Final Technical Report Template

2019 Final Technical Report

'Yardstick' Demonstrations for the Western Region Port Zones

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Abstract

The “Yardstick” project was developed to identify rules of thumb for profitable and productive cropping enterprises in the GRDC Western Region. In 2018 and 2019 Mingenew Irwin Group (MIG) managed four trial sites in the Northern Agricultural Region and focused on nutrition for the main crop types of wheat, barley and canola.

The project was initiated by growers after some initial trials by MADFIG raising questions about whether varieties differed in their responses to fertiliser management. Local growers had questioned whether National Variety Trial (NVT) results were applicable to them, given the standard rate of fertilisers used in NVT trials was higher than rates commonly used by growers in the area. They wanted to give growers confidence that varieties that perform well within the NVT program should also perform well when grown under their own management systems.

Both seasons during the trial period were challenging with low finishing rains and high temperatures that induced crop stress at all locations. It was difficult to draw conclusions from the two years of research undertaken, but it was a worthwhile exercise for the fact that growers did have to seriously consider the impact rainfall and nutrition had on crop yield and overall profit, in two varied seasons. The season and location of the trial impacted yield greater than variety choice and fertiliser decisions, with the optimum nutrition regime differing between seasons and locations.

Executive Summary

The Yardstick trials were initiated after growers raised questions around how new varieties would respond to standard fertilizer rates used by growers rather than the high rates used for consistency in the NVT testing program.

MIG established and managed four trials over a two-year period and tested wheat, barley and canola with four nutrition strategies in the first year and wheat and barley with three nutrition strategies in the second year. The nutrition strategies were developed for three scenarios by considering target yield for a particular site. The target yield was determined by the local growers and agronomists who predicated yield in their paddock if they had a Decile 1, 4 or 7 rainfall year.

There was no evidence from the research to indicate any wheat, barley or canola varieties yielded comparatively differently at higher rates of nutrition. This conclusion confirms that growers are receiving correct information from the early variety evaluation trials. This research is beneficial to growers and industry.

Contents

Background

In 2018 MIG established and managed four trial sites for testing a range of crop types, varieties and nutrition packages in four climatic conditions and soil types within the Geraldton port zone. Treatments were developed and trialled by the MIG with support from local agronomists and in consultation with the host grower. This work was repeated at the same sites, or within the same geographical region in 2019. The research aimed to determine nutrition rules of thumb for the most common varieties of the main crop types grown in the region to assist growers in growing profitable crops that will ensure their future sustainability.

The project was initiated by growers after some initial trials with the Merredin and Districts Farm Improvement Group (MADFIG) raised questions about whether varieties differed in their responses to fertiliser management. Some local growers had questioned whether NVT results were fully applicable to the region, given the standard rate of fertilisers used in NVT trials was higher than rates commonly used by growers in the area. They wanted to give growers confidence that varieties that perform well within the NVT program should also perform well when grown under their own management systems.

The trials in the Geraldton Port Zone were part of a state wide trial run in each of WA's five grain receival port zones.

Project objectives

The research objective is to develop reliable 'Yardstick' information that will enable growers to make decisions on management packages and crop types using rules of thumb that suit their farming systems by April 2020.

Field walks were held during the year to observe and extend the information from the trials.

In 2018 the trials consisted of three crop types – Wheat, Barley and Canola, and four tailored nutrition packages to target expected yield with Decile 1,4 or 7 rainfall. There was also a "Play the Season" treatment that was managed based on the grower's expectations of the current season.

In 2019 the trials were reduced to two crop types – Wheat and Barley, and four tailored nutrition packages to target expected yield with Decile 1,4 or 7 rainfall. Reducing the number of crop types meant that the number of varieties of each type could be increased from two to four.

Methodology

The MIG consulted with local growers, grower groups and agronomists to locate four trial sites across the Northern Agricultural Region. MIG worked with local groups YFIG (Yuna Farm Improvement Group) and MFIG (Morawa Farm Improvement Group).

The trials were located at Three Springs, Mingenew, Morawa and Yuna in 2018. The Mingenew trial was located at the MIG main trial site on red loam. This main site moves to a different location each year and in 2019 was located at Irwin on a light sand over gravel soil type. The Three Springs and Yuna sites both moved paddocks due to rotations but remained on the same soil types. The Morawa site remained in the same paddock.

All trials in 2018 and 2019 used randomised complete block design with four replications. The trial paddocks changed each year but were located within the same shires, with the exception of the Mingenew sites, with the 2018 trial located in Irwin. Trials were managed using farmer best practise, with the DPIRD (Department of Primary Industries and Regional Development) research support unit (Geraldton) sowing, applying pesticides and harvesting the trial. Grain sample quality analysis was conducted by Cooperative Bulk Handling (CBH) Geraldton.

In 2018 treatments at each site consisted of two varieties of three crop types including wheat, barley and canola. Nutrition treatments were tailored to match target yields which were determined using rainfall deciles 1, 4 and 7 for each location and farmer and agronomist knowledge and experience. A 'play the season' treatment was included and allowed the grower or agronomist to change the estimated yield during the season based on crop performance and seasonal conditions. The target yields listed in the tables in Apendix A for 'play the season' are based on the grower's final crop yield estimate in July when post fertiliser decisions had to be made.

In 2019 the trials tested four barley and four wheat varieties and tailored nutrition treatments to match the target yields if the year turned out to be a decile 1,4 or 7 rainfall year. The nutrition treatments in the trial were reduced as there was no 'play the season' treatment included in 2019 as agreed by the working group for this project. Each paddock was registered for Yield Prophet (a yield prediction platform) to compare the actual crop performance with the predicted performance. The decile 4 nutrition strategy was used in Yield Prophet.

Seeding and in-season fertiliser rates were calculated and applied based on soil test results and the target yield. Each site had tailored target yields for each crop type. Plots were sown and harvested by DPIRD using small plot machinery. Throughout 2018 and 2019 the majority of trials were sown dry (see seeding dates for each trial in Site and Seasonal Details), with crops germinating shortly after the break of each season; 25th May, 2018 and 11th June, 2019. In-season fertiliser was applied by MIG with a small plot push spreader. Temperature was recorded throughout the season in the crop canopy using TinyTags.

The tables below summarise the soil analysis, target yield, nutrition treatments and rainfall for each site over the life of the project.

Treatments

Table 1 outlines the varieties used during the trial period, at each site. Varieties were determined by consultation with local agronomists and host farmers.

Table 1: Variety selections across trial sites and years.

	Wheat		Barley		Canola
Site	2018	2019	2018	2019	2018
Yuna	Scepter, Ninja	Scepter, Devil, Ninja, Zen	Spartacus, Scope	Spartacus, Planet, Buff, Rosalind	43Y23, Hyola 404
Morawa	Scepter, Ninja	Scepter, Devil, Ninja, Zen	Spartacus, Scope	Spartacus, Planet, Buff, Rosalind	Stingray, Bonito
Mingenew/Irwin	Scepter, Ninja	Scepter, Devil, Ninja, Zen	Spartacus, Scope	Spartacus, Planet, Buff, Rosalind	43Y23, Hyola 404
Three Springs	Scepter, Ninja	Scepter, Devil, Ninja, Zen	Spartacus, Scope	Spartacus, Planet, Buff, Rosalind	43Y23, Hyola 404

Nutrition treatments varied across crop type and season, and were determined by soils tests, yield targets and rainfall deciles, and were applied by the Mingenew Irwin Group using a small-plot push spreader. Treatments are outlined in Appendix A, Target Yield and Nutrition Treatments.

Site and Seasonal Details

Table 2. Rainfall summary (mm) for Bureau of Meteorology weather sites, closest to trial site location.

