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Project Code	
Project Type	

# FINAL REPORT 2023

Final reports must be submitted using the online application form at [www.sagit.com.au](http://www.sagit.com.au) with this Word document attached **within two months** after the completion of the Project Term.

<b>PROJECT CODE</b>	UNF119
<b>PROJECT TITLE</b>	Upper North time of sowing and yield loss from frost/heat stress for Barley

<b>PROJECT DURATION</b> <i>These dates <b>must</b> be the same as those stated in the Funding Agreement.</i>					
<b>Project start date</b>	1/04/2019				
<b>Project end date</b>	30/06/2022				
<b>SAGIT Funding</b>	2019		2020		2021

<b>PRINCIPAL INVESTIGATOR</b> <i>(responsible for the overall project and reporting)</i>		
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<b>ADMINISTRATION CONTACT DETAILS</b> <i>(responsible for all administrative matters relating to project)</i>		
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**PROJECT REPORT:** Please provide a clear description for each of the following:

**Executive Summary** (200 words maximum)

- In 2019, Maximus CL, Spartacus CL and Fathom sown in TOS1 yielded the highest. TOS1 also had the best overall biomass results due to the extreme dry finish.
- In 2020, all yields were statistically equivalent across the TOS due to the mild seasonal conditions at the site.
- In 2021, Planet numerically yielded the highest across all times of sowing at 5.21t/ha at TOS1, 5.87 t/ha at TOS2 and 3.57 t/ha at TOS3. Later sowing had a negative impact on yield and grain quality across all varieties.
- Earlier time of sowings produced the highest yields across three years.

**Project objectives**

The Barley Time of Sowing trial was conducted for three years at Booleroo Centre.



Figure 1: Trial Locations in the 2019, 2020 and 2021 seasons. Trials were rotated in the paddock each year.

The aims of this trial included:

- Evaluate how heat stress at the end of the season affects grain fill,
- Capture how frost stress during flowering affects grain development,
- Identify phenotype differences within barley varieties that may enable farmers in the Upper North to manage their seeding window and variety choices to minimise risk/maximise yield across their barley crop.

**Overall Performance**

The project aims (see project objectives) were achieved. Key findings regarding sowing times, variety selections and how frost and heat affect flowering and grain fill were identified. There was great feedback from local farmers for this project. The research project was managed by several cooperators including Ruth Sommerville/Matt McCallum (2019), Jamie Wilson (2020) and Jade Rose (2021). The trials were managed by various staff at AgXtra across the three years. A key error during the management of this trial was the change in varieties in 2020, this led to decreased statistical value of the project in not allowing comparisons between years to be made. However, despite this, a mild season in 2020 led to minimal statistical outcomes for the trial that year anyway.

**KEY PERFORMANCE INDICATORS (KPI)**

KPI	Achieved	If not achieved, please state reason.
3 time of sowing treatments established (2019)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	

Report of trial data complete in preparation for publishing in the UNFS Annual Report (2020)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
A minimum of 1 site visit by farmers of the UN (2019)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
3 time of sowing treatments established (2020)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
A minimum of 1 site visit by farmers of the UN (2020)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Report of trial data complete in preparation for publishing in the UNFS Annual Report (2020)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
3 time of sowing treatments established (2021)	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	

### TECHNICAL INFORMATION (Not to exceed **three** pages)

#### Frost (2019 only)

Frost visual scores were taken on the 9<sup>th</sup> October (Table 7). The percentage of heads across the plot with frost damage were recorded based on the severity of the damage of the head (Tipping – just the tip of the head, ¼ - quarter of the head, half – half of the head, ¾ - 3 quarters of the head damaged).

Table 7. Frost visual scores (Oct. 9<sup>th</sup>). Variety 1- Spartacus CL, V2- Fathom, V3- Maximus CL, V4- Banks, V5- Urambie

TOS1	Tipping	One quarter	Half	Three quarter
V4	10	40	50	0
V3	50	15	0	0
V2	10	0	0	0
V1	50	30	0	0
V5	70	20	0	0
TOS2	Tipping	One quarter	Half	Three quarter
V4	0	90	0	0
V3	80	0	15	0
V2	0	40	30	20
V1	50	0	30	0
V5	0	30	0	0
TOS3	Tipping	One quarter	Half	Three quarter
V4	85	0	0	0
V3	90	0	0	0
V2	10	0	0	0
V1	10	40	45	0
V5	40	30	10	0

Whilst a higher percentage of heads with frost damage was noticed in TOS3, the most severe frost damage was noticed in TOS2 with greater amount of the plant head damaged.

