Final Technical Results Report

2023

NGN - Investigating late winter to early spring cereal cropping opportunities for grain growers following autumn waterlogging - South-Western Australia

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REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	YES ☐ NO ☒
Results are incomplete	YES ☐ NO ☒
Commercial/IP concerns	YES ☐ NO ☒
Embargo date	YES ☐ NO ☒ If Yes, Date: N/A

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ABSTRACT

In the high rainfall zone (HRZ) of Western Australia (WA) waterlogging is an ever-present issue on the commonly found shallow duplex soils. As a result, paddocks can be untrafficable at seeding, crops can fail to emerge (seed burst), and staggered germination is commonplace. Often these seeding attempts are chemically terminated and paddocks abandoned. The trials undertaken as part of the project aimed to determine how late into the growing season farmers could profitably sow winter cereal crops (barley and wheat), and under what optimised agronomic strategies (crop/cultivar choice, fertiliser strategy). In both 2022 and 2023, four small plot trials were sown along the South Coast HRZ of WA. These trials included three barley and two wheat cultivars, with two nitrogen strategies applied to each cultivar, across three times of sowing (TOS). In 2022, a decile 9 rainfall year, the cereal yield results were outstanding, likely due to each TOS treatment being seeded into a full soil moisture profile and the cool, wet finish to the season. Yields ranged from >5t/ha for crops sown late-August to yields of >2.5t/ha for crops sown late-September. In 2023, results were less positive with initial severe waterlogging being followed by a hot and dry season finish. The Albany TOS1 treatments and the first Dalyup trial site were terminated (seed burst/waterlogging). Cereal yields from the Condingup site, particularly TOS1, were good given the season, with barley achieving in excess of 4 t/ha. The highest grain yields at the Takalarup and Gnowellen sites were achieved with Rosalind barley and were just above 1.5 t/ha and 2.5 t/ha, respectively. Importantly, the economic analysis conducted in 2023 highlighted that in even in challenging conditions, late sowing can be profitable with correct crop type/cultivar choice and fertiliser strategy.

EXECUTIVE SUMMARY

Background

The South Coast grain growing region of Western Australia is prone to waterlogging events that severely impact grain production. Waterlogging can reduce wheat yields in this region by up to 37% (Zhang et al, 2004). In the Albany Port Zone in 2021 and Esperance Port Zone in 2021 and 2022, large areas of crops remained unplanted well into July and August. This was due to crop failure or highly waterlogged soils making the paddocks non-trafficable for seeding machinery/equipment.

This investment aimed to build on the results of similar GRDC investment SCF2208-001SAX and provide growers and advisers along the South Coast of WA with further confidence to make decisions on whether to sow a cereal crop later in the growing season (late winter, early spring) after crop failure, or inability to seed, due to early season waterlogging. Given the near perfect season and excellent yield results in 2022, it was hoped a more realistic season in 2023 would achieve this increased grower confidence.

Methodology

In 2023, another four small plot trials, with similar treatments and trial designs, were implemented along the South Coast of WA in 2022. Two of these were located in the Albany Port Zone (Gnowellen and Takalarup) and two in the Esperance Port Zone (Dalyup and Condingup). Each trial site included:

- Three times of sowing (late July, mid to late August, mid-September)
- Two wheat (Vixen and Scepter) and three barley varieties (Maximus, Rosalind, Neo – Albany, Combat – Esperance)
- Two nitrogen treatments (High - 80 units of nitrogen, Low - 40 units of nitrogen)

The trials were sown by experienced trial providers and were monitored throughout the growing season. Measurements for each treatment across each time of sowing included:

- Plant establishment (plants/m2)
- Biomass (dry matter kg/ha)
- Plant tissue nitrogen concentration
- Growth stages
- Harvest yield (t/ha) & Grain Protein (%)

Results & Discussion

Crop grain yields in 2023, across both sites, were significantly lower than those achieved in the 2022 late sown cereals trials, where yields were in excess of 5t/ha across each of the times of sowing. This highlights how the season finish can dramatically impact on the success of late sown cereals. As a comparison, from the date TOS3 was seeded in 2023 at Takalarup to the date of harvest, the site received 42.4mm of rainfall. In 2022, the same location received 269.2mm over the same time period. Essentially in a two year period, the area around Takalarup has been faced with both the best and worst case scenarios for late seeding of cereals after waterlogging.

In the Esperance trials (Condingup & Dalyup 2), plant establishment was relatively stable across all times of sowing, keeping in mind the second Dalyup site was sown later after initial failure (due to

waterlogging). The failure of this first site and the issues in establishment for the TOS1 in both the Gnowellen and Takalarup trials show the impact of sustained waterlogging (due to continued rainfall) on late sown cereals. Seed burst was a large issue with heavy (and unpredicted) rain falling within a week of seeding TOS1 at Gnowellen and Takalarup.

The grain yield achieved at the Condingup site best showed the potential upside of seeding cereals late, even in a year like 2023. At this site, germination was good and there was ample soil moisture (particularly for TOS1) to allow for flowering and grain fill to occur during times of limited plant stress, even with a drier than usual finish. The Condingup results (over 4 t/ha for barley) are reflective of what occurred in the first iteration of this trial, conducted in similar locations in 2022 (SCF2208-001SAX, 2022). Although not as high yielding as the Condingup site, the TOS2 and TOS3 treatments at Gnowellen and Takalarup also produced viable crops with the highest yields occurring in the Rosalind barley treatments (2.5 t/ha and 1.5 t/ha, respectively).

At all sites, barley out-yielded wheat across most times of sowing with the exception of TOS3 at Condingup. The results from the 2023 trials also showed a trend towards increased yields in the quicker maturing varieties compared with the mid-maturing varieties across all times of sowing. The nitrogen (N) treatments had no significant impact on crop yield, across any crop type, at either time of sowing.

Although the 2023 season was more challenging than 2022, there was more learning to take away from the 2023 data. Firstly, in conditions where the finish is going to be tight, or more likely where growers are unsure of how the season is going to play out, the 2023 data supports utilising a shorter season varieties. Vixen, Maximus and Rosalind, all out yielded the longer season varieties. Quicker maturing varieties are able to quickly move through growth stages when seeded so late in the season, as they are primarily driven by the increased daylight that is available in the spring. In 2023, this reduced the crops susceptibility to heat stress and water stress during the grain fill period by having this occur earlier in the season.

Another key learning is that the different N rates had no significant impact on grain yield or on grain protein. It is likely that in 2023, the yields were low enough that the N was not a limiting factor to yield production and the reduced growing season length did not allow the crops enough time to uptake and utilise the additional N. Also, given the crops were planted so late into the season, there was likely to be additional available N in the soil from the turnover or previous residues.

Conclusion

The 2023 season was a challenging year for late-sown cereals. The trials implemented at Condingup, Gnowellen and Takalarup demonstrated that even in extremely unfavourable conditions, if the sowing time was right and quicker season varieties were sown (and preferably barley over wheat), yields could be economical. The data generated by this investment is positive as it delivers on the GRDC outcome by giving growers and advisers further confidence in late sowing decisions (importantly across varying seasons) where early season waterlogging has occurred, and autumn sowing was not possible (or autumn sown crops failed).

BACKGROUND

The South Coast grain growing region of Western Australia is prone to waterlogging events that severely impact grain production. Waterlogging can reduce wheat yields in this region by up to 37% (Zhang et al, 2004). In the Albany and Esperance Port Zones in 2021 and 2022, large areas of paddocks remained unplanted well into July and August. This was due to crop failure or highly waterlogged soils making the paddocks non-trafficable for seeding machinery/equipment.

This was a grower-led investment, whereby growers wanted to know more about the viability of seeding cereal crops in late winter and into early spring. At the commencement of the first iteration of this investment (2022), there was no publicly available data on late sowing of wheat and barley for growers to reference to assist them in deciding a) what to plant in these situations and b) how late they could (profitably) seed. According to Esperance consultant Quentin Knight, some Esperance growers would face this scenario once every five years due to their proximity to the coast and shallow duplex soils, which are prone to waterlogging. He recommended that an independent data set showing the yield potential of the main season wheat and barley varieties compared to shorter season varieties would be extremely useful tool for growers and advisors. By comparing the two, it would help farmers to confidently decide whether to seed grain on hand (typically main season) or go to the effort to purchase shorter season varieties.

This investment also included varying nitrogen treatments. Growers were keen to also understand the nitrogen nutrition requirements of later sown crops. It was estimated that yields would be somewhat lower than earlier sown cereal crops due to a shorter growing season length.

This 2023 late sown cereals project looked to further examine the viability and productivity of late winter and early spring seeded cereal varieties in Western Australia's Southern region under different seasonal conditions. The 2022 trial results showed late sown cereals to be extremely successful due to the soft spring finish (almost perfect) experienced in 2022. Uncertainty remained amongst growers as to how late sown crops would perform in season with a less favourable finish.

PROJECT OBJECTIVES

The 2023 late sown cereals project aimed to further build on the data and knowledge captured in the 2022 trials. By again establishing four identical trial sites in 2023 across four different locations (along the South Coast), with differing characteristics, grown under different seasonal conditions, it was hoped that a more comprehensive data set could be collated. The trials aimed to provide more data on sowing date, varietal and nitrogen fertiliser influences on productivity of later sown crops.

This one-year investment aimed to give growers and advisers along the South Coast of WA further confidence in sowing cereals late when early season waterlogging prohibited an earlier sowing, or they had experience crop failure.

GRDC Investment outcome:

By March 2024, All Western Region growers and advisers will have access to trial information on late winter to early spring sown cereals (wheat and barley) on the south coast of WA to assist in making educated decisions to sow at this time when waterlogging presents and cereal crops cannot be sown at the traditional time or for other reasons that may present for a later sowing opportunity such as weed issues or poor crop establishment.

METHODOLOGY

In 2023, Stirlings to Coast Farmers (SCF) worked collaboratively with SEPWA to implement and manage four small plot trials along the South Coast of the Western Region. Two were in the Albany Port Zone (APZ) and managed by SCF (Takalarup & Gnowellen) and two were in the Esperance Port Zone (EPZ) and managed by SEPWA (Dalyup & Condingup). Experienced trial providers were sub-contracted to seed and manage the trials, and SCF and SEPWA staff were responsible for recording trial measurements and for sample collection.

The trial sites were established in late-July with the first time of sowing (TOS) treatments sown at this time (Table 1). Two subsequent TOS treatments were sown approximately three weeks apart, after this first timing. Each TOS included three barley varieties and two wheat varieties and a main and a quick season variety was included for each crop type (Table 2).