Site													
2018	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Yuna	44.8	1.4	4.2	0	24.8	42.8	78.8	59.4	5.6	15.0	3.6	10.2	290.6
Morawa	59.4	6.4	3.0	0	30.2	40.4	79.1	59.8	5.2	16.2	22.6	4.0	326.3
Mingenew	71.6	0	15.4	0	34.8	45.4	87.8	70.0	5.2	33.4	1.0	0	364.6
Three Springs	41.4	0	3.2	0	36.5	46.2	102.9	68.6	2.6	19.7	4.3	0.6	326.0
2019													
Yuna	0.4	0	0	6.8	0.4	100.4	45.0	21.8	6.4	5.2	1.2	0	187.6
Morawa	0	5.0	1.0	20.2	0.6	97.0	36.4	35.0	4.2	7.4	1.6	0.2	208.6
Irwin	0	0	0	0	4.0	145.0	35.2	39.0	13.2	7.2	0	0	243.6
Three Springs	0.8	0	0.8	6.6	0.6	118.4	48.6	30.8	6.4	12.6	0.8	0	226.4

Yuna Site Details

Table 3. 2018 Yuna Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	OC (%)	pH ($CaCl^2$)	EC (dS/m)
1	0-10cm	27	32	194	0.42	5.0	0.119
2	0-10cm	35	20	222	0.37	5.0	0.108

Table 4. 2019 Yuna Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	S (mg/kg)	OC (%)	pH ($CaCl^2$)	EC (dS/m)
1	0-10cm	4	16	126	7	0.45	6.3	0.047
2	0-10cm	3	16	153	7	0.41	6.5	0.057

The trial site at Yuna was on a red-sandy soil and soil test results post seeding 2018 and pre-seeding 2019 have been provided in Table 3 and Table 4. Soil testing was not able to be undertaken at this site prior to seeding in 2018.

Yuna 2018 Site Summary

Seeding date – Wheat 23rd May 2018, Barley 23rd May 2018, Canola 26th April 2018.
This site received 226.4mm rainfall (Table 2) during the 2018 season and high yields for all treatments suggest the soil nutrition was adequate. Germination occurred on June 1st. In 2018 higher temperatures were experienced at this location than the other sites and from the 7th August maximum daily temperatures were above 30°C. For four days from the 11th August, minimum daily temperatures were just below 0°C.

Yuna 2019 Site Summary

Seeding – Wheat 14th May 2019, Barley 14th May 2019
The trial was sown in May but did not emerge until after the first rainfall event on the 7th June, a late emergence for this region. The site received 100mm of rainfall for the month of June but below season average rainfall followed and the finish was dry. The season finished just above a decile 1 rainfall year.

2019 had extreme weather events during the flowering and grain fill period of crop development. There were multiple occasions when temperatures below zero were recorded during flowering and grain fill in August and September, however no frost damage was recorded upon grain quality analysis. Combined with nearly every day from the 3rd of July to the end of September recording daily maximum temperatures of 32°C or above, it is expected that these events have contributed to low yields achieved.

Morawa Site Details

Table 5. 2018, Morawa Site Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)

1	0-10cm	14	26	174	0.49	6.0	0.050
2	0-10cm	13	23	245	0.39	6.3	0.056

Table 6. 2019, Morawa Site Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	S (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)
1	0-10cm	7	23	131	4.2	0.47	6.4	0.064

The trial site at Morawa was on a loamy red sand soil type.

Morawa 2018 Site Summary

Seeding – Wheat 14th May 2018, Barley 14th May 2018, Canola 14th May 2018
This trial was sown dry and the crop germinated after the break of season on June 1st. Some extreme temperatures were experienced during flowering and seed development at this site with a low of -2°C on the 11th August, though no frost or frost damage was observed. There were 11 days above 30°C in August with the highest temperature being 39°C on the 25th August. The first day above 40°C was on the 9th September. This site had 50mm of summer rainfall in 2018.

The grower commented that their average rainfall is around 300ml and 2018 was slightly below this. The season break was four days after the average on May 24th and the crops did set up for a big yield but with the short, hot finish yields did not reach potential.

Morawa 2019 Site Summary

Seeding – Wheat 16th May 2019, Barley 16th May 2019
2019 had extreme weather events during the flowering and grain fill period of crop development. There were four temperatures recorded below 0°C at this site during flowering in August. The impact of frost events on the trial were not assessed individually. These events combined with the 36 days of maximum temperatures 32°C or above from the end of July to the end of September are expected to have contributed to the low yields achieved.

The trial was sown in May but did not emerge until after the first rainfall event on the 7th June, a late emergence for this region. The site received good rainfall for the month of June but was below average following the month of June and was followed by a dry finish. The season finished just above a decile 1 rainfall year.

Mingenew/Irwin Site Details

Table 7. 2018, Mingenew Site Soil Analysis (red loam soil type)

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)
1	0-10cm	26	28	97	0.50	6.3	0.09
2	0-10cm	28	31	134	0.53	6.6	0.12

Table 8. 2019, Irwin Site Soil Analysis (sandplain soil type)

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	S (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)
1	0-10	11	12	30	7.0	1.30	5.9	0.06
2	10-20	9	9	19	5.4	0.70	5.2	0.05

Mingenew 2018 Site Summary **–** Red loam

Seeding – Wheat 15th May 2018, Barley 15th May 2018, Canola 11th May 2018
This trial germinated on 1st June, after the season break on May 25th. Temperatures throughout the season ranged from 0.8ºC to 43.7ºC. The minimum temperature was recorded on the 11th of August and the maximum temperature was recorded on the 7th of October. Temperatures were recorded from the 9th of August until the 9th of October. Low temperatures were reached only once during the trial, once within the trial, on the 11th of August where a minimum of 0.8ºC was reached. High temperatures were reached often during the trial period. Data indicates that 29 days during the trial exceeded 30ºC. The start of October brought high temperatures, continuing until the 8th of October. These temperatures ranged from 32.0ºC on the 5th of September, to 43.7 on the 7th of October.

The grower commented that they were slightly disappointed with how the paddock performed and that the dry end of the season was difficult to manage. They think that when the soil in the trial paddock dries it does tend to restrict plant root growth and that this impacted final yield.

Irwin 2019 Site Summary **–** Light sand over gravel

Seeding – Wheat 15th May 2019, Barley 15th May 2019. All crops germinated on June 11th, 2019.
2019 had extreme weather events during the flowering and grain fill period of crop development (August). There were over 60 days recorded from mid-June to the end of September with maximum temperatures of 32°C or above. There were no temperatures recorded below 0°C at this site. It is expected that the high temperatures at this site would have affected final crop yield as they occurred during flowering and grain fill.

The trial was sown in May but did not emerge until after the first rainfall event on the 7th June. The site received 145mm of rain for the month of June, but rainfall was below average for the remaining growing season and was then followed by a dry finish. The season finished just below a decile 4 rainfall season, but it is expected that crop yields were limited by when the rain fell during the season and only reached the target yield for a decile 1 season. Rainfall at the site during June which may have caused nitrogen leaching. During June plant growth stage went from emergence to four leaf/early tillering. The plants appeared visually poor in leaf colour and development during this time and may not have taken up the seeding nitrogen applied before it leached on this soil type. Leaching was not measured at this site.

Three Springs Site Details

Table 9. 2018, Three Springs Site Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)
1	0-10cm	19	15	68	0.65	5.0	0.04
2	0-10cm	18	20	50	0.63	4.7	0.05

Table 10. 2019, Three Springs Site Soil Analysis

Site	Depth	N (mg/kg)	P (mg/kg)	K (mg/kg)	OC (%)	pH ($CaCL^2$)	EC (dS/m)
1	0-10	2	14	83	0.75	5.8	0.03
2	0-10	2	17	91	0.60	5.5	0.03

Three Springs 2018 Site Summary

Seeding – Wheat 17th May 2018, Barley 17th May 2018, Canola 17th May 2018
At this site crops germinated on June 1st. There were 12 days in August of heat stress when temperatures recorded above 30°C. From September 14th growing conditions were consistently above 30°C and it is assumed no further growth of the plants occurred after this time. This site had 50mm of summer rainfall.

The grower commented that the 2018 season yielded above average for their canola, barley and wheat. The lack of rain in September reduced yield potential and the trial site location ended up being lower pH than expected when trial site selection occurred, and this affected the top end yield in the trial.

Three Springs 2019 Site Summary

Seeding – Wheat 17th May 2019, Barley 17th May 2019
2019 had extreme weather events during the flowering and grain fill period of crop development. There were nine temperature recordings below 0°C at this site during flowering and grain fill in August and September. The impact of each frost event on the trial was not assessed individually. These events combined with the 51 days from the end of July to the end of September with daily maximum temperatures of 32°C or above are expected to have contributed to the low yields achieved.

The trial was sown in May but did not emerge until after the first rainfall event on the 7th June. The site received 118.4mm of rain for the month of June but rainfall was below average for the remainder of the year. The season finished as a decile 1 year.

