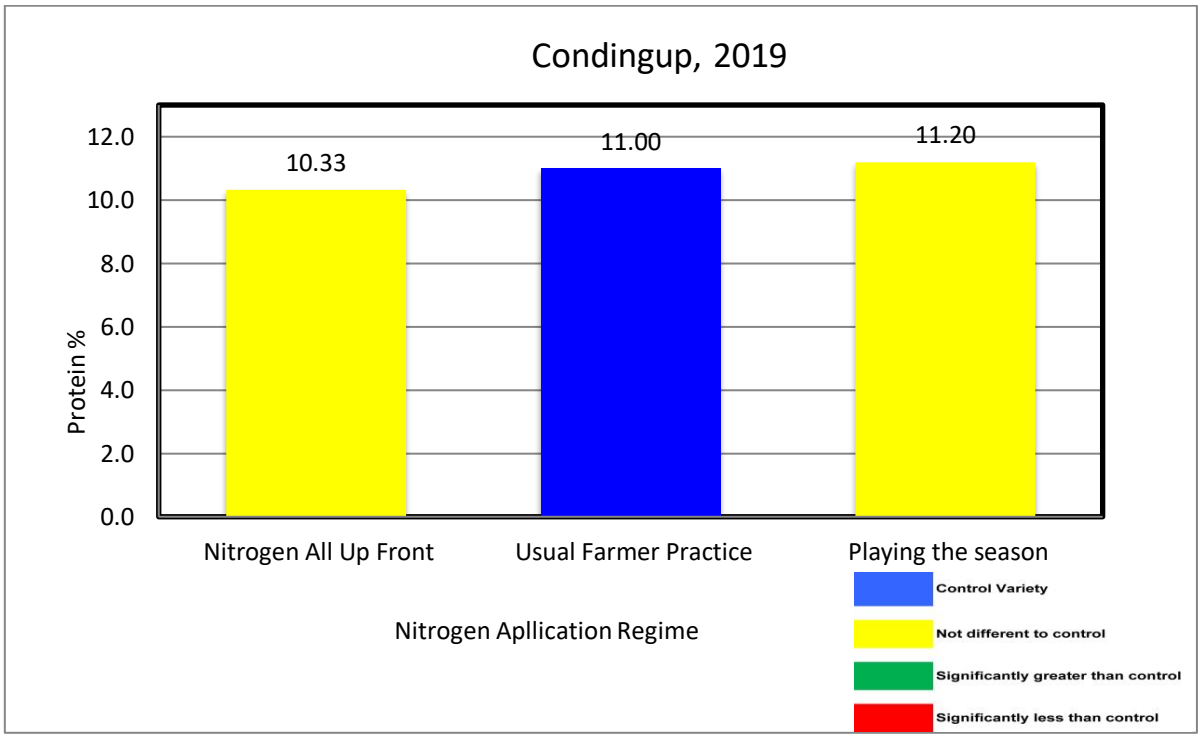

Figure 18: Average 2019 Scepter grain protein level per nitrogen application treatment at the Condingup demonstration site, 2019 where the LSD between treatments = 0.873%, at p = 0.112.

There was little difference in protein between wheat from the 'Farmer Practice' and 'Playing the Season' replicates though it was lower in wheat from the 'All Up Front' replicates.

Table 19: Scepter wheat average grain yield and protein from each nitrogen application regime at the Condingup demonstration site in 2019.

Treatment	Nitrogen Applied (kg/ha)				TOTAL N (kg/ha)	Average Yield (t/ha)	Average Grain protein (%)
	Seeding	Post Emergent					
	17/05/2019	20/06/2019	4/07/2019	5/08/2019			
Farmer Practice	32.2	0	55.8	46	134	5.660	11
All Up Front	32.2	46	55.8	0	134	5.651	10.3
Playing the season	32.2	27.6	55.8	27.6	143.2	5.776	11.2

Grain price varied by only \$0 to \$10/t between nitrogen treatments applied at this demonstration site (Table 20). The most profitable treatment was the 'Playing the Season' treatment with the highest rate of nitrogen applied and the latest application date (ie 5th August) when the crop was at growth stage Z24/32-33; known as leaf dissection, which is just prior to flag leaf emergence. Previous research has shown careful nitrogen management at this stage is important.