Table 1: TOS dates for each of the trials sown in 2023.

Time of Sowing	Albany Trials	Esperance Trials
TOS1 Date	Gnowellen – 31 July 2023 Takalarup – 31 July 2023	Dalyup Site 1 – 25 July Condingup – 25 July Dalyup Site 2 – 28 August
TOS2 Date	Gnowellen – 23 August 2023 Takalarup – 23 August 2023	Dalyup Site 1 – 17 August Condingup – 17 August Dalyup Site 2 – 11 September
TOS3 Date	Gnowellen – 20 September 2023 Takalarup – 20 September 2023	Dalyup Site 1 – 19 September Condingup – 19 September Dalyup Site 2 – 21 September

Table 2: Varieties sown in each of the trials, 2023.

Albany Port Zone	Esperance Port Zone
Wheat: Vixen (quick), Scepter (mid)	Wheat: Vixen (quick), Scepter (mid)
Barley: Rosalind (quick-mid), Maximus (quick-mid), Neo (mid-long)	Barley: Rosalind (quick-mid), Maximus (quick-mid), Combat (mid)

Trial Designs

Each of the treatments in all four trials were triple replicated and fully randomised with assistance from AAGI (Figures 1-4).

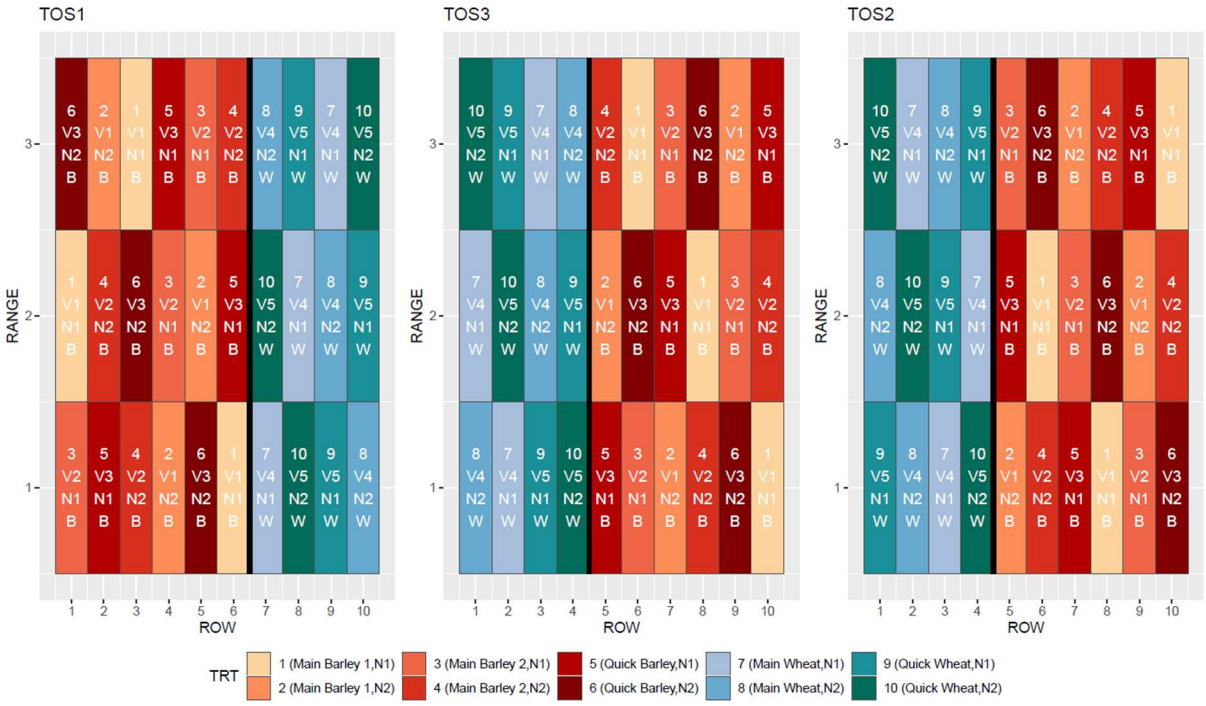

Figure 1: Late Sown Cereal Trial Design, Dalyup 2023.

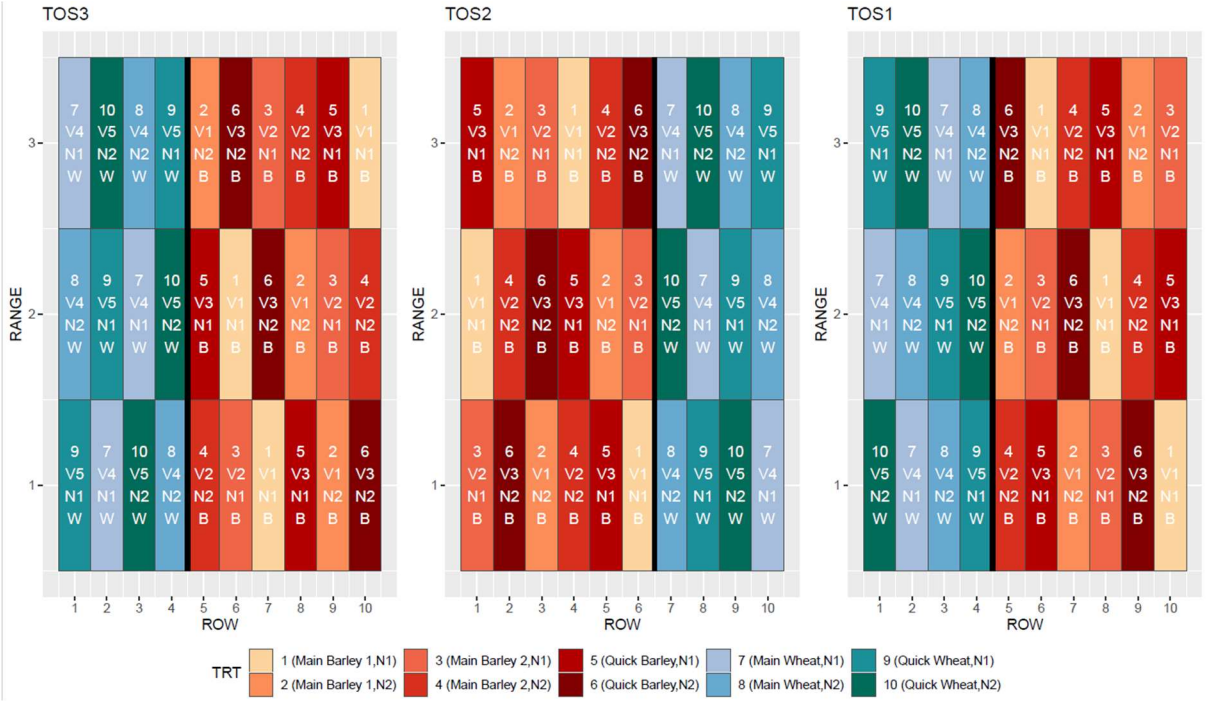

Figure 2: Late Sown Cereal Trial Design, Condingup 2023.

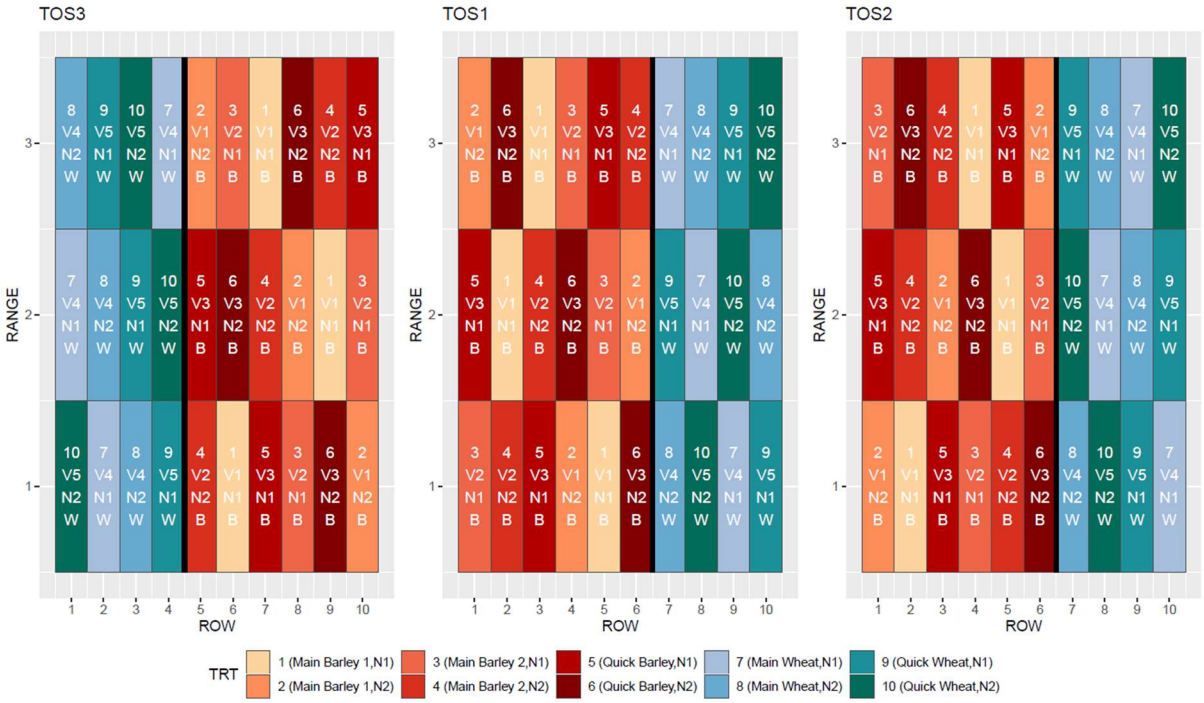

Figure 3: Late Sown Cereal Trial Design, Takalarup 2023.