Location

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1 2018 and 2019	115 06 21	28 05 51
Nearest Town	Yuna	
Trial Site #2 2018 and 2019	115 49 43	29 02 21
Nearest Town	Morawa	
Trial Site #3 2018	115 35 01	29 09 06
Nearest Town	Mingenew	
Trial Site #3 2019	115 05 38	29 10 48
Nearest Town	Dongara	
Trial Site #4 2018 and 2019	115 42 27	29 41 32
Nearest Town	Three Springs	

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or Agro - Ecological Zone/s please indicate which in the table below:

Research	Benefiting GRDC Region (can select up to three regions)	Benefiting GRDC Agro-Ecological Zone (see link: http://www.grdc.com.au/About-Us/GRDC-Agroecological-Zones) for guidance about AE-Zone locations	
Experiment Title	Choose an item. 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

Yield results between nutrition treatments, varieties and locations varied depending on season. The results discussed below are explained by site location.

Yuna

In 2018 and 2019 the Yuna wheat site showed significant differences in yield related to nutrition treatment, not variety selection. Table 11 shows the wheat yield differences in 2018 related to nutrition. Ninja and Scepter with a decile 1 nutrition treatment yielded significantly higher than all other treatments, apart from Scepter with a decile 7 nutrition treatment.

In 2019, significant grain yield responses in the wheat trial were in response to the level of nutrition, not variety selection (Table 12). The decile 7 nutrition treatments yielded significantly higher than the decile 1, however there was no significant yield difference between decile 4 and decile 7 and decile 4 and decile 1. Ninja and Zen gained Australian noodle classification at each nutrition level, while Scepter and Devil achieved a feed classification at each nutrition level.

The barley trials at the Yuna site in 2018 and 2019 indicated there was a significant difference in yield due to variety selection, but not nutrition treatment, shown in tables 13 and 14. In 2018 Spartacus barley yielded higher than Scope across all nutrition treatments (deciles). Rosalind, a feed variety, was the highest yielding and most profitable barley variety across the three nutrition treatments in 2019. Spartacus was the only variety that achieved a malt classification but yielded less than Rosalind at all nutrition levels.

Canola varieties were included in the 2018 trial only and are shown in Table 15. Two commonly grown varieties in the region at the time, 43Y23 and Hyola 404 were used in the trial, with both of these being hybrid, Roundup Ready varieties. There was no significant difference between variety or nutrition treatment in this trial.

Table 16 highlights that no specific fertiliser strategy was consistently the most profitable over the trial period (accumulative 2-year return/ha) due to differences between the 2018 and 2019 seasons. For wheat, Decile 7 in 2018 attracted the highest returns ($854), while in 2019 it was Decile 4 ($162). The fertiliser strategies attracting the highest returns for barley was Decile 1 in 2018 ($1224) and Decile 4 in 2019 ($107).

Table 11. Yuna 2018 Wheat results

Treatment	Plants/ m^2 (Z13)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Ninja D1	78	3.40a	10.4	75.9	5.3	ANW2	19	868
Scepter D1	80	3.30a	10.4	76.9	7.0	AGP1	19	741
Ninja D4	78	3.10b	10.4	75.5	5.3	ANW2	47	778
Scepter D4	78	3.10b	10.2	75.9	6.7	AGP1	47	798
Ninja D7	75	3.10b	11.0	75.4	6.4	ANW2	89	896
Scepter D7	87	3.20ab	10.7	75.5	7.0	AGP1	89	811
Ninja PS	65	3.10b	10.9	74.4	7.0	ANW2	87	840
Scepter PS	72	3.10b	11.4	72.4	6.7	AGP1	87	986
LSD 5%		*0.20*						
CV %		*7.57*						

Notes: Target yields D1: 0.5 t/ha, D4: 1.5 t/ha, D7: 2.4 t/ha, PS: 2.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 12. Yuna 2019 Wheat results

Treatment	Plants/ m^2 (Z13)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Scepter D1	97	0.63b	9.1	83.7	12.8	FED1	35	137
Devil D1	90	0.65b	9.3	81.6	12.0	FED1	35	142
Ninja D1	89	0.54b	9.9	82.2	9.2	ANW2	35	133
Zen D1	103	0.61b	9.5	82.4	7.4	ANW2	35	155

Scepter D4	89	0.69ab	9.3	83.4	12.6	FED1	35	153
Devil D4	95	0.68ab	9.1	82.7	13.0	FED1	35	151
Ninja D4	92	0.64ab	9.4	82.5	10.0	ANW2	35	164
Zen D4	87	0.69ab	9.6	83.0	6.8	ANW2	35	180
Scepter D7	94	0.72a	12.1	81.7	13.1	FED1	70	127
Devil D7	85	0.70a	12.2	80.5	13.5	FED1	70	121
Ninja D7	92	0.66a	12.0	81.0	9.9	ANW2	49	156
Zen D7	92	0.75a	12.0	81.5	8.5	ANW2	49	184
SED Deciles		*0.10*						
SED Decile/Variety		*NS*						

Notes: Target yields D1: 0.8 t/ha, D4: 1.5 t/ha, D7: 2.5 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 13. Yuna 2018 Barley results

Treatment	Plants/m^2 (Z13)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Spartacus D1	90	4.30b	9.2	61.0	68.3	12.5	MALT2	19	1253
Scope D1	90	4.10c	9.5	60.0	67.7	20.5	MALT2	19	1194
Spartacus D4	88	4.40ab	9.6	60.8	68.2	21.1	MALT2	47	1255
Scope D4	96	4.00cd	9.8	59.8	67.6	22.0	MALT2	47	1137
Spartacus D7	79	4.50a	9.8	61.3	69.3	12.2	MALT1	84	1248
Scope D7	93	4.00cd	10.6	60.3	66.8	23.7	MALT2	84	1100
Spartacus PS	96	4.40ab	9.8	61.3	67.4	19.5	MALT1	71	1231
Scope PS	90	3.90d	10.0	60.0	67.2	21.9	MALT2	71	1083
LSD 5%		*0.14*							
CV %		*4.80*							

Notes: Target yields D1: 0.5 t/ha, D4: 1.5 t/ha, D7: 2.4 t/ha, PS: 2.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 14. Yuna 2019 Barley results

Treatment	Plants/ m^2 (Z13)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Spartacus D1	111	0.49bc	10.2	63.0	73.3	28.2	MALT2	35	97
Planet D1	95	0.44c	10.3	63.7	74.5	40.8	BFED1	35	82
Buff D1	102	0.55ab	9.5	63.7	68.9	37.5	BFED1	35	111
Rosalind D1	99	0.59a	9.5	61.7	71.1	35.7	BFED1	35	121
Spartacus D4	119	0.54ab	10.4	64.3	74.4	23.4	MALT2	35	111
Planet D4	109	0.40c	9.9	62.0	73.6	41.0	BFED1	35	72
Buff D4	101	0.56ab	9.6	63.0	70.4	35.7	BFED1	35	113
Rosalind D4	102	0.62a	9.3	61.3	71.0	37.1	BFED1	35	130
Spartacus D7	103	0.55ab	10.3	63.0	73.5	25.7	MALT2	35	114
Planet D7	100	0.42c	9.9	62.0	71.5	37.1	BFED1	35	72
Buff D7	105	0.55ab	9.7	63.3	71.4	36.2	BFED1	35	111
Rosalind D7	113	0.59ab	9.3	61.0	70.8	37.6	BFED1	35	121
SED variety		*0.08*							
SED Decile/Variety		*NS*							

Notes: Target yields D1: 0.8 t/ha, D4: 1.5 t/ha, D7: 2.5 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 15. Yuna 2018 Canola results

Treatment	Plants/m^2 (2 leaf)	Yield (t/ha)	Oil (%)	Grade	Inputs ($/ha)	Profit ($/ha)
43Y23 D1	24	2.00ab	41.6	CAG1	19	855
Hyola 404 D1	26	1.80bc	45.0	CAG1	19	932

43Y23 D4	19	1.90abc	41.8	CAG1	24	1099
Hyola 404 D4	16	1.70c	45.1	CAG1	24	1082
43Y23 D7	25	2.10a	41.2	CAG1	76	1120
Hyola 404 D7	21	1.80bc	44.5	CAG1	76	975
43Y23 PS	23	2.00ab	40.2	CAG1	100	1066
Hyola 404 PS	25	1.80bc	35.0	CAG1	100	1028
LSD 5%		*0.21*				
CV %		*7.20*				

Notes: Target yields D1: 0.3 t/ha, D4: 0.8 t/ha, D7: 1.3 t/ha, PS: 1.5 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018
Canola oil premiums have been included in Profit ($/ha)

Table 16. Return on investment and total farm gate margins (Net return/ha $) for three fertiliser treatments for wheat and barley over two seasons at Yuna. Averages of all varieties were used.