At TOS2, Spartacus, Fathom and Maximus all suffered half head loss throughout the plot but also recorded similar growth stages throughout the year at this particular time of sowing (Figure1).

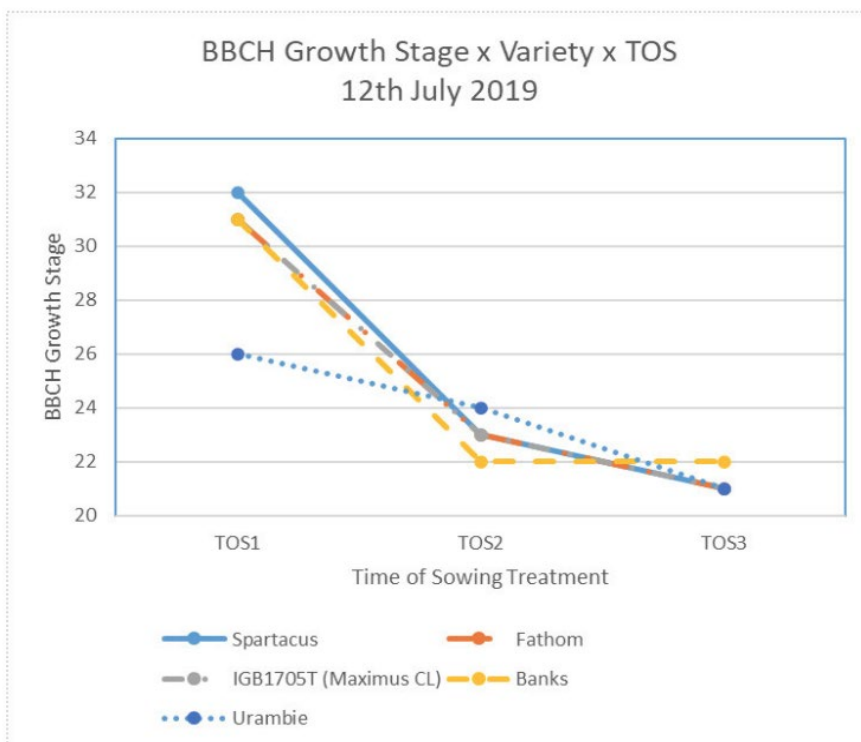


Figure 1. Growth stage by Time of sowing by variety on 12<sup>th</sup> July 2019

### Growth and Flowering

2019

Flowering was spread out across the 3 time of sowing treatments. Flowering occurred as follows for TOS1 - Spartacus and Maximus flowering on 20<sup>th</sup> August; by 26<sup>th</sup> August all varieties were flowering apart from Urambie. Urambie flowered on 11<sup>th</sup> September. For TOS2 all varieties but Urambie flowered on 11<sup>th</sup> September. TOS3 flowering was not recorded but was approximately the end of September for all varieties.

2020

Given the year and consistent rainfall, all the varieties developed and matured as expected based on their time of sowing. Up until the 10<sup>th</sup> of August, growth stages within their times of sowing were consistent. On the 10<sup>th</sup> of August however, Spartacus and Maximus CL in TOS1 were further developed than the other varieties which then meant earlier flowering. In TOS3 on the 10<sup>th</sup> of August, Leabrook was further ahead in maturity. This did not correlate to earlier flowering, with Spartacus and Maximus CL still flowering before all other varieties for TOS3.

2021

Because TOS1 had to be watered, there was less than two weeks between TOS1 and TOS2 germinating. They remained consistent throughout the season and developed as expected. TOS3 fell far behind in growth and then a late start that went straight into cold weather meant there was very slow establishment and early growth. Less than average spring rain held it back further meaning the plants did not flower until far too late, in mid-October. This resulted in a significant yield penalty for TOS3 across all varieties.

### Biomass and yield 2019

Due to a change in varieties for the 2020 and 2021 seasons, 2019 has been kept separate in this report.

Table 8. Means, Grain Yield and Biomass of the Barley TOS trial in 2019.