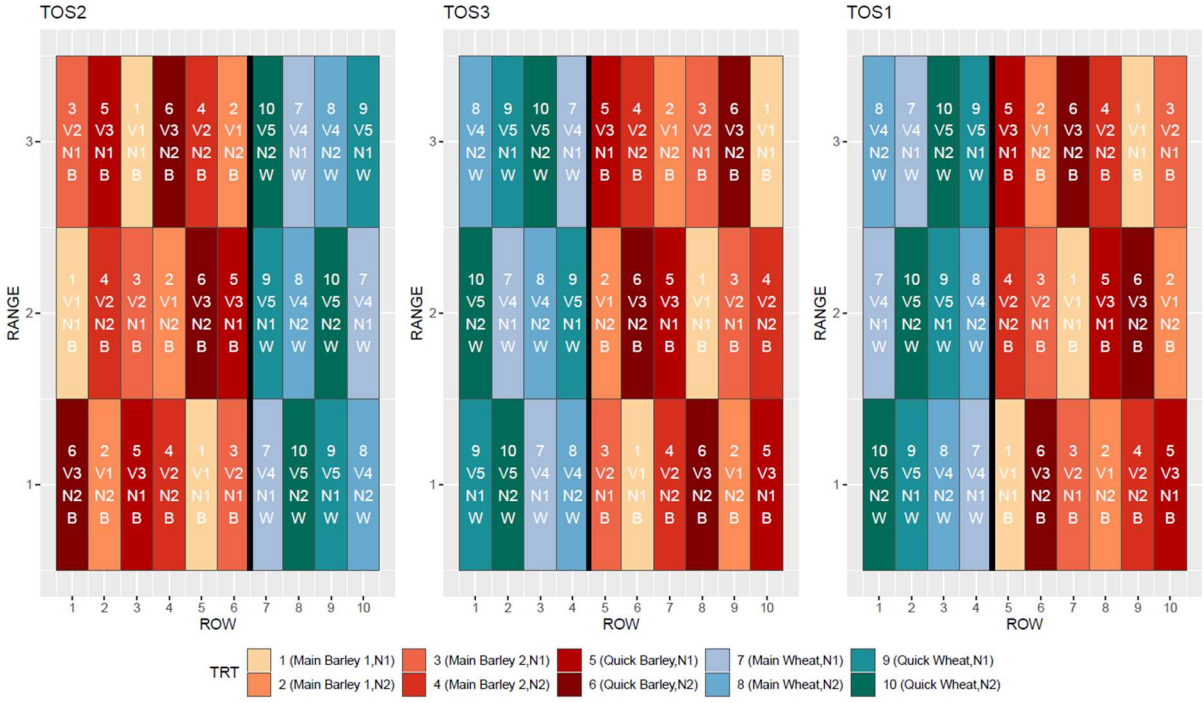

Figure 4: Late Sown Cereal Trial Design, Gnowellen 2023.

Trial Monitoring & Measurement

For each treatment, the following measurements were undertaken:

- Pre-seeding soil moisture content
- Plant establishment counts (plants/m2)
- In -season biomass sampling (dry matter kg/ha)
- In-season tissue testing
- Flowering date assessment
- Harvest yield (small-plot header)
- Grain quality
- Rainfall observations
- Weed, disease and pest observations

The statistical analysis was conducted by Stirlings to Coast Farmers for all four small plot trial sites using the program JMP Pro. The use of this program was discussed with AAGI who were in agreeance that the program was sufficient for analysing the data from these trials.

LOCATION

Where field trials have been conducted, provide the following location details in the table below: latitude and longitude, or nearest town. (Add additional rows as required.)

Site #	Latitude (decimal degrees)	Longitude (decimal degrees)	Nearest town
Trial Site #1	-34.33899	118.50030	Gnowellen
Trial Site #2	-34.60891	118.05065	Takalarup
Trial Site #3	-33.743242	122.959458	Condingup
Trial Site #4	-33.745971	121.536604	Dalyup 2

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or GRDC agro-ecological zone/s, indicate which in the table below:

Research	Benefiting GRDC region (select up to three)	Benefitting GRDC agro-ecological zone	
NGN - Investigating late winter to early spring cereal cropping opportunities for grain growers following autumn waterlogging - South-Western Australia	Western Region Choose an item. Choose an item.	☐ Qld Central ☐ NSW NE/Qld SE ☐ NSW Vic Slopes ☐ Tas Grain ☐ SA Midnorth-Lower Yorke Eyre ☐ WA Northern ☐ WA Eastern ☐ WA Mallee	☐ NSW Central ☐ NSW NW/Qld SW ☐ Vic High Rainfall ☐ SA Vic Mallee ☐ SA Vic Bordertown-Wimmera ☐ WA Central ☒ WA Sandplain

RESULTS

Challenging Season - 2023

Unfortunately, 2023 was a challenging one. In the APZ, the first time of sowing at both sites was not harvestable due to plant establishment issues. Significant rainfall was received immediately after sowing and seed burst was an issue (Figure 5). Average daily temperatures were somewhat more favourable at the Condingup site towards the end of the growing season, in comparison with the Takalarup site, and more so, the Gnowellen site (Figure 6).

In the EPZ, the first Dalyup site was severely waterlogged and had to be abandoned. SEPWA implemented a second site in Dalyup "Oaks', however, sheep got into the paddock and limited measurements were conducted.

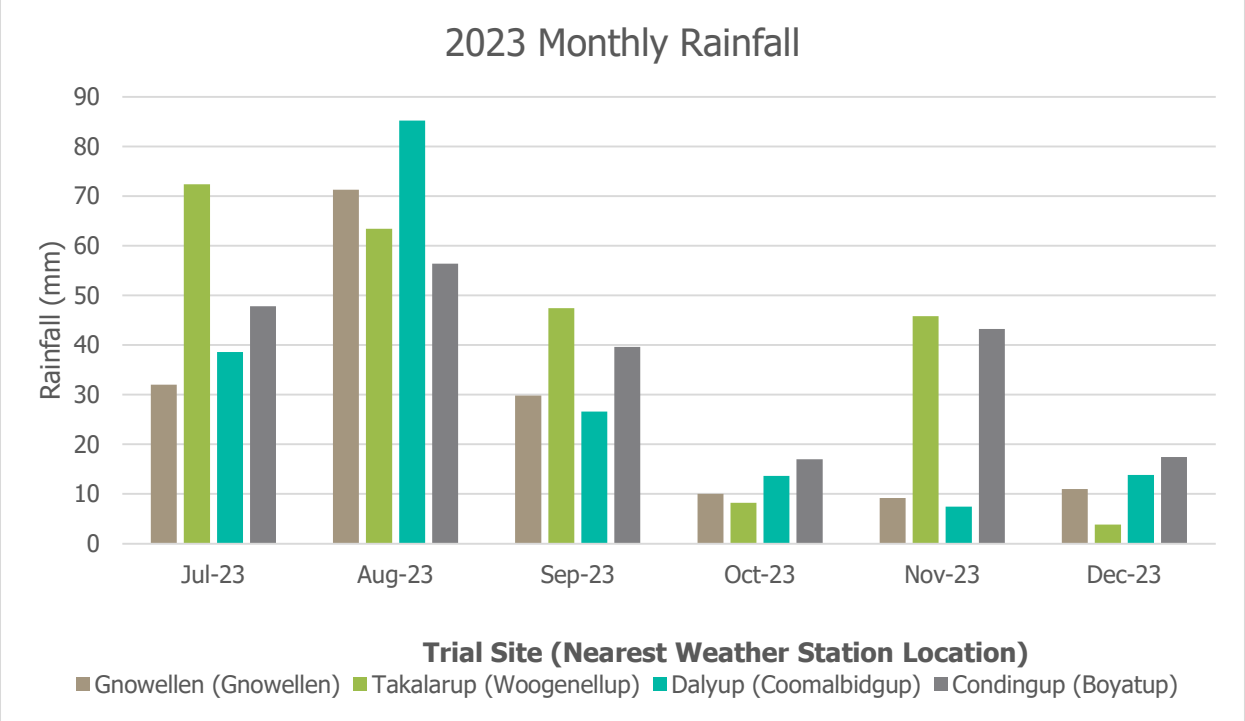

Figure 5: Monthly rainfall totals for each of the trial sites, July – December 2023.

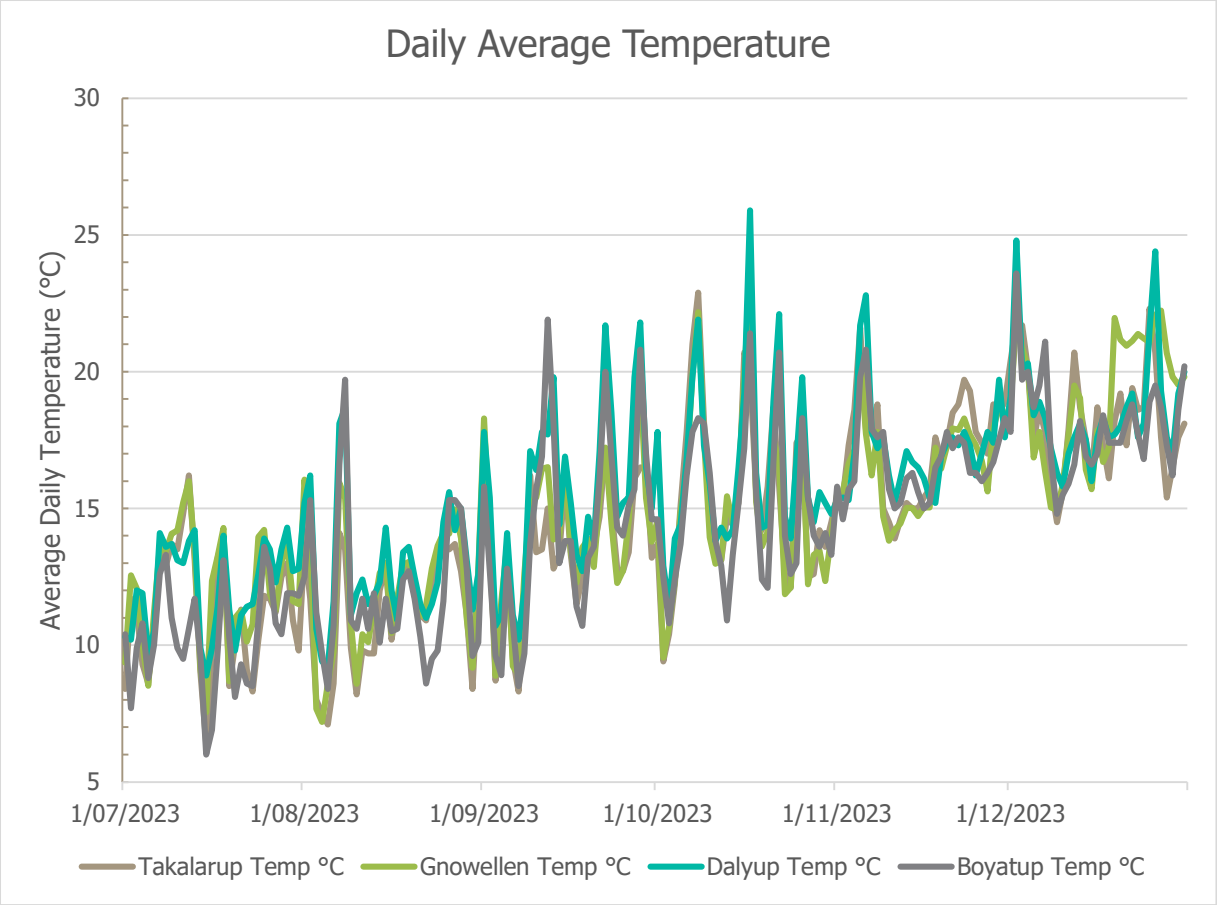

Figure 6: Average daily temperatures for each of the trial sites, July – December 2023.