	2018		2019		Accum. 2 year Return/ha ($)
Wheat	**t/ha**	**Net return/ha ($)**	**t/ha**	**Net return/ha ($)**	
Decile 1	3.35	805	0.61	142	947
Decile 4	3.10	788	0.61	162	950
Decile 7	3.15	854	0.71	147	1001
Barley					
Decile 1	4.20	1224	0.52	103	1327
Decile 4	4.20	1196	0.53	107	1303
Decile 7	4.25	1174	0.53	105	1279

Morawa

At the Morawa wheat trials in 2018 and 2019 there was a significant yield increase between nutrition levels, where decile 7 nutrition treatments yielded significantly higher than all other decile nutrition treatments, outlined in Table 17. The decile 7 treatments had a higher target yield, receiving higher nutrition levels, and combined with high rainfall, this contributed to the significantly higher yield results for decile 7. Table 18 shows there was no significant difference between nutrition treatments in 2019, and this may be attributed, to the low rainfall for the season. There were no variety differences in yield in both years of the trial.

Table 19 and 20 show the barley yield results for 2018 and 2019 respectively. There were no significant differences in yield across any treatments at the Morawa site for both years. Spartacus received a MALT grade classification for deciles 1 and 7 in 2019, however, in 2018 Spartacus achieved feed grade classification.

In 2018, Triazine Tolerant (TT) canola varieties, Stingray and Bonito, were grown in at the Morawa site. There were significant differences to yield between nutrition levels, including both Stingray and Bonito yielding significantly higher in decile 7 compared to decile 1, as described in Table 21.

Table 22 highlights that no specific fertiliser strategy was consistently the most profitable over the trial period (accumulative 2-year return/ha) due to differences between the 2018 and 2019 seasons. The fertiliser strategies attracting the highest returns for wheat was Decile 7 in 2018 ($1148) and Decile 1 in 2019 ($415). For barley, Decile 7 in 2018 attracted the highest returns ($1010), while in 2019 it was Decile 1 ($368).

Table 17. Morawa 2018 Wheat results

Treatment	Plants/ m^2 (Z13)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Scepter D1	73	2.56bc	6.9	80.8	2.4	AGP1	19	872
Ninja D1	76	2.38c	7.1	79.4	3.2	ANW2	19	785
Scepter D4	88	2.90b	7.5	79.8	2.3	ANW2	35	948
Ninja D4	85	2.91b	6.9	81	2.2	AGP1	35	974
Scepter D7	86	3.73a	7.4	80.3	1.7	AGP1	89	1209
Ninja D7	81	3.48a	7.9	80.1	1.6	ANW2	89	1087
Scepter PS	83	2.91b	7.1	80.8	2.2	AGP1	36	976
Ninja PS	92	2.61bc	7.3	79.3	2.6	ANW2	36	846
LSD 5%		*0.37*						
CV %		*8.36*						

Notes: Target yields D1: 0.6 t/ha, D4: 1.5 t/ha, D7: 2.3 t/ha, PS: 1.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 18. Morawa 2019 Wheat Results

Treatment	Plants /m² (Z13)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profits ($/ha)
Scepter D1	88	1.50	9.7	79.5	6.4	AGP1	35	414
Devil D1	72	1.48	9.9	77.8	6.6	AGP1	35	409
Ninja D1	78	1.34	10.5	78.2	5.8	ANW2	35	382
Zen D1	74	1.37	10.2	80.3	2.7	ANW1	35	453
Scepter D4	69	1.42	10.4	77.7	8.2	AGP1	99	327
Devil D4	72	1.51	10.9	77.8	6.8	AGP1	99	354
Ninja D4	75	1.45	11.3	78.7	5.2	ANW2	81	370
Zen D4	82	1.40	10.7	79.1	3.1	ANW1	81	419
Scepter D7	90	1.45	11.4	78.0	8.6	AGP1	146	289
Devil D7	73	1.45	12.4	75.9	10.2	FED1	146	248
Ninja D7	85	1.45	11.9	78.1	5.6	ANW2	122	329
Zen D7	86	1.45	11.5	78.8	3.4	ANW1	122	396
SED Variety		*NS*						
SED Decile/Variety		*NS*						

Notes: Target yields D1: 0.1 t/ha, D4: 2.4 t/ha, D7: 3.2 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 19. Morawa 2018 Barley results

Treatment	Plants/ m² (Z13)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Spartacus D1	94	2.65	6.8	64.0	69.9	7.9	BFED1	19	765
Scope D1	99	2.91	7.6	62.5	69.3	13.7	BFED1	19	842
Spartacus D4	99	2.76	7.0	64.2	69.7	8.0	BFED1	23	794
Scope D4	100	3.21	7.1	61.7	69.5	14.9	BFED1	23	927
Spartacus D7	84	3.25	7.3	64.0	69.8	9.1	BFED1	65	897
Scope D7	94	4.01	7.4	62.5	69.0	12.1	BFED1	65	1122
Spartacus PS	105	2.81	7.2	64.3	70.0	8.3	BFED1	50	782
Scope PS	102	2.64	7.0	62.5	69.2	10.4	BFED1	50	731
LSD 5%		*NS*							
CV%		*16.76*							

Notes: Target yields D1: 0.6 t/ha, D4: 1.5 t/ha, D7: 2.3 t/ha, PS: 1.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 20. Morawa 2019 Barley Results

Treatment	Plants/ m² (Z13)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profits ($/ha)
Spartacus D1	118	1.62	10.0	67.3	67.7	26.5	MALT2	35	403
Planet D1	114	1.27	11.6	64.0	67.1	36.9	BFED1	35	302
Buff D1	112	1.58	10.0	66.7	63.5	46.1	BFED1	35	384
Rosalind D1	107	1.57	9.7	64.7	67.6	28.1	BFED1	35	381
Spartacus D4	129	1.72	12.0	67.3	65.3	40.9	BFED1	62	394
Planet D4	107	1.30	13.7	63.7	66.2	45.8	BFED1	62	283
Buff D4	120	1.54	11.6	66.7	62.9	38.2	BFED1	62	346
Rosalind D4	111	1.58	11.6	66.3	64.6	41.5	BFED1	62	357
Spartacus D7	115	1.64	11.2	67.3	68.2	23.0	MALT2	97	346
Planet D7	118	1.37	12.6	64.7	67.4	37.6	BFED1	97	266
Buff D7	123	1.55	10.7	66.7	63.3	44.2	BFED1	97	314
Rosalind D7	110	1.56	10.9	65.3	66.9	34.0	BFED1	97	316
SED Variety		*NS*							
SED Decile/Variety		*NS*							

Notes: Target yields D1: 1.0 t/ha, D4: 2.4 t/ha, D7: 3.2 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 21. Morawa 2018 Canola results

Treatment	Plants/m^2 (2 leaf)	Yield (t/ha)	Oil (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Stingray D1	18	0.92c	49.6	CAN1	19	515
Bonito D1	22	1.04bc	51.1	CAN1	19	586
Stingray D4	25	1.03bc	50.1	CAN1	40	557
Bonito D4	17	0.87c	49.9	CAN1	40	464
Stingray D7	25	1.23ab	48.2	CAN1	110	603
Bonito D7	17	1.35a	49.6	CAN1	110	673
Stingray PS	19	1.14abc	48.4	CAN1	69	592
Bonito PS	17	1.20ab	49.6	CAN1	69	627
LSD 5%		*0.27*				
CV %		*15.93*				

Notes: Target yields D1: 0.5 t/ha, D4: 0.8 t/ha, D7: 1.3 t/ha, PS: 1.1 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018
Canola oil premiums have been included in Profit ($/ha)

Table 22. Return on investment and total farm gate margins (Net return/ha $) for three fertiliser treatments for wheat and barley over two seasons at Morawa. Averages of all varieties were used.