The 'Farmer Practice' treatment was the next most profitable of those applied, the difference being \$28.58/ha, followed by the 'All Up Front' treatment with a margin of \$31/ha.

Table 20: Scepter wheat average gross income from each nitrogen application treatment, Condingup demonstration site, 2019.

Nitrogen Application Treatment	Yield (t/ha)	Quality Grade	Price (\$/t)	Gross Income (\$/ha)	N Product Cost (\$/ha)	N Application Cost (\$/ha)	Gross Income - Nitrogen Cost (\$/ha)	Average Gross Income - Nitrogen Cost (\$/ha)
Farmer Practice	6.009	APW1	\$350.00	\$2,103	\$174.20	\$30.00	\$1,898.95	\$1,776.68
Farmer Practice	5.447	APW1	\$350.00	\$1,906	\$174.20	\$30.00	\$1,702.25	
Farmer Practice	5.523	APW1	\$350.00	\$1,933	\$174.20	\$30.00	\$1,728.85	
All Up Front	5.631	ASW1	\$340.00	\$1,915	\$174.20	\$30.00	\$1,710.34	\$1,745.67
All Up Front	5.798	APW1	\$350.00	\$2,029	\$174.20	\$30.00	\$1,825.10	
All Up Front	5.524	APW2	\$345.00	\$1,906	\$174.20	\$30.00	\$1,701.58	
Playing the season	5.96	H2	\$355.00	\$2,116	\$186.16	\$40.00	\$1,889.64	\$1,805.26
Playing the season	5.7	APW1	\$350.00	\$1,995	\$186.16	\$40.00	\$1,768.84	
Playing the season	5.667	APW1	\$350.00	\$1,983	\$186.16	\$40.00	\$1,757.29	

6.0 CONCLUSIONS

Dry growing conditions prevailed in 2019 at each of the three optimising nitrogen demonstration sites in the Esperance Port Zone. Annual rainfall was well below average in all locations and no waterlogging occurred. In addition, a significant frost event occurred in early September that affected crops at both the Jerdacuttup and Speddingup sites.

In terms of the rate and timing of nitrogen treatments applied to Scepter wheat at each of the demonstration sites the following can be said:

1. Jerdacuttup – This site was seeded to a late April sown Scepter wheat crop and experienced below average rainfall and no waterlogging during the growing season. The site also experienced a highly unusual frost in early September.

While the rate of nitrogen applied to the treatment replicates varied from:

a) 45.2kg/ha applied once at seeding in the 'Playing the Season' treatment to,

b) 91.2kg/ha applied as 45.2kg/ha at seeding followed by 46kg/ha 8 weeks after seeding in the 'Farmer Practice' treatment to,

c) 100.1kg/ha applied as 45.2kg/ha at seeding followed by 54.9kg/ha 5 weeks after seeding in the 'All Up Front' treatment,

this did not translate to a statistically significant difference in grain yield or protein between the three nitrogen application regimes applied. Harvest yield ranged from 2.595 to 2.877 which was below the paddock's 5-year wheat average (up to 2019) of 3.6 t/ha. This result was a product of 2019's drier than average growing conditions and September's unusual frost.

There was however a difference in grain quality grade achieved between the treatments with grain from the 'All Up Front' replicates achieving H2 while grain from the 'Farmer Practice' replicates achieved AUH2 and grain from 'Playing the Season' achieved APW1. Once the costs associated with respective nitrogen treatments were factored in to the equation the 'All Up Front' treatment, which received the highest rate of nitrogen, was the most profitable, followed by 'Farmer Practice', which received the second highest rate of nitrogen followed lastly by 'Playing the Season', which received the lowest rate of nitrogen.

At this site, despite dry growing conditions and exposure to a significant frost, the crop that received the highest rate of nitrogen was the most profitable. The margin between the most profitable and the least profitable treatment was $79/ha while the difference in nitrogen rate applied between these two was 54.9kg/ha.