Baseline Soil Sampling & Soil Moisture

Baseline soil sampling was completed at all sites prior to the first time of sowing. There were no issues with the soil test results. All sites good soil pH which varied from being slightly acidic (pH 5.45 in H2O) to neutral (pH 7.4 in H2O).

All time of sowing treatments at both sites were seeded into soils at field capacity. This was a result of the significant rainfall that had been received in the months of June, July and August across both the Esperance and Albany coastal regions.

Plant Establishment

Esperance PZ

Plant establishment at the second Dalyup site (sown later) showed a slight trend towards greater plant numbers as the time of sowing progressed further into the season (Figure 7). While this was not significant, this trend is likely a factor of the soils drying out slightly, leading to a higher germination percentage. At the Condingup site, there was no relationship observed between TOS and plant establishment (Figure 8).

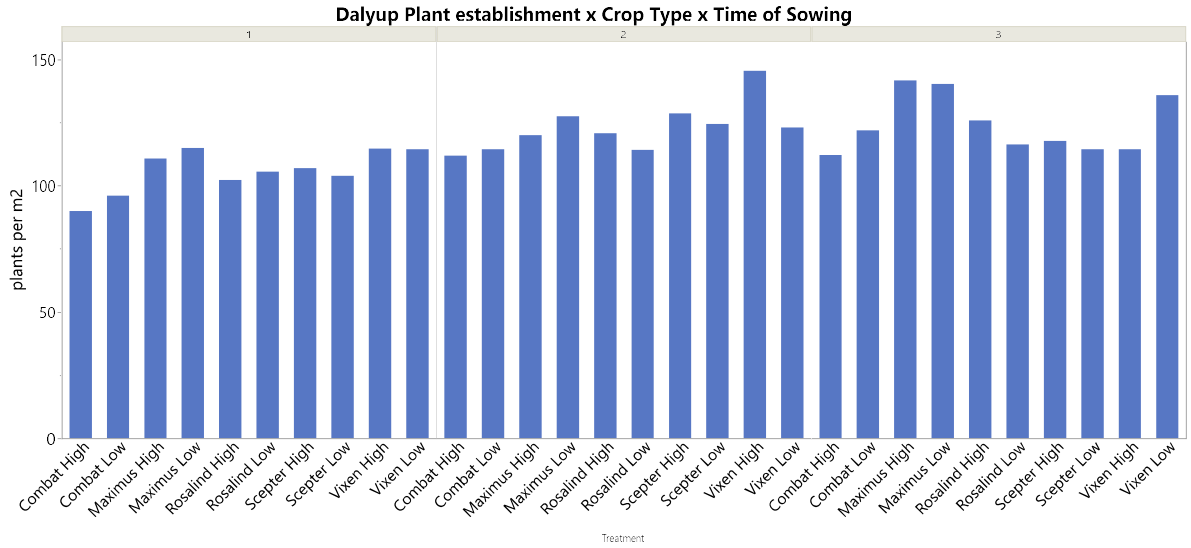

Figure 7: Average plant establishment counts for each treatment, Dalyup 2023.

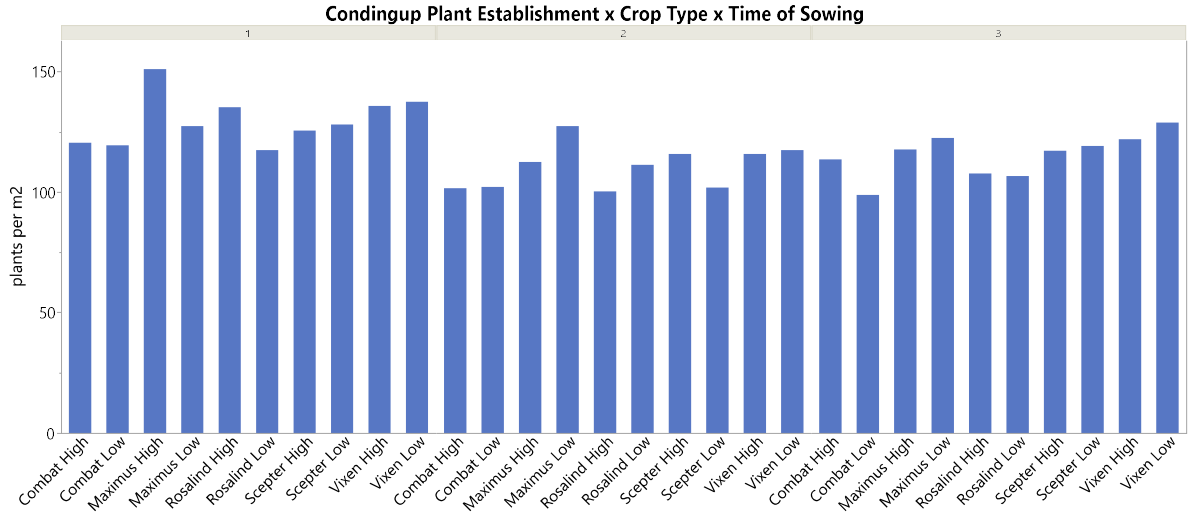

Figure 8: Average plant establishment counts for each treatment, Condingup 2023.

Albany PZ

TOS1 at Gnowellen failed to successfully germinate due to significant rainfall being received immediately after seeding. No significant relationship was observed between time of sowing and plant establishment in TOS2 and TOS3 at this site (Figure 9). Treatments in TOS1 at Takalarup germinated, however, the germination was extremely patchy, again due to significant rainfall causing waterlogging (Figure 10). There was no significant difference observed between plant establishment and time of sowing for TOS2 and TOS3 at this site either.

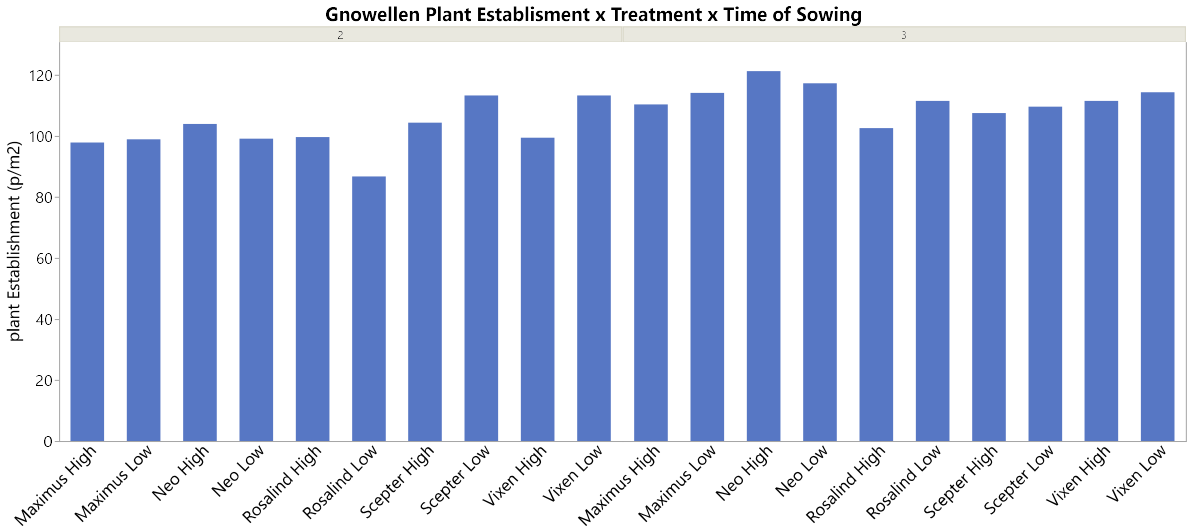

Figure 9: Average plant establishment counts for each treatment, Gnowellen 2023.

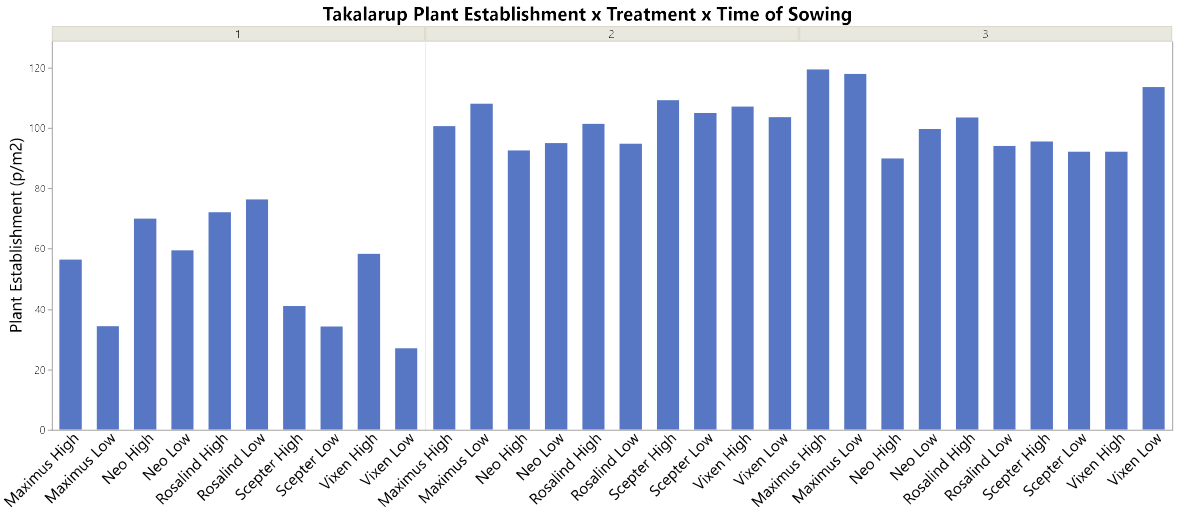

Figure 10: Average plant establishment counts for each treatment, Takalarup 2023.