	2018		2019		Accum. 2 year Return/ha ($)
Wheat	**t/ha**	**Net return/ha ($)**	**t/ha**	**Net return/ha ($)**	
Decile 1	2.47	829	1.42	415	1244
Decile 4	2.91	961	1.45	368	1329
Decile 7	3.61	1148	1.45	316	1464
Barley					
Decile 1	2.78	804	1.51	368	1172
Decile 4	2.99	861	1.54	345	1206
Decile 7	3.63	1010	1.53	311	1321

Mingenew/Irwin

In 2018, the wheat trial at the Mingenew site did not achieve it's target yield in any treatment. The decile 1 treatment was the highest yielding treatment (Table 23). There was a significant difference in yield between Ninja and Scepter, with Scepter yielding higher than Ninja in decile 4, 7 and 'play the season' nutrition levels in 2018.

In 2019, Ninja showed a significantly higher yield in decile 4 and 7 nutrition treatments compared to decile 1 treatments, and Zen yielded significantly higher with decile 7 nutrition compared to decile 1 nutrition treatments, shown in Table 24. Decile 4 and 7 treatments had higher protein levels than decile 1, likely to be a result of the additional nitrogen applied both at the beginning of the season and during the season.

Yield results for barley are shown in Table 25 and 26 and indicate that there were no significant differences in yield between treatments in 2018 or 2019.

There were no significant differences in yield between treatments in the canola trial sown in 2018, shown in Table 27.

Table 28 highlights that no specific fertiliser strategy was consistently the most profitable over the trial period (accumulative 2-year return/ha) due to differences between the 2018 and 2019 seasons. It is difficult to compare the Mingenew sites, however as the soil types and trial location varied between the two seasons. The fertiliser strategies attracting the highest returns for wheat was Decile 1 in 2018 ($761) and Decile 4 in 2019 ($21). For barley, Decile 4 in 2018 attracted the highest returns ($1057), while in 2019 it was Decile 1 ($151).

Table 23. Mingenew 2018 Wheat results

Treatment	Plants /m^2 (Z12)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profits ($/ha)
Scepter D1	83	2.39a	11.2	74.1	5.1	APW1	28	861
Ninja D1	80	1.98abc	13.2	72.0	7.8	AGP1	28	661
Scepter D4	85	2.38a	12.8	69.7	6.8	AGP1	38	774
Ninja D4	83	1.82bc	14.2	66.5	8.9	FED1	38	507
Scepter D7	81	2.04ab	14.3	66.3	10.3	FED1	61	480
Ninja D7	81	1.54c	15.9	65.8	14.7	FED1	61	326
Scepter PS	89	2.36a	12.3	69.5	5.72	AGP1	38	713
Ninja PS	81	1.88bc	14.4	67.1	10.6	FED1	38	471

LSD 5%		*0.46*						
CV %		*15.3*						

Notes: Target yields D1: 1.5 t/ha, D4: 2.5 t/ha, D7: 4.0 t/ha, PS: 3.0 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 24. Irwin 2019 Wheat results

Treatment	Plants /m² (Z12)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profits ($/ha)
Scepter D1	76	0.29*bc*	11.1	78.7	2.5	APW1	95	-1
Devil D1	74	0.28*c*	11.4	80.0	2.6	APW1	95	-4
Ninja D1	82	0.26*c*	11.3	78.3	2.4	ANW1	84	9
Zen D1	95	0.42*a*	11.1	78.2	1.4	ANW1	84	66
Scepter D4	73	0.30*bc*	13.8	77.0	2.5	H1	138	37
Devil D4	90	0.27*c*	13.2	78.8	2.7	H1	138	47
Ninja D4	77	0.33*b*	14.3	76.6	2.5	ANW2	110	-7
Zen D4	105	0.38*ab*	14.0	78.5	1.6	ANW2	110	8
Scepter D7	92	0.26*c*	14.1	77.2	3.0	H1	192	-104
Devil D7	87	0.23*c*	13.7	77.7	2.8	H1	192	-114
Ninja D7	97	0.34*b*	14.8	77.3	2.2	ANW2	157	-51
Zen D7	108	0.35*b*	14.6	75.9	2.8	ANW2	157	-48
SED Variety		*0.046*						
SED Decile/Variety		*NS*						

Notes: Target yields D1: 0.9 t/ha, D4: 2.0 t/ha, D7: 2.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 25. Mingenew 2018 Barley results

Treatment	Plants/m² (Z12)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Spartacus D1	131	3.55	9.70	61.0	68.5	36.5	BFED1	28	1023
Scope D1	138	3.38	10.6	59.8	64.7	67.4	BFED1	28	972
Spartacus D4	138	3.87	10.25	60.7	67	49.2	BFED1	38	1089
Scope D4	129	3.65	10.32	59.8	65.7	64.3	BFED1	38	1024
Spartacus D7	152	3.65	12.75	60.7	64.2	81.6	BFED1	61	943
Scope D7	141	3.11	12.9	59.5	61.7	85.5	BFED1	61	784
Spartacus PS	136	3.57	10.62	59.0	66.6	54.0	BFED1	38	966
Scope PS	191	3.37	11.3	61.2	62.7	80.3	BFED1	38	907
LSD 5%		*NS*							
CV %		*11.3*							

Notes: Target yields D1: 1.5 t/ha, D4: 2.5 t/ha, D7: 4.0 t/ha, PS: 3.2 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 26. Irwin 2019 Barley results

Treatment	Plants /m² (Z12)	Yield (t/ha)	Protein (%)	Colour	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profits ($/ha)
Spartacus D1	111	0.81	15.6	58	62.0	28.0	BFED1	75	140
Planet D1	114	0.76	12.5	56	61.3	37.0	BFED1	75	126
Buff D1	114	0.82	10.0	57	61.1	30.8	BFED1	75	142
Rosalind D1	111	1.00	12.5	55	62.8	27.3	MALT2	75	195
Spartacus D4	116	0.77	13.5	57	62.8	28.4	BFED1	85	119
Planet D4	92	0.72	9.5	56	61.7	26.2	BFED1	85	106
Buff D4	111	0.79	12.1	57	61.4	35.7	BFED1	85	124
Rosalind D4	86	1.02	12.3	55	60.6	25.6	BFED1	85	185
Spartacus D7	112	0.72	15.9	58	58.6	38.2	BFED1	124	67
Planet D7	94	0.71	11.7	56	62.4	28.3	MALT2	124	68
Buff D7	130	0.79	13.6	57	60.5	38.5	BFED1	124	85
Rosalind D7	119	0.86	14.1	55	61.6	27.4	BFED1	124	104
SED Variety		*NS*							

SED Decile/Variety		*NS*							

Notes: Target yields D1: 0.9 t/ha, D4: 2.0 t/ha, D7: 2.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 27. Mingenew 2018 Canola results

Treatment	Plants/m² (2 leaf)	Yield (t/ha)	Oil (%)	Grade	Inputs ($/ha)	Profit ($/ha)
43Y23 D1	28	1.46	43.1	CAG1	45	729
Hyola 404 D1	37	1.61	41.9	CAG1	45	808
43Y23 D4	39	1.59	40.2	CAG1	97	746
Hyola 404 D4	35	1.54	39.7	CAG1	97	718
43Y23 D7	32	1.64	39.9	CAG1	242	627
Hyola 404 D7	28	1.65	38.1	CAG1	242	632
43Y23 PS	35	1.55	40.9	CAG1	33	788
Hyola 404 PS	46	1.63	40.3	CAG1	33	831
LSD 5%		*NS*				
CV %		*7.6*				

Notes: Target yields D1: 1.0 t/ha, D4: 1.5 t/ha, D7: 3.0 t/ha, PS: 1.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018
Canola oil premiums have been included in Profit ($/ha)

Table 28. Return on investment and total farm gate margins (Net return/ha $) for three fertiliser treatments for wheat and barley over two seasons at Mingenew/Irwin. Averages of all varieties were used.