No.	Name	Biomass T/Ha		Yield T/Ha	
1	Early Spartacus CL	7.01	a	2.57	ab
2	Early 'Fathom	6.39	a	2.56	abc
3	Early Maximus CL - IGB1705T	6.27	a	2.65	a
4	Early Banks	5.83	ab	2.18	d
5	Early Urambie	4.48	c	1.4	f
6	Mid Spartacus CL	4.5	c	2.19	cd
7	Mid Fathom	4.69	bc	2.23	bcd
8	Mid Maximus CL - IGB1705T	4.68	bc	2.05	de
9	Mid Banks	4.59	bc	1.71	ef
10	Mid Urambie	3.22	de	1.01	g
11	Late Spartacus CL	3.96	cd	1.69	ef
12	Late Fathom	3.6	cde	1.66	f
13	Late Maximus CL - IGB1705T	3.74	cd	1.68	f
14	Late Banks	3.19	de	1.35	fg
15	Late Urambie	2.38	e	0.58	h
Means followed by same letter or symbol do not significantly differ (P=.05, LSD).					

In 2019, all varieties showed declining yield and biomass production with delayed time of sowing (Table 8), however; these responses were not equal due to the phenology of each variety. The decline in yield and biomass as a result of delayed sowing time is likely due to a number of factors including soil temperature during establishment, impacts of frosts and the combined interactions of growth stages, biomass and severe moisture and heat stress at the end of the season.

The first time of sowing resulted in the largest biomass production and yield in all varieties, with Maximus CL, Spartacus CL and Fathom yielding significantly higher than all other treatments. Grain yield in all but two varieties showed a statistically significant decline as time of sowing was delayed in 2019. Time of sowing one resulted in the largest biomass production across all varieties, but Banks being statistically greater than TOS2. TOS3 showed reduced yield and biomass. This is not all due to frost and heat stress but also day length, radiation and as the soil temperature is cooling, it slows the physiological development of the plant.



**2020**

*Table 9. Summary Table of Means of Yield and Biomass data of Barley TOS trial 2020.*

Crop Name	Spring barley	Spring barley	Spring barley
Crop Variety	Various	Various	Various
Description	Biomass - fresh	Biomass - dry	Yield
Assessment Date	15-Sep-20	15-Sep-20	30-Nov-20
Part Assessed	WEIFRE C	WEIDRY C	PLOT C
Assessment Type	WEFRRE	WEDRRE	YIELD
Assessment Unit	g	g	T-MET
Reporting Basis	1.0 PLOT	1.0 PLOT	1 PLOT
Crop Stage Majority/Min/Max	49 77 71	49 77 71	99 - -
Plant-Eval Interval	111 DP-1	111 DP-1	187 DP-1
ARM Action Codes			TY1
<b>Td</b> Treatment			
No. Name	19	20	22
1TOS 1 - 14 April 2020 Barley cv. Planet	572.7ab	261.3b	1.74-
2TOS 1 - 14 April 2020 Barley cv. Lebrook	591.7a	288.3a	1.70-
3TOS 1 - 14 April 2020 Barley cv. Maximus	436.3cde	227.3c	1.66-
4TOS 1 - 14 April 2020 Barley cv. WI4592	481.3a-e	229.0c	1.79-
5TOS 1 - 14 April 2020 Barley cv. Spartacus	512.3a-d	247.7bc	1.76-
6TOS 2 - 09 May 2020 Barley cv. Planet	478.7b-e	196.7d	1.78-
7TOS 2 - 09 May 2020 Barley cv. Lebrook	543.7abc	225.7c	2.14-
8TOS 2 - 09 May 2020 Barley cv. Maximus	447.7cde	195.7d	1.59-
9TOS 2 - 09 May 2020 Barley cv. WI4592	426.7de	181.7de	1.85-
10TOS 2 - 09 May 2020 Barley cv. Spartacus	419.3de	184.7de	2.04-
11TOS 3 - 27 May 2020 Barley cv. Planet	418.3de	128.0g	1.77-
12TOS 3 - 27 May 2020 Barley cv. Lebrook	420.7de	161.7ef	1.63-
13TOS 3 - 27 May 2020 Barley cv. Maximus	475.7b-e	172.0def	1.82-
14TOS 3 - 27 May 2020 Barley cv. WI4592	421.0de	155.7f	2.04-
15TOS 3 - 27 May 2020 Barley cv. Spartacus	397.3e	155.7f	1.61-
LSD P=.05	112.37	25.24	0.483
Standard Deviation	67.18	15.09	0.289
CV	14.31	7.52	16.1
Grand Mean	469.56	200.73	1.795
Bartlett's X2	17.718	27.269	11.606
P(Bartlett's X2)	0.22	0.018	0.638
Rank X2			
P(Rank X2)			
Skewness	0.2179	0.3814	-0.2292
Kurtosis	-0.6389	-0.5507	-1.2299
Analyzed as	RCE	RCE	RCB
Replicate F	2.747	7.770	4.797
Replicate Prob(F)	0.0814	0.0021	0.0162
Treatment F	2.452	26.393	0.967
Treatment Prob(F)	0.0210	0.0001	0.5075