In-season Biomass

Esperance PZ

Biomass (dry matter kg/ha) assessed at the Condingup site showed slightly more biomass accumulation in TOS1 compared to TOS2 (Figure 11). There was significantly more biomass accumulated in the TOS1 and TOS2 barley treatments compared to the TOS3 barley treatment. Interestingly, this difference was much less pronounced in the wheat treatments and wheat overall produced less biomass in the TOS1 and TOS2 treatments in comparison to barley. In TOS3, wheat and barley biomass accumulation were relatively equal.

Biomass cuts were not possible at the Dalyup site due to grazing by sheep prior.

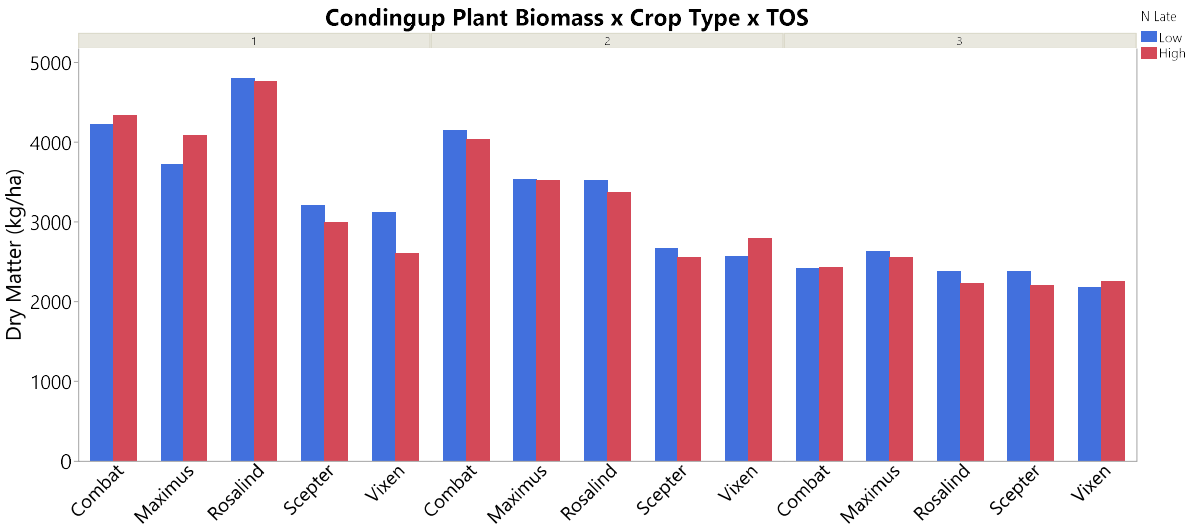

Figure 11: Average plant biomass for each treatment, Condingup 2023.

Albany PZ

The sowing date had a significant impact on plant biomass at both sites within the APZ (Figure 12 & 13). The delay in time of sowing caused a marked decrease in plant biomass, most likely due to the limited plant available water (PAW) as the season progressed resulting in a shorter time to build up biomass. At the Takalarup site, the TOS2 biomass measurements were significantly higher in most treatments (except Maximus) that had the higher N rate applied (an additional 40 units N/ha). This same trend was not evident at the Gnowellen site (Figure 13).

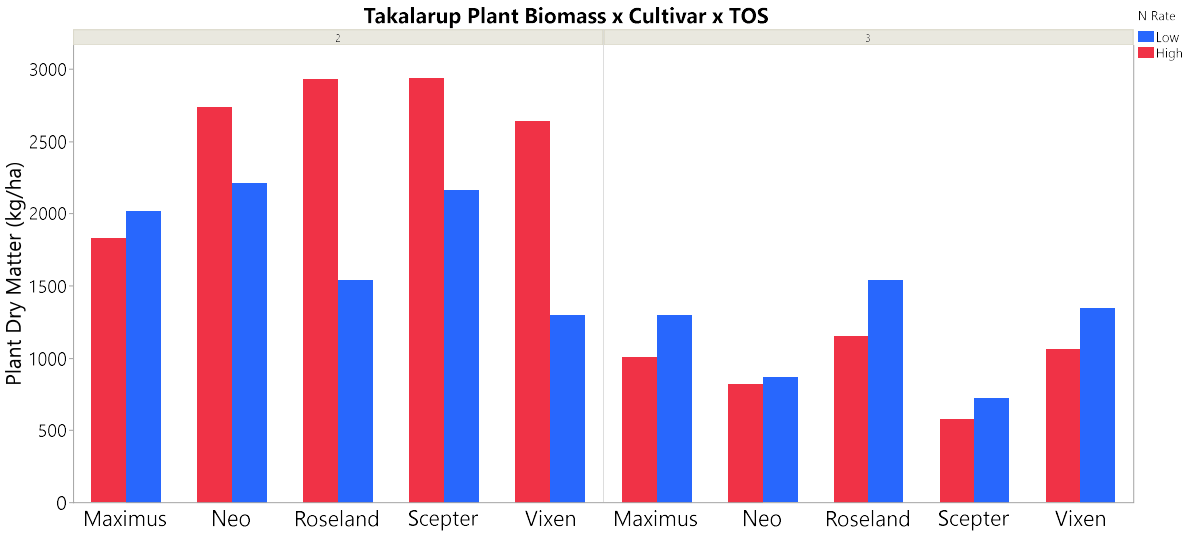

Figure 12: Average plant biomass for each treatment, Takalarup 2023.

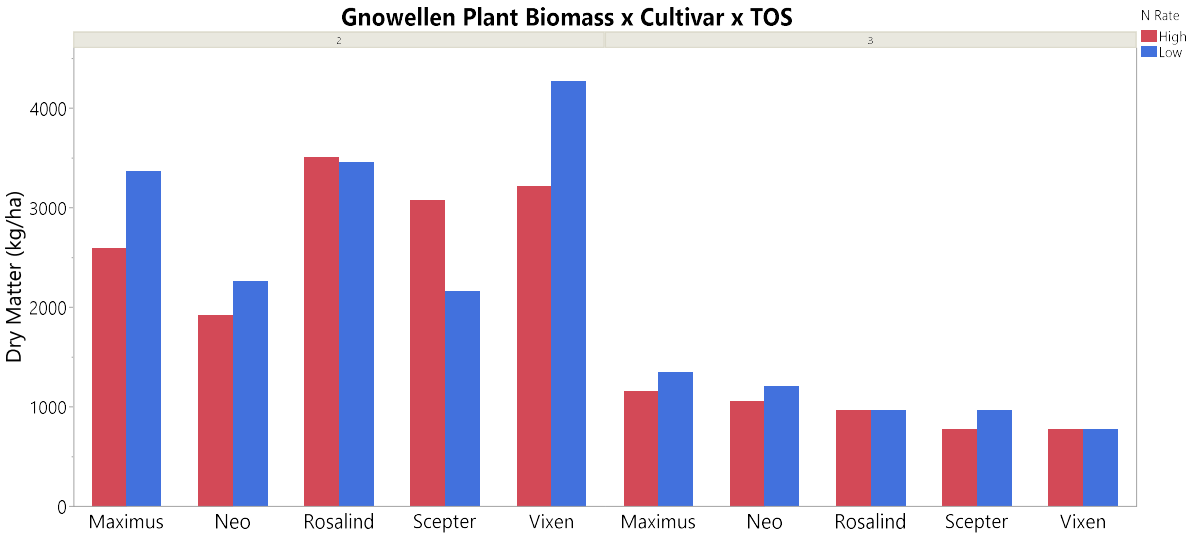

Figure 13: Average plant biomass for each treatment, Gnowellen 2023.

Plant Tissue Sampling

Esperance PZ

Plant tissue results at both Esperance sites showed an increase in N concentration with each later time of sowing (Table 3 & Table 4). For the Condingup site, the increased plant tissue N concentration corresponded with decreasing biomass (Figure 11). Nitrogen concentration tended to be higher in the higher N treatments, however, this difference reduced with each subsequent time of sowing.

Table 3: Average plant tissue sample results for nitrogen (total N%), Condingup, 2023.

Barley	High N	Low N		Wheat	High N	Low N
TOS1	1.24	1.033333		TOS1	1.59	1.635
TOS2	2.08	1.91		TOS2	2.265	2.435
TOS3	4.833333	4.756667		TOS3	4.85	5.005

Table 4: Average plant tissue sample results for nitrogen (total N%), Dalyup, 2023.

Barley	High N	Low N		Wheat	High N	Low N
TOS1	3.14	2.903333		TOS1	3.425	3.205
TOS2	4.45	4.573333		TOS2	4.34	4.44

Albany PZ

For the two Albany trial sites, there was a similar trend in the plant tissue N as compared to the Esperance sites (Tables 5 & 6). The N concentration increased as the seeding date was delayed (and the biomass decreased). However, unlike in Esperance, there was no link between the higher N treatments and the plant tissue N concentration in wheat or barley across all times of sowing.

Table 5: Average plant tissue sample results for nitrogen (total N%), Takalarup, 2023.

Barley	High N	Low N		Wheat	High N	Low N
TOS1	1.5	1.623333		TOS1	1.75	1.88
TOS2	1.53	1.44		TOS2	1.635	1.385
TOS3	2.203333	2.423333		TOS3	2.82	2.285

Table 6: Average plant tissue sample results for nitrogen (total N%), Gnowellen, 2023.

Barley	High N	Low N		Wheat	High N	Low N
TOS2	1.566667	1.48		TOS2	1.71	1.575
TOS3	2.055	2.096667		TOS3	2.92	2.69

Flowering Dates

The flowering dates across both the Esperance PZ and Albany PZ trials were similar for each crop type within each TOS (Tables 7, 8 and 9).

Esperance PZ

Table 7: Average growth stage for each of the treatments, Condingup 2023.

	20 Oct 2023	25 Oct 2023	16 Nov 2023
	TOS1	TOS2	TOS3
Sceptre	60	60	60
Vixen	60	70	60
Maximus	70	60	55*

Rosalind	80	60	55*
Combat	70	60	55*

*Indicates flowering in the boot

Albany PZ

Table 8: Average growth stage for each of the treatments, Gnowellen 2023.