	2018		2019		Accum. 2 year Return/ha ($)
Wheat	**t/ha**	**Net return/ha ($)**	**t/ha**	**Net return/ha ($)**	
Decile 1	2.19	761	0.31	18	779
Decile 4	2.10	641	0.32	21	662
Decile 7	1.79	403	0.30	-79	324
Barley					
Decile 1	3.47	998	0.85	151	1149
Decile 4	3.76	1057	0.83	134	1191
Decile 7	3.38	864	0.77	81	945

Three Springs

Wheat results at the Three Springs sites showed varied results (Table 26), with no significant difference in yield be determined in 2018 between any treatments, and 2019 (Table 27) results showing significant yield differences within varieties and the nutrition level. When grown with the decile 1 nutrition level, Scepter achieved significantly higher yield compared to decile 4 and decile 7, with decile 4 treatments also yielding significantly higher than decile 1. Devil yielded significantly higher in the decile 1 treatments than decile 4 and 7. Scepter and Devil yields decreased significantly as crop nutrition increased. Zen yield remained relatively stable across each nutrition treatment while Ninja yield increased, but not significantly. Decile 1 treatments were the most profitable.

The Three Springs barley site showed that there was no significant response to yield for the nutrition treatments in both years. 2018 saw no significant yield response to varieties (Table 28), while 2019 saw varieties significantly impacting yield (Table 29). Planet yielded significantly less than all other varieties tested across all decile ranges. Grain protein was highest in the decile 7 treatment.

Table 30 shows there was a significant yield response to nutrition in canola. The Decile 1 nutrition treatment canola yielded above the target but significantly less than the other treatments irrespective of variety.

Table 34 highlights that for wheat there was no specific fertiliser strategy that was consistently the most profitable over the trial period (accumulative 2-year return/ha) due to differences between the 2018 and 2019 seasons. The fertiliser strategies attracting the highest returns for wheat was Decile 7 in 2018 ($840) and Decile 1 in 2019 ($316). For Barley, Decile 4 attracted the highest returns in 2018 ($708) and 2019 ($240) and was therefore consistently the most profitable nutrition strategy over the trial period.

Table 29. Three Springs 2018 Wheat results

Treatment	Plants /m² (Z13)	Yield (t/ha)	Protein (%)	Weight (kg/hl)	Screenings (%)	Grade	Inputs ($/ha)	Profit ($/ha)
Scepter D1	115	2.55	9.1	80.9	3.6	AGP1	39	865
Ninja D1	109	2.25	9.4	81.3	2.9	ANW2	39	738

Scepter D4	117	2.37	9.4	80.6	3.6	AGP1	71	764
Ninja D4	124	2.50	9.4	81.6	3.7	ANW2	71	706
Scepter D7	116	2.83	9.4	82.1	3.1	AGP1	113	895
Ninja D7	126	2.60	9.6	81.8	3.6	ANW1	113	785
Scepter PS	134	2.66	9.4	80.1	3.5	AGP1	80	858
Ninja PS	115	3.10	9.8	82.1	3.3	ANW1	80	992
LSD 5%		*NS*						
CV %		*15.81*						

Notes: Target yields D1: 1.5 t/ha, D4: 2.4 t/ha, D7: 2.8 t/ha, PS: 3.0 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 30. Three Springs 2019 Wheat results

Treatment	**Plants /m² (Z13)**	**Yield (t/ha)**	**Protein (%)**	**Weight (kg/hl)**	**Screenings (%)**	**Grade**	**Inputs ($/ha)**	**Profit ($/ha)**
Scepter D1	86	1.43a	9.0	80.7	5.5	AGP1	64	365
Devil D1	92	1.25b	8.9	78.8	5.1	AGP1	64	311
Ninja D1	84	1.18b	9.2	79.0	4.9	ANW2	64	303
Zen D1	100	1.12bc	9.0	78.0	3.9	ANW2	64	284
Scepter D4	111	1.25b	9.3	80.5	5.5	AGP1	98	277
Devil D4	105	1.00c	8.7	79.3	4.7	ASW1	98	213
Ninja D4	93	1.21b	10.5	79.8	5.2	ANW2	76	300
Zen D4	92	0.98c	10.5	80.5	3.0	ANW1	76	274
Scepter D7	91	0.96cd	10.4	80.1	6.2	AGP1	142	146
Devil D7	100	0.80d	9.5	79.8	4.9	ASW1	142	107
Ninja D7	82	1.33ab	10.2	80.0	5.3	ANW2	114	300
Zen D7	115	1.10bc	10.0	81.4	3.3	ANW1	114	279
SED Deciles		*0.10*						
SED Decile/Variety		*0.17*						

Notes: Target yields D1: 0.9 t/ha, D4: 2.0 t/ha, D7 Noodle: 2.8 t/ha, D7 Hard: 3.2 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 31. Three Springs 2018 Barley results

Treatment	**Plants /m² (Z13)**	**Yield (t/ha)**	**Protein (%)**	**Colour**	**Weight (kg/hl)**	**Screenings (%)**	**Grade**	**Inputs ($/ha)**	**Profit ($/ha)**
Spartacus D1	80	2.75	9.2	57	66.7	16.5	MALT2	24	790
Scope D1	75	2.08	8.4	56	62.7	17.8	BFED1	24	591
Spartacus D4	81	2.54	9.0	58	64.6	16.8	MALT2	61	690
Scope D4	70	2.66	9.0	57	63.7	23.6	MALT2	61	726
Spartacus D7	115	2.30	8.6	58	65.9	18.6	BFED1	103	577
Scope D7	80	2.60	8.9	57	67.3	17.4	BFED1	103	665
Spartacus PS	75	2.41	8.9	58	66.5	14.4	BFED1	85	628
Scope PS	56	2.84	9.2	56	62.9	20.0	MALT2	85	755
LSD 5%		*NS*							
CV %		*11.34*							

Notes: Target yields D1: 1.5 t/ha, D4: 2.4 t/ha, D7: 2.8 t/ha, PS: 3.5 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018

Table 32. Three Springs 2019 Barley results

Treatment	**Plants /m² (Z13)**	**Yield (t/ha)**	**Protein (%)**	**Colour**	**Weight (kg/hl)**	**Screenings (%)**	**Grade**	**Inputs ($/ha)**	**Profit ($/ha)**
Spartacus D1	109	1.05e	10.1	60	63.6	32.5	MALT2	64	220
Planet D1	106	0.80g	9.7	60	64.1	44.5	BFED1	64	148
Buff D1	113	1.29b	9.2	61	62.3	33.9	MALT2	64	284
Rosalind D1	119	1.19c	9.3	58	62.7	39.4	BFED1	64	251
Spartacus D4	103	1.10d	10.0	60	64.2	29.7	MALT2	64	233

Planet D4	92	0.88f	9.5	58	60.7	43.0	BFED1	64	169
Buff D4	113	1.28b	9.5	61	62.9	32.4	MALT2	64	282
Rosalind D4	116	1.28b	9.5	58	63.0	39.1	BFED1	64	275
Spartacus D7	108	1.16c	11.3	60	63.9	39.8	BFED1	85	222
Planet D7	95	0.79g	11.5	59	59.7	45.1	BFED1	85	124
Buff D7	78	1.33ab	10.5	59	64.4	36.5	BFED1	85	267
Rosalind D7	110	1.34a	10.3	58	63.5	45.1	BFED1	85	270
SED Variety		*0.04*							
SED Variety/Decile		*NS*							

Notes: Target yields D1: 0.9 t/ha, D4: 2.0 t/ha, D7: 2.8 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2019

Table 33. Three Springs 2018 Canola results

Treatment	**Plants/m^2 (2 leaf)**	**Yield (t/ha)**	**Oil (%)**	**Grade**	**Inputs ($/ha)**	**Profit ($/ha)**
43Y23 D1	78	1.65e	46.5	CAG1	24	850
Hyola 404 D1	77	1.76de	49.6	CAG1	24	908
43Y23 D4	51	2.12ab	46.2	CAG1	56	1067
Hyola 404 D4	106	2.04abc	48.6	CAG1	56	1025
43Y23 D7	84	2.26a	46.8	CAG1	163	1033
Hyola 404 D7	46	1.84bcde	49.4	CAG1	163	812
43Y23 PS	77	2.20ab	46.1	CAG1	154	1012
Hyola 404 PS	78	1.94bcd	49.8	CAG1	154	874
LSD 5%		*0.27*				
CV %		*8.61*				

Notes: Target yields D1: 0.75 t/ha, D4: 1.2 t/ha, D7: 1.4 t/ha, PS: 2.0 t/ha
Profit has been calculated by subtracting fertilizer inputs ($/ha) from grain returns
All grain prices are net delivered to Geraldton and are GST exclusive as at 1st December 2018
Canola oil premiums have been included in Profit ($/ha)

Table 34. Returns per hectare and total farm gate margins (Net return/ha $) for three fertiliser treatments for wheat and barley over two seasons at Three Springs. Averages of all varieties were used.