Nitrogen Application Treatment	Average Yield (t/ha)	Average Grade	Average Price	Average Gross Income ($/ha)	N Product Cost ($/ha)	N Application Cost ($/ha)	Gross Income - N Cost ($/ha)
All Up Front	2.9	H2	$355	$1,029.50	$130.13	$20.00	$879.37
Farmer Practice	2.806	AUH2	$346	$970.88	$118.56	$20.00	$832.32
Playing the Season	2.482	APW1	$350	$868.70	$58.76	$10.00	$799.94

2. Speddingup – This site was seeded to a mid-June sown Scepter wheat crop and experienced below average rainfall and no waterlogging during the growing season. The site also experienced a frost in early September.

Four nitrogen application regimes were implemented at this site in 2019 and there was no statistically significant difference in grain yield between treatments. Average harvest yield ranged from 2.203 to 2.427 t/ha which was below the paddock's 5-year wheat average (up to 2019) of 3.5 t/ha. This result was a product of 2019's drier than average growing conditions coupled with the frost that occurred in early September.

While the rate of nitrogen applied to the treatment replicates varied from 79kg/ha (Farmer Practice) to 100kg/ha (Playing the Season) and 121kg/ha (All Up Front and Regular Intervals) this did not translate to a significant difference in grain yield. Neither did the timing of nitrogen application. Similarly, while protein varied slightly between treatments (those receiving more nitrogen; regardless of timing, produced grain of higher protein than those receiving less nitrogen) the difference was not enough to affect the H2 grain quality grade achieved from all 4 nitrogen treatments.

Although the difference between gross income achieved from each of the 4 treatments was very small, the variation in input costs did affect profitability. The most profitable treatment was the 'Farmer Practice' treatment as it had the lowest fertiliser input cost with little yield or grain quality penalty. The 'Regular Intervals' treatment was the least profitable of the nitrogen treatments in 2019 as the input and application costs were highest.

Nitrogen Application Treatment	Average Yield (t/ha)	Average Grade	Average Price	Average Gross Income ($/ha)	N Product Cost ($/ha)	N Application Cost ($/ha)	Gross Income - Nitrogen Cost ($/ha)
Farmer Practice	2.394	H2	$355	$849.88	$102.70	$20.00	$727.18
All Up Front	2.440	H2	$355	$866.12	$157.30	$30.00	$678.82
Playing the Season	2.427	H2	$355	$861.48	$130.00	$20.00	$711.48
Regular Intervals	2.402	H2	$355	$852.86	$157.30	$40.00	$655.56

3. Condingup – This site was seeded to Scepter wheat in mid-May and growing season conditions were below average in rainfall and no waterlogging occurred.

The nitrogen application regime implemented at the Condingup site consisted of 3 treatments:

a) 134kg/ha in total applied, 32.2kg/ha at seeding, 55.8kg/ha 7 weeks after seeding and 46kg/ha 11.5 weeks after seeding in the 'Farmer Practice' treatment,

b) 134kg/ha in total applied, 32.2kg/ha at seeding followed by 46kg/ha 5 weeks after seeding and 55.8kg/ha 7 weeks after seeding in the 'All Up Front' treatment, and

c) 143.2kg/ha in total applied, 32.3kg/ha at seeding, 27.6kg/ha 5 weeks after seeding, 55.8kg 7 weeks after seeding and 27.6kg/ha 11.5 weeks after seeding in the 'Playing the Season' treatment.

There was no statistically significant difference in Scepter wheat grain yield or protein between the three nitrogen application regimes applied despite there being a difference in the rate of nitrogen and timing of application. The 'Playing the Season' treatment replicates yielded highest (5.776t/ha), followed by the 'Farmer Practice' replicates (5.660t/ha) which were very closely followed by the 'All Up Front' replicates (5.651t/ha). There was little difference in protein between wheat from the 'Farmer Practice' and 'Playing the Season' replicates though it was lower in wheat from the 'All Up Front' replicates.