	1 Nov 2023	7 Nov 2023
	TOS2	TOS3
Sceptre	65	65
Vixen	70	70
Maximus	70	65
Rosalind	70	65
Neo	65	65

Table 9: Average growth stage for each of the treatments, Takalarup 2023.

	16 Oct 2023	1 Nov 2023	1 Nov 2023
	TOS1	TOS2	TOS3
Sceptre	50	60	50
Vixen	55	60	65
Maximus	59	65	70*
Rosalind	59	65	70*
Neo	50	65	70*

*Indicates head forming in the boot

Grain Yield & Quality

Esperance PZ

No Harvest data from the Dalyup site was recorded as sheep got into trial late in October 2023. This was reported to GRDC by SEPWA immediately.

Grain Yield at Condingup for TOS 1 (sown 25 July), showed that barley significantly out yielded wheat (Figure 14). In TOS2, this same trend was less evident but still significant. In TOS3, the trend was reversed with wheat significantly outperforming barley.

Overall, yield declined with each later time of sowing, particularly in TOS3 with the highest yield being the Vixen wheat at 0.96 t/ha (Figure 14). There was no consistant or significant difference in yield in response to the fertiliser treatments across all times of sowing.

The grain protein results from the Condingup site show a reverse trend to the grain yields, with average grain protein increasing with each later time of sowing (Figure 15). The additional 40 units of

applied N led to an increase in grain protien across all crop types in TOS1 and TOS2, however this trend was not observed in TOS3.

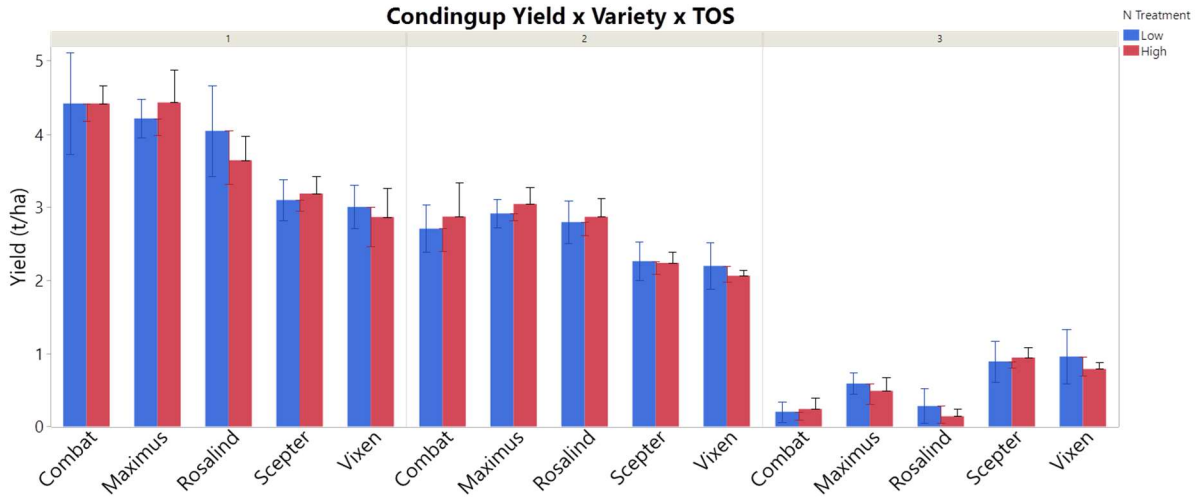

Figure 14: Average grain yield (t/ha) for each of the treatments, Condingup 2023.

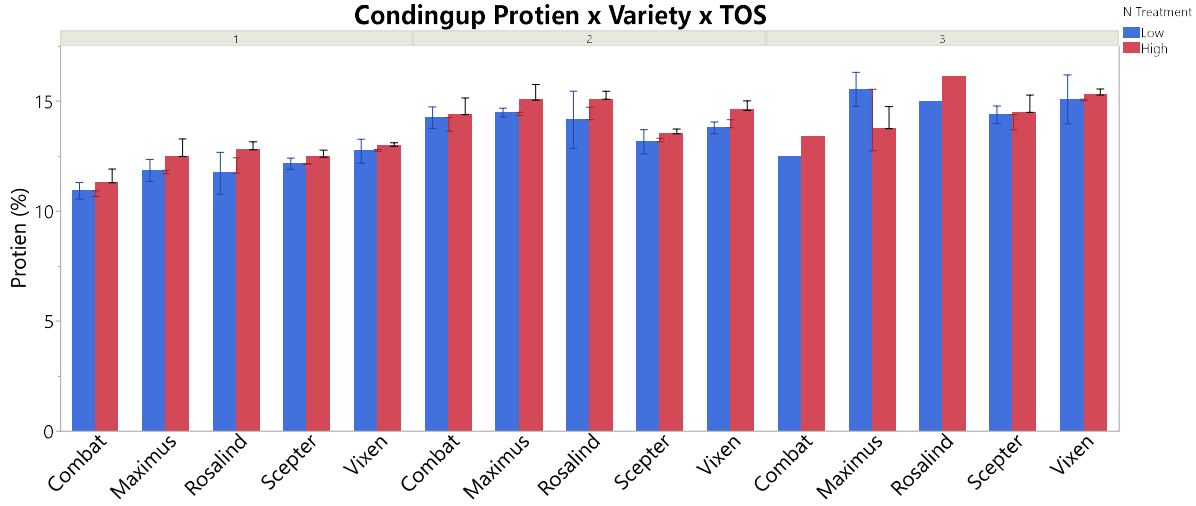

Figure 15: Average grain protein (%) for each of the treatments, Condingup 2023.

Albany PZ

Grain yield for TOS1 is not recorded for both Albany sites due to crop failure (waterlogging & seed burst issues) and the subsequent failure to meet maturation.

At the Gnowellen site, TOS2 and TOS3 produced viable crop yields with barley out-yielding wheat across both times of sowing (Figure 16). At the Gnowellen site there was also a significant trend

towards the shorter season cultivars outyielding the longer season cultivars across both times of sowing i.e., Vixen over Scepter (*P=.0054*) and Maximus and Rosalind over Neo (*P=0012*).

At the Takalarup site, the two shorter barley cultivars (Maximus and Rosalind) and wheat cultivar, Vixen, significantly outyielded the longer season cultivars, Neo and Scepter, across both times of sowing (Figure 17). However, this was more prevalent in TOS3. Overall, crop yields were reduced in TOS3 compared to TOS2, and barley still had a significant advantage over wheat in both times of sowing.

Fertiliser treatment at both the Gnowellen and Takalarup sites did not significantly impact on grain yields (Figure 16 and 17).

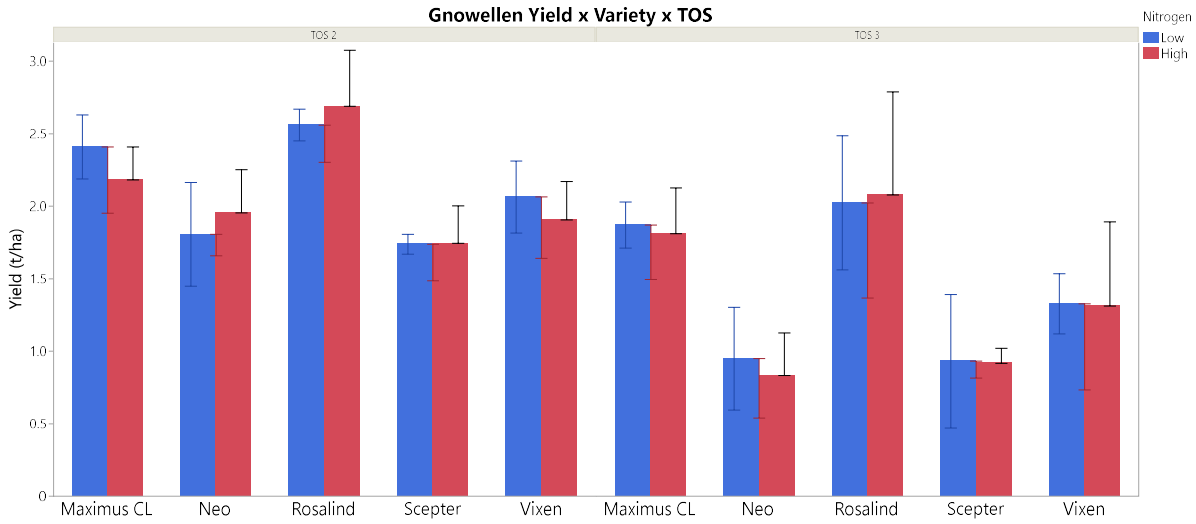

Figure 16: Average grain yield (t/ha) for each of the treatments, Gnowellen 2023.

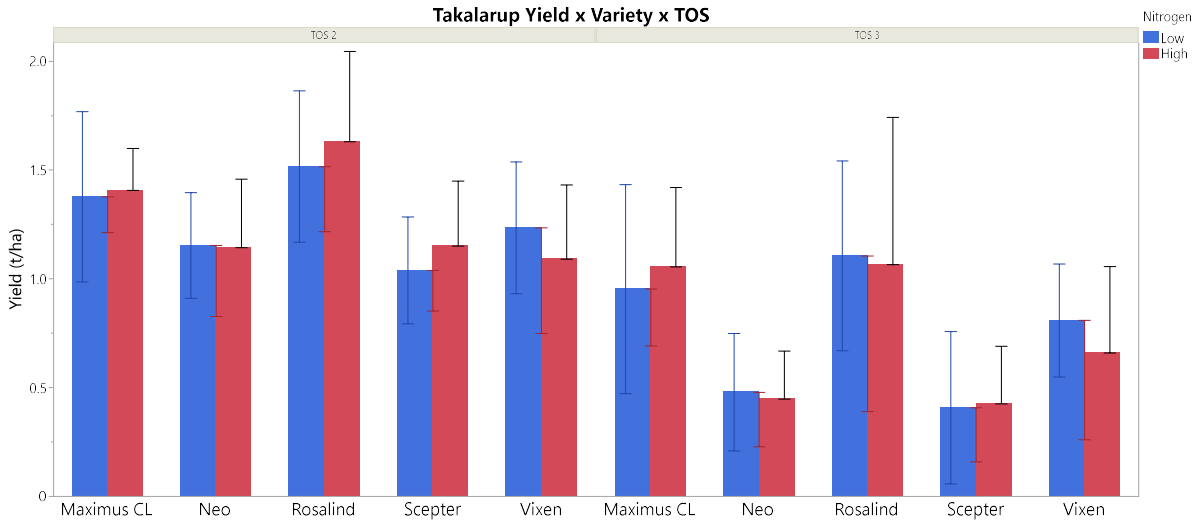

Figure 17: Average grain yield (t/ha) for each of the treatments, Takalarup 2023.