	2018		**2019**		**Accum. 2 year Return/ha ($)**
Wheat	**t/ha**	**Net return/ha ($)**	**t/ha**	**Net return/ha ($)**	
Decile 1	2.40	802	1.25	316	1118
Decile 4	2.44	735	1.11	266	1001
Decile 7	2.72	840	1.05	208	1048
Barley					
Decile 1	2.42	691	1.08	226	917
Decile 4	2.60	708	1.14	240	948
Decile 7	2.45	621	1.16	221	842

Discussion of Results

The Yardstick trials located in the Northern Agricultural Region over two seasons showed varying results in terms of nutrition and variety impacts on yield. The season and location of the trial impacted yield greater than variety choice and fertiliser decisions, with the optimum nutrition regime differing between seasons and locations. Results varied depending on site location and seasonal conditions, making it difficult to make general conclusions for the Geraldton Port Zone.

At the Yuna site in 2018 and 2019 there was a significant difference in the yield of wheat due to nutrition treatment. In 2018, both varieties (Ninja and Scepter) in decile 1 yielded significantly higher than the same varieties in decile 4 and decile 7, with the exception of Scepter in decile 7. In 2019, decile 7 nutrition treatments yielded significantly higher than decile 1 nutrition treatments. The Yield Prophet Crop report predicted a 1.9t/ha yield for this trial on 22nd October 2019 using a decile 4 rainfall year. All treatments yielded below this estimate and the program may not have accounted for the full effect of high temperatures on yield during crucial stage of crop development.

The barley trials at Yuna in 2018 and 2019 found that there was a significant difference in yield due to variety selection, but not nutrition treatment. In 2018 Spartacus barley yielded higher than Scope across all nutrition treatments. This suggests that Spartacus barley is more suited to this location than Scope. In 2019, a different selection of barley varieties were tested in the same geographic location and again, significant yield responses were in response to variety selection. Rosalind was the highest yielding and most profitable variety across the three nutrition treatments. In the same year there was only a $5/t difference between MALT2 and FEED1 barley grades at the time of analysis.

At Morawa in 2019, there was a significant wheat yield increase between nutrition levels, where decile 7 nutrition treatments yielded significantly higher than all other decile nutrition treatments. The decile 7 treatments had a higher target yield, receiving higher nutrition levels, and combined with high rainfall, this contributed to the significantly higher yield results for decile 7. There was no significant difference between nutrition treatments in 2019, and this may be attributed, to the low rainfall for the season. In 2019, Yield Profit estimated a wheat yield of 0.9t/ha on 22nd October 2019 at decile 4 nutrition. All treatments achieved a higher yield than this prediction.

There were no significant differences in barley yields across any treatments at the Morawa site for both 2018 and 2019.

In 2018, Triazine Tolerant (TT) canola varieties were grown in at the Morawa site. TT canola was chosen over RR varieties due to their lower cost, and reduced risk for this typically lower rainfall area within the Geraldton Port Zone. In 2018, both canola varieties in the trial yielded significantly higher in decile 7 compared to decile 1.

The Mingenew sites varied between 2018 and 2019, with the 2018 site being located east of Mingenew, on a loam soil type, and the 2019 site, located in Irwin west of Mingenew on sandplain soil type. These varying soil types make it difficult to compare the yields between years, as soil type and location greatly influence the deciles and associated treatments.

In 2018, the wheat trial at the Mingenew site did not achieve it's target yield in any treatment. The decile 1 nutrition treatment was the highest yielding treatment, indicating that nutrition was not a limiting factor in crop yield at this site. High temperatures at the end of the season may have resulted in a reduction of yield. There was a significant difference in yield between Ninja and Scepter in decile 4, 7 and 'play the season' nutrition levels. This indicates that at this site, Scepter was more suited to and more profitable in this location.

The 2019 the Irwin site yielded poorly, due to a combination of poor soil type (sandplain), and rainfall which erratic throughout the season and included large amounts of rainfall followed by long dry periods. Ninja showed a significantly higher yield in decile 4 and 7 nutrition treatments, and Zen yielded significantly higher with decile 7 nutrition. Yield Prophet was used to estimate potential yield at the Irwin site. The final yield predicted was 1.7t/ha, approximately four times the actual yield recorded of wheat. Nutrition leaching in the soil profile on this soil type and extreme weather conditions may have contributed to this yield profit estimation. Decile 4 and 7 treatments had higher protein levels than decile 1, likely to be a result of the additional nitrogen applied both at the beginning of the season and during the season. There was some damage from cockatoos at this site. Unfortunately, the damage was random throughout the plots so no plots were able to be excluded from the results.

There were no significant differences in yield between treatments in the Mingenew canola trial sown in 2018. There were three days above 30°C in August and on 9th September the site reached a high temperature of 36°C, and it is expected that these high temperatures impacted flowering and grain fill, and the final yield.

Wheat results at the Three Springs sites showed varied results, with no significant difference in yield be determined in 2018 between any treatments. While 2019 results showed significant yield differences within varieties and the nutrition level. Decile 1 treatments were the most profitable. The season finished as a decile 1 year and decile 1 nutrition targets were achieved by all varieties, while decile 4 and 7 targets were not. Yield Prophet estimated a

wheat yield of 0.8t/ha for this site at decile 4 nutrition on the 22nd October 2019. This yield sits within the range of final wheat yields achieved.

The Three Springs barley site showed that there was no significant response to yield for the nutrition treatments in both years. 2018 saw no significant yield response to varieties, while 2019 saw varieties significantly impacting yield. Planet yielded significantly less than all other varieties tested across all decile ranges and therefore may not be the most suitable barley variety for this location within the GPZ.

There was a significant yield response to nutrition in canola at Three Springs, with the decile 1 nutrition treatment yielding above the target but significantly less than the other treatments irrespective of variety.

Conclusion

This short term project focused on varieties and nutrition on three crop types, in four locations over two seasons. After the first year of the project, the working group changed the design of the project to focus on cereals, thus allowing more varieties to be evaluated in 2019. Although the research proved interesting, it is difficult to conclude solid findings based on the two varying seasons and varying varieties tested.

The research has indicated that nutrition levels can play a role in crop yields, especially in seasons where rainfall deciles are below average. The interaction between varieties and nutrition levels on yield could be seen in some sites, however there did not appear to be any consistency between varieties across sites and across years. There are no 'rules of thumb' that can be developed using this research.

Further research could be focused on targeting yield throughout the season based of nutrition levels and the impact these decisions have on the final grain yield and profit. It was clear in the two seasons this trial was conducted that there is no way to actively forecast the outcome of the year in terms of rainfall, so having the ability to adjust fertiliser decisions through the season is important to ensure fertiliser inputs are not wasted by the crop (nutrition is not utilised for yield or quality). Growers need to have the ability to make informed decisions around paddock nutrition, to ensure profitable enterprises over varying seasons.