Grain price varied by only $0 to $10/t between nitrogen treatments applied at this demonstration site. The most profitable treatment was the 'Playing the Season' treatment with the highest rate of nitrogen applied and the latest application date (ie 5th August) when the crop was at growth stage Z24/32-33; just prior to flag leaf emergence. Previous research has shown careful nitrogen management at this stage is important.

The 'Farmer Practice' treatment was the next most profitable of those applied, the difference being $28.58/ha, followed by the 'All Up Front' treatment with a margin of $31/ha. The difference between the most profitable and least profitable treatment was $60/ha.

Nitrogen Application Treatment	Yield (t/ha)	Quality Grade	Price ($/t)	Gross Income ($/ha)	N Product Cost ($/ha)	N Application Cost ($/ha)	Gross Income - Nitrogen Cost ($/ha)	Average Gross Income - Nitrogen Cost ($/ha)
Farmer Practice	6.009	APW1	$350.00	$2,103	$174.20	$30.00	$1,898.95	$1,776.68
Farmer Practice	5.447	APW1	$350.00	$1,906	$174.20	$30.00	$1,702.25	
Farmer Practice	5.523	APW1	$350.00	$1,933	$174.20	$30.00	$1,728.85	
All Up Front	5.631	ASW1	$340.00	$1,915	$174.20	$30.00	$1,710.34	$1,745.67
All Up Front	5.798	APW1	$350.00	$2,029	$174.20	$30.00	$1,825.10	
All Up Front	5.524	APW2	$345.00	$1,906	$174.20	$30.00	$1,701.58	
Playing the season	5.96	H2	$355.00	$2,116	$186.16	$40.00	$1,889.64	$1,805.26
Playing the season	5.7	APW1	$350.00	$1,995	$186.16	$40.00	$1,768.84	
Playing the season	5.667	APW1	$350.00	$1,983	$186.16	$40.00	$1,757.29	

SOCIAL MEDIA POSTING

GRDC uses social media to showcase research investments and disseminate timely, relevant and practical information to key stakeholders in the grains industry. Our audiences are predominantly growers and agricultural advisers.

SOCIAL MEDIA ACCOUNTS:

Facebook: https://www.facebook.com/theGRDC
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Is there any reason why this report cannot be communicated on social media? (Insert info here)

If no, please provide the following:

1. Who is the target audience for this content? (e.g., growers, adviser, researchers, policy makers, etc.)
    a. *Growers and advisers*

2. At what time of year is this content most relevant to the target audience?
    a. *May – August ie after seeding and before crop maturation when nitrogen timing decisions are being made.*

3. On which of GRDC's social media accounts would you like this content posted? Please provide text (2-3 sentences for Facebook and LinkedIn and 140 characters for Twitter), images, graphs, or charts that support the content. Where applicable, please include any relevant Twitter handles (usernames) for project staff.

a. *(Insert info here)*

PROJECT SOCIAL MEDIA ACCOUNTS

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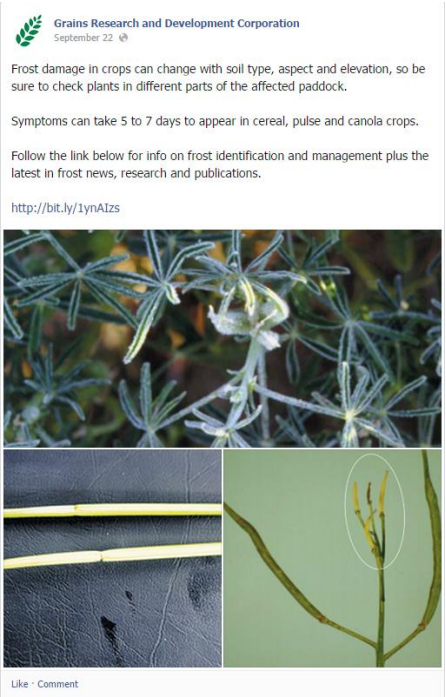

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Contact the social media team at socialmedia@grdc.com.au with any questions.

Please note that publication of content to GRDC social media accounts is at the discretion of GRDC's social media team.

REFERENCES & USEFUL LINKS

List of key publication references and web links relevant to the project and for further exploration of the topic.