The grain protein levels at the Gnowellen site increased as the seeding date was delayed, however, additional 40 units of N, on top of the 40 units applied at seeding (high N treatment), had no influence on grain protein levels (Figure 18). The grain protein levels at the Takalarup site showed no distinct trend across any crop type or TOS, with the shorter and longer season wheat and barley varieties accumulating similar levels of grain protein (Figure 19).

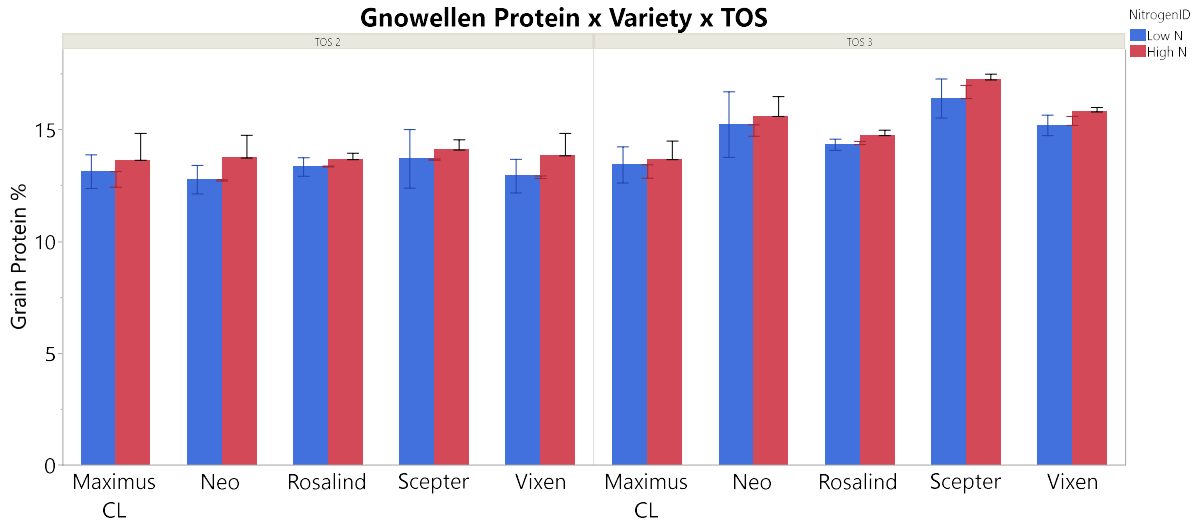

Figure 18: Average grain protein (%) for each of the treatments, Gnowellen 2023.

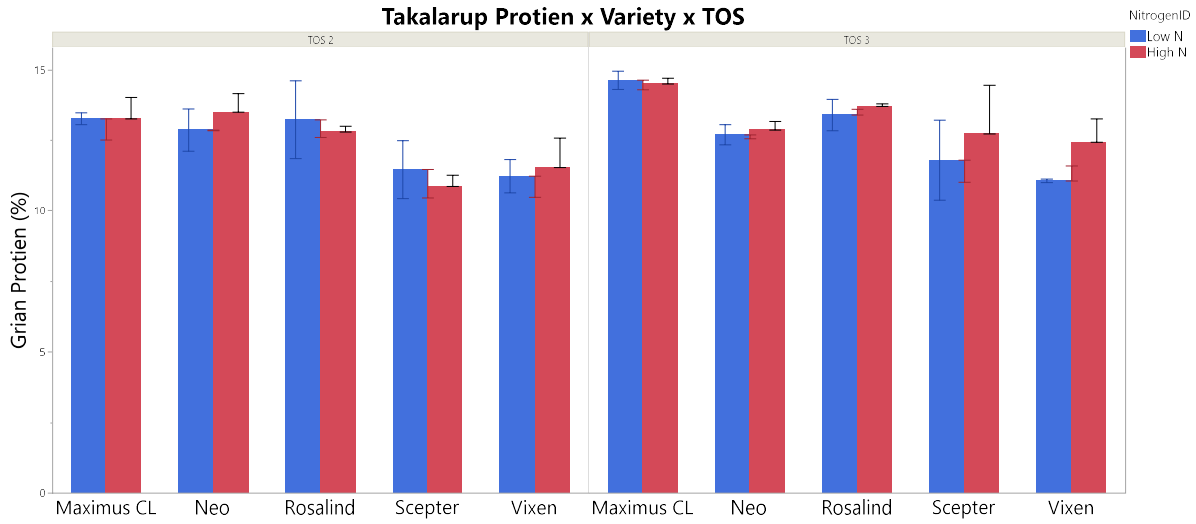

Figure 19: Average grain protein (%) for each of the treatments, Takalarup 2023.

The Economic Analysis

A basic economic analysis was conducted for each of the sites/treatments that were taken through to harvest. The costs used in the calculations included the operating costs of a single failed cereal crop and the cost required to re-seed this same crop type a second time, after initial failure (as so often happens along the South Coast of WA). The costs involved in individual farming businesses are highly variable, so the calculations were completed using anonymised farmer data (averaged). This was run past local agronomists to validate the numbers.

The costs included covered chemical expenses, fuel, labour, seed, seeding expenses and fertiliser applications at seeding. A figure of $320-$350/ha was used to represent the cost of the failed cereal crop, with an additional $62/ha used as the cost to terminate the failed crop, re-seed with seed on-hand, and apply 40 units of additional nitrogen fertiliser. With harvest expenses also considered the total cost used for this economic analysis was $437/ha, with this figure needing to be recovered for farmers to recoup their expenses at the very least.

The economic analysis conducted for the Condingup trial site (Figure 20), shows TOS1 and TOS2 to both have been profitable decisions (TOS1 more so than TOS2). The markedly lower grain yields in TOS3 resulted in this time of sowing making a loss, more so the barley treatments.

The economic analysis for the Gnowellen site showed that on average overall, TOS2 was more profitable than TOS3 (Figure 21). At this site, the shorter cultivars (Rosalind, Maximus and Vixen) were more profitable than the longer season cultivars (Neo and Scepter). In TOS3, only the Rosalind treatment managed to make a slight profit, all other treatments made a loss.

For the Takalarup site, the economic analysis showed greater losses than the Gnowellen site, due to the lower yields. Only the high input Rosalind and the Maximus barley returned a profit (Figure 22). However, the losses were minimal across all crop types in TOS2, besides the Neo high input and the Scepter high input.

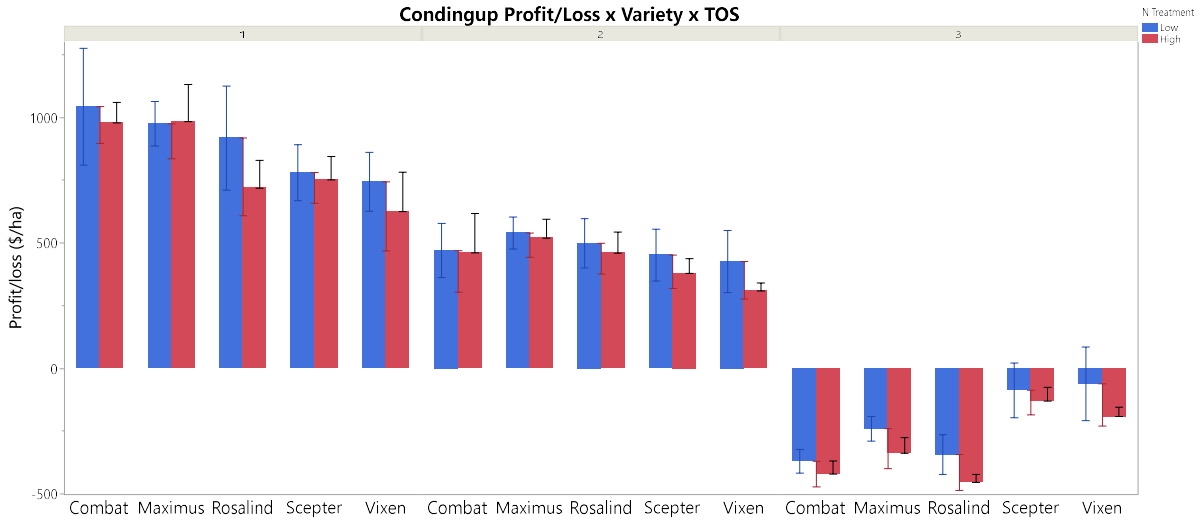

Figure 20: Basic economic analysis for each treatment, Condingup 2023.

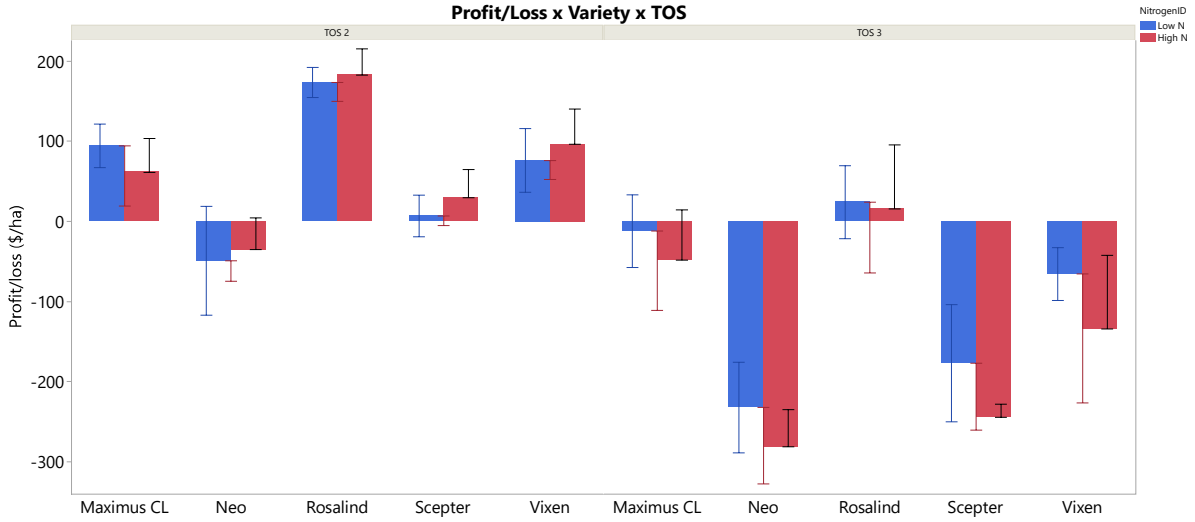

Figure 21: Basic economic analysis for each treatment, Gnowellen 2023.