Implications

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Appendix A.
Target Yield and Nutrition Treatments Title

Table 31. 2018 Yuna Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N (Units)	Total P (Units)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 19th July (kg/ha)
		Wheat				
Decile 1 (178mm)	0.5	4	4	29kg Agstar	Nil	Nil
Decile 4 (270mm)	1.5	28	5	36kg Agstar	46kg	Nil
Decile 7 (342mm)	2.4	52	8	57kg Agstar	65kg	36kg Urea
PTS	2.8	52	8	57kg Agstar	46kg	50kg Urea
		Barley				
Decile 1	0.5	4	4	29kg Agstar	Nil	Nil
Decile 4	1.5	28	5	36kg Agstar	46kg	Nil
Decile 7	2.4	52	8	57kg Agstar	65kg	25kg Urea
PTS	2.8	40	8	57kg Agstar	46kg	20kg Urea
		Canola				
Decile 1	0.3	4	4	29kg Agstar	Nil	Nil
Decile 4	0.8	5	5	36kg Agstar	Nil	Nil
Decile 7	1.3	45	8	57kg Agstar	Nil	76kg Urea
PTS	1.5	68	8	57kg Agstar	Nil	122kg Urea

Table 32. 2019 Yuna Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N Applied (kg/ha)	Total P Applied (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 1st August (kg/ha)
		Wheat				
Decile 1 (178mm)	0.8	7	7	50kg Agstar Extra	Nil	Nil
Decile 4 (270mm)	1.5	7	7	50kg Agstar Extra	Nil	Nil
Decile 7 Noodle (342mm)	2.5	18	7	50kg Agstar Extra	Nil	30kg NS51
Decile 7 Hard (342mm)	2.5	34	7	50kg Agstar Extra	Nil	73kg NS51
		Barley				
Decile 1	0.8	7	7	50kg Agstar Extra	Nil	Nil
Decile 4	1.5	7	7	50kg Agstar Extra	Nil	Nil
Decile 7	2.5	7	7	50kg Agstar Extra	Nil	Nil

Table 33. 2018, Morawa Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N (kg/ha)	Total P (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding	Post Fertiliser 18th July (kg/ha)
		Wheat				
Decile 1 (188mm)	0.6	4	4	29kg Agstar	Nil	Nil
Decile 4 (270mm)	1.5	15	5	36kg Agstar	Nil	22kg Urea
Decile 7 Noodle (336mm)	2.3	54	8	57kg Agstar	65kg	35kg Urea
Decile 7 Hard (336mm)	2.3	58	8	57kg Agstar	65kg	43kg Urea
PTS Noodle	1.8	16	5	36kg Agstar	Nil	24kg Urea
PTS Hard	1.8	19	5	36kg Agstar	Nil	31kg Urea
		Barley				
Decile 1	0.6	4	4	29kg Agstar	Nil	Nil
Decile 4	1.5	5	5	35kg Agstar	Nil	Nil
Decile 7	2.3	33	8	57kg Agstar	54kg	Nil
PTS	1.8	19	8	57kg Agstar	Nil	25kg Urea
		Canola				
Decile 1	0.5	4	4	29kg Agstar	Nil	Nil
Decile 4	0.8	16	6	43kg Agstar	Nil	22kg Urea
Decile 7	1.3	61	9	64kg Agstar	Nil	140kg NS51
PTS	1.1	42	6	43kg Agstar	Nil	79kg Urea

Note: * this site had 50mm of summer rainfall

Table 34. 2019, Morawa Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N (kg/ha)	Total P (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding	Post Fertiliser 1st August (kg/ha)
		Wheat				
Decile 1 (188mm)	1.0	7	7	50kg Agstar Extra	Nil	Nil
Decile 4 Noodle (270mm)	2.4	47	7	50kg Agstar Extra	Nil	87kg Urea
Decile 4 Hard (270mm)	2.4	62	7	50kg Agstar Extra	Nil	120kg Urea
Decile 7 Noodle (336mm)	3.2	83	7	50kg Agstar Extra	Nil	165kg Urea
Decile 7 Hard	3.2	103	7	50kg Agstar Extra	Nil	209kg Urea
		Barley				
Decile 1	1.0	7	7	50kg Agstar Extra	Nil	Nil
Decile 4	2.4	31	7	50kg Agstar Extra	Nil	52kg Urea
Decile 7	3.2	61	7	50kg Agstar Extra	Nil	117kg Urea

Table 35. 2018, Mingenew Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N applied (kg/ha)	Total P applied (kg/ha)	Pre-seeding (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 19th July (kg/ha)
		Wheat					
Decile 1 (218mm)	1.5	27	6	100kg SOA	43kg Agstar	Nil	Nil
Decile 4 (324mm)	2.5	41	8	100kg SOA	57kg Agstar	Nil	33kg Urea
Decile 7 (395mm)	4.0	112	14	100kg SOA	93kg Agstar	65kg Urea	104kg Urea
PTS	3.0	89	8	100kg SOA	57kg Agstar	52kg Urea	84kg Urea
		Barley					
Decile 1	1.5	27	6	100kg SOA	43kg Agstar	Nil	Nil
Decile 4	2.5	41	8	100kg SOA	57kg Agstar	37kg Urea	Nil
Decile 7	4.0	105	14	100kg SOA	93kg Agstar	65kg Urea	83kg Urea
PTS	3.2	77	8	100kg SOA	57kg Agstar	46kg Urea	58kg Urea
		Canola					
Decile 1	1.0	41	5	100kg SOA	43kg Agstar	Nil	33kg Urea
Decile 4	1.5	86	7	100kg SOA	50kg Agstar	Nil	126kg Urea
Decile 7	3.0	175	12	100kg SOA	86kg Agstar	Nil	384kg NS51
PTS	1.8	112	7	100kg SOA	50kg Agstar	Nil	183kg Urea

Note: * This site had 50mm of summer rainfall

Table 36. 2019, Irwin Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N applied (kg/ha)	Total P applied (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 1st August (kg/ha)
		Wheat				
Decile 1 Noodle (270mm)	0.9	18	12	100kg K-Till Extra	17kg	Nil
Decile 1 Hard (270mm)	0.9	27	12	100kg K-Till Extra	37kg	Nil
Decile 4 Noodle (320mm)	2.0	38	12	100kg K-Till Extra	17kg	54kg NS51
Decile 4 Hard	2.0	60	12	100kg K-Till Extra	37kg	89kg NS51
Decile 7 Noodle (410mm)	2.8	74	13	100kg K-Till Extra	17kg	151kg NS51
Decile 7 Hard	2.8	101	13	100kg K-Till Extra	37kg	200kg NS51
		Barley				
Decile 1	0.9	10	12	100kg K-Till Extra	Nil	Nil
Decile 4	2.0	18	12	100kg K-Till Extra	Nil	20kg NS51
Decile 7	2.8	47	13	100kg K-Till Extra	Nil	100kg NS51

Table 37. 2018, Three Springs Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N applied (kg/ha)	Total P applied (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 19th July (kg/ha)
		Wheat				
Decile 1 (201mm)	1.5	19	5	36kg Agstar	30kg Urea	Nil
Decile 4 (294mm)	2.4	38	8	57kg Agstar	65kg Urea	Nil
Decile 7 (352mm)	2.8	70	10	71kg Agstar	65kg Urea	67kg Urea
PTS Hard	3.0	49	8	57kg Agstar	46kg Urea	43kg Urea
PTS Noodle	3.0	49	8	57kg Agstar	65kg Urea	28kg Urea
		Barley				
Decile 1	1.5	5	5	36kg Agstar	Nil	Nil
Decile 4	2.4	29	8	57kg Agstar	46kg Urea	Nil
Decile 7	2.8	61	10	71kg Agstar	65kg Urea	46kg Urea
PTS	3.5	50	8	57kg Agstar	46kg Urea	46kg Urea
		Canola				
Decile 1	0.75	5	5	36kg Agstar	Nil	Nil
Decile 4	1.2	22	8	57kg Agstar	Nil	38kg NS51
Decile 7	1.4	99	10	71kg Agstar	Nil	241kg NS51
PTS	2.0	97	8	57kg Agstar	Nil	241kg NS51

Note: *This site had 50mm summer rain

Table 38. 2019, Three Springs Target Yield and Nutrition Treatments

Decile	Target Yield (t/ha)	Total N applied (kg/ha)	Total P applied (kg/ha)	Seeding Compound (kg/ha)	Urea at Seeding (kg/ha)	Post Fertiliser 31st July (kg/ha)
		Wheat				
Decile 1 (201mm)	0.9	9	10	85kg K-Till Extra	Nil	Nil
Decile 4 Noodle (294mm)	2.0	18	10	85kg K-Till Extra	Nil	25kg NS51
Decile 4 Hard	2.0	35	11	85kg K-Till Extra	Nil	71kg NS51
Decile 7 Noodle (352mm)	2.8	47	11	85kg K-Till Extra	Nil	103kg NS51
Decile 7 Hard	3.2	68	11	85kg K-Till Extra	Nil	160kg NS51
		Barley				
Decile 1	0.9	9	10	85kg K-Till Extra	Nil	Nil
Decile 4	2.0	9	10	85kg K-Till Extra	Nil	Nil
Decile 7	2.8	25	10	85kg K-Till Extra	Nil	44kg NS51