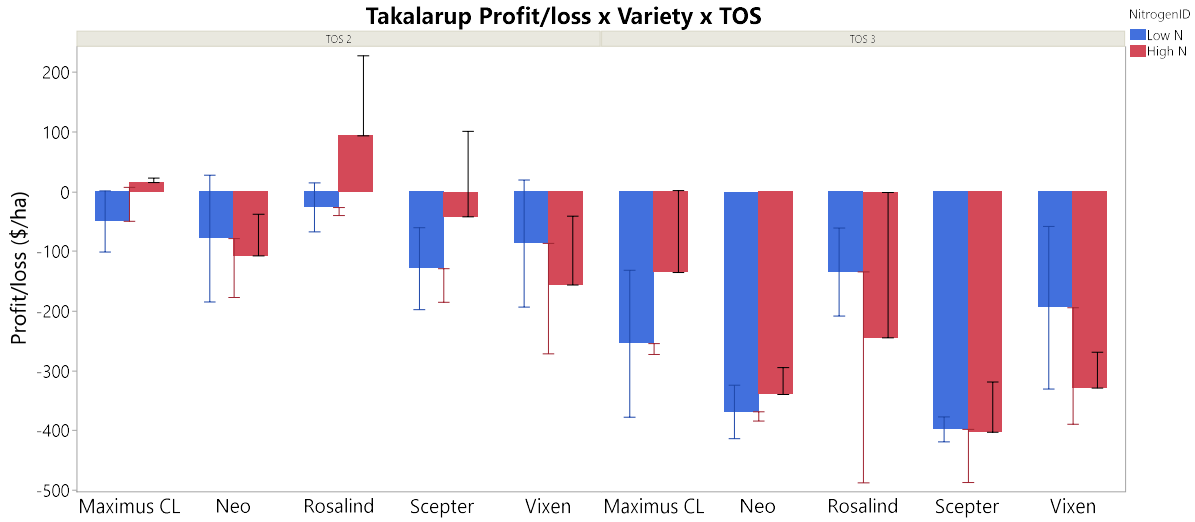

Figure 22: Basic economic analysis for each treatment, Takalarup 2023.

Trial Photos

Figure 23: Aerial photo taken of the Condingup Trial site, 1 November 2024.

Figure 24: Aerial photo taken of the Takalarup Trial site, Trials Tuesday Field Walk, 3 October 2023.

Figure 25: Photos taken from the Late Sown Cereals Field Walk, Gnowellen Site, 24 October 2023.

DISCUSSION OF RESULTS

The seasonal conditions experienced in the 2023 season had a significant impact on the results, especially when compared to the 2022 late sown cereal results. In 2022, cereal crops sown well into September yielded as high as 4 t/ha due to the very soft and cool finish to the season.

In the 2023 season, paddocks that had been waterlogged from June through till August quickly dried out from October onwards, with minimal rain falling between October and December at most sites. Condingup had the most conducive growing conditions in 2023, with more cumulative rainfall recorded in the last three months of the year compared to the other sites. This contributed to relatively good yields, particularly in the TOS1 treatments.

In the Esperance trials (Condingup & Dalyup 2), plant establishment was relatively stable across all times of sowing, keeping in mind the second Dalyup site was sown later after initial failure (due to waterlogging). The failure of this first site and the issues in establishment for the TOS1 in both the Gnowellen and Takalarup trials show the impact of sustained waterlogging (due to continued rainfall) on late sown cereals. Seed burst was a large issue with heavy (and unpredicted) rain falling within a week of seeding TOS1 at Gnowellen and Takalarup.

Crop emergence at TOS2 and TOS3 in the Albany trials was much improved and shows the benefit of holding off seeding if further rainfall is predicted and the soil profile is already saturated. Shallow duplex soils which are commonplace in the APZ, recharge quickly after rainfall. As a result, paddocks can go from being trafficable to saturated after small rainfall events, further complicating sowing decisions. Even as profiles begin to dry out deciding to seed is still a challenge for growers as weather predictions are not always accurate.

Across all sites (both Esperance and Albany) there was a trend of increasing plant tissue N concentration with each later time of sowing (the inverse of recorded biomass). In the Esperance region trials, plant tissue N concentration tended to be higher in the higher N treatments, however, this difference reduced with each subsequent time of sowing. In later time of sowings plants would have less time to build biomass and to uptake the additional N. Unlike in Esperance, there was no link between the higher N treatments and the plant tissue N concentration in wheat or barley across all times of sowing in the Gnowellen and Takalarup trials.

Photoperiod was likely the driver of plant development in 2023, given flowering dates were similar for each time of sowing across all trial sites.

At the TOS1 seeding date, it is possible that had the spring been mild and wet, the reproductive stage may have been delayed and the crops would have been able to build more biomass leading to better yields, as what occurred in 2022. However, by TOS3, irrespective of the seasonal outlook, the photoperiod drive would have pushed the crops to race through their grow stages, and any yield differences are likely to have been driven by plant available water and environmental conditions during flowering and seed set, rather than the building of biomass. This is demonstrated at both trial sites where barley seeded in TOS3 flowered in the boot, with ear emergence only fully occurring during grain fill.

Biomass accumulation across all trial sites was significantly lower in the TOS3 compared to the TOS1 (Condingup) and TOS2 (all sites). This is due to the warm and dry finish to the season from October onwards. The TOS3 treatments did not have sufficient time to build biomass and raced through growth stages.

Nitrogen treatment only played a role at the Takalarup site in TOS2, where there was a marked increase in biomass in the higher N treatments. This may have been due to a lack of available N in the soil at this site, but it did not then result in higher yields at harvest. There were no other observable trends as a result of N application, including on grain protein concentration. Grain protein concentration increases were driven more by later times of sowing. This is likely a symptom of heat/drought stress causing a protein accumulation in the grain, as the grain fill period was delayed into hostile conditions. Additionally, the low grain yield in comparison to the level of biomass produced, likely meant there was excess protein in the plants that pooled in the grain.

The grain yield achieved at the Condingup site best showed the potential upside of seeding cereals late, even in a year like 2023. At this site, germination was good and there was ample soil moisture (particularly for TOS1) to allow for flowering and grain fill to occur during times of limited plant stress, even with a drier than usual finish. The Condingup results are reflective of what occurred in the first iteration of this trial, conducted in similar locations in 2022 (SCF2208-001SAX, 2022).

For growers to maximise their chances of growing a profitable crop after a period of waterlogging, it is important that they get on the paddock to seed as soon as it is safe to do so. However, TOS1 at both Gnowellen and Takalarup, highlight the risk in seeding too soon after a period of waterlogging. TOS1 at both these locations were seeded when the soil was saturated but trafficable. Unfortunately, this was followed by a larger than expected rainfall event occurring in the week after seeding. As a result, the seed burst, and the plots needed to be terminated, highlighting a continuing challenge to growers.

The difference in barley yields to wheat yields across the trial sites is likely a result of the barley being primarily driven by photoperiod, and maturing quicker than the wheat, which suffered late season heat and drought stress. Interestingly, grain yield at Condingup for TOS1 (sown 25 July), showed that barley significantly out yielded wheat. In TOS3, the trend was reversed with wheat significantly outperforming barley. This is likely due to the wheat having a longer vegetative period, that allowed the wheat to build a greater level of biomass to drive more yield at this later sowing time compared to barley, which ran too quickly to head.

The basic economic analysis showed that the sooner a late sown cereal could be ‘successfully’ established after waterlogging, the better. It should be noted that the analysis included the cost of having already attempted to sow a cereal (failed). In most cases in this analysis, even where a loss was made, the loss would have been more significant has not some of the losses been recouped by a second late sown cereal.

CONCLUSION

Although 2022 was a near perfect year for late sown cereals, it can be argued that the 2023 season provided more valuable data. Learnings from the failure of the first Dalyup site and the TOS1 treatments at Gnowellen and Takalarup were valuable in showing that it doesn't take much to tip the balance from a 'just' trafficable paddock to enable seeding to another crop failure due to seed burst and continued waterlogging (with just one more decent rainfall event).

The data from the 2023 trials also showed the barley to be more reliable in most late sowing scenarios as it generally yielded higher than the wheat. The trial results also showed that the quicker maturing varieties (both barley and wheat) had an edge on the mid-maturing varieties. This information was not so prevalent in the 2022 trials, as everything yielded very well. Growers looking to 'hedge their bets' on what the season will do, should probably consider sowing quicker maturing varieties when seeding cereals late.

Overall, the trial results from the 2022 and 2023 late sown cereals projects give growers good data on what 'best case' and 'worst case' scenarios might look like. This information is very valuable as data from the extreme scenarios allows growers to extrapolate to situations that might occur between the two, providing them with much more knowledge and confidence to make informed late sowing decisions.

IMPLICATIONS

The lack of reliability in seasonal outlook forecasts and short-term forecasts is problematic for growers looking to seed late sown cereals after periods of early growing season rainfall. The high amount of rain that fell after TOS1 was seeded in the Albany region had not been adequately forecast. There was no doubt that whole paddocks had been seeded at the same time as TOS1 in the region, and SCF did hear of growers having to reseed for a third time after a second failure. Timing is crucial, however unfortunately, the tools growers have available to make these crucial decisions are not always accurate. The same goes for seasonal outlooks as the results achieved in the 2022 trials were far different to what was achieved in 2023.

RECOMMENDATIONS

SCF would like to recommend that modelling of the trial data be conducted to give growers a better understanding of what yields might be achieved across a range of seasonal scenarios. By undertaking this modelling work, further grower confidence could be achieved, by allowing growers to investigate different seasonal scenarios and the impact this might have on their late sowing decisions.

GLOSSARY AND ACRONYMS

Below is a sample abbreviations and acronyms list. Be sure to include all abbreviations and acronyms that appear in the report.

APZ	Albany port zone
EPZ	Esperance port zone
HRZ	High rainfall zone
N	Nitrogen
PAW	Plant Available water
TOS	Time of sowing

REFERENCES

Zhang H, Turner N, Poole M (2004) Yield of wheat and canola in the high rainfall zone of south-western Australia in years with and without a transient perched water table. *Australian Journal of Agricultural Research* **55(4)**, 461-470.