Lebrook at TOS1 had the numerically highest biomass of all treatments (Table 9). This was statistically equivalent to all other varieties in TOS1 except Maximus which had lower mean biomass. Lebrook in TOS2 was also statistically equivalent. In TOS3, Maximus had significantly higher biomass fresh weights than the other varieties.

Dry matter weights showed Lebrook at TOS1 was significantly higher than all other varieties across the three times of sowing (Table 9). Lebrook also had a significantly higher biomass than the other varieties in TOS2 only. In TOS3 only, Maximus was numerically higher in biomass dry weight and statistically equivalent only to Lebrook. There were no significant differences in yield across all treatments (Table 9). Numerically, Lebrook in TOS2 recorded the highest average yield.

## 2021

Table 10. Summary Table of Means of Grain Yields and Biomass Data of Barley TOS trial in 2021.

		Fresh weight		Dry weight		Grain yield	
		WEIGHT (g)		WEIGHT (g)		YIELD (t/ha)	
		1 PLOT		1 PLOT		1 ha	
TOS1							
1	Planet	1461.8	ab	483.5	-	5.21	ab
2	Leabrook	1476.5	ab	513.8	-	4.58	bcd
3	Maximus	1338.8	bc	439.5	-	4.28	cde
4	Laparouse	1508.8	ab	469.8	-	4.73	bcd
5	Spartacus	1517.5	ab	508.3	-	4.4	b-e
TOS2							
6	Planet	1360.3	abc	440.8	-	5.87	a
7	Leabrook	1615	a	505.8	-	5.09	abc
8	Maximus	1321	bc	410.5	-	4.02	def
9	Laparouse	1420	ab	412	-	4.83	bcd
10	Spartacus	1448.5	ab	445.3	-	4.41	b-e
TOS3							
11	Planet	1132.8	cd	533.3	-	3.57	ef
12	Leabrook	999.3	de	481.3	-	2.41	g
13	Maximus	970.5	de	450.3	-	2.53	g
14	Laparouse	822.5	e	401.5	-	3.09	fg
15	Spartacus	873	de	426.3	-	3.31	fg
LSD P=.05		274.52		103.63		0.921	
Standard Deviation		192.38		72.62		0.645	
CV		14.98		15.74		15.39	

In 2021, TOS 1 and 2 achieved the highest grain yields with all varieties being statistically equivalent in each time of sowing (Table 10). Planet numerically outperformed all varieties across all times of sowing and produced the greatest grain yield at TOS2 across the whole trial.

Apart from Planet, all varieties in TOS3 had yields that were statistically lower than TOS1 and 2. Factors affecting this can include, the late time of sowing and the seasonal conditions stated above, but also the lack of chemistry left in the soil to combat germinating weeds, creating greater competition. Two plots from replication four were removed as outliers where the weeds were problematic, and their poor yields skewed otherwise sound data.

Leabrook in TOS2 had the highest numerical fresh weight across all varieties and times of sowing (Table 10). Apart from Planet, all varieties in TOS3 had significantly lower fresh weights than TOS2 and 3. In the dry weights, there were no significant differences across all the varieties and times of sowing. Planet in TOS3 produced the highest dry weight numerically.

#### CONCLUSIONS REACHED &/OR DISCOVERIES MADE (Not to exceed one page)

Barley is a versatile and slightly more frost- tolerant (1°C) option to wheat, allowing it to be planted earlier in the season. Other trials have also shown it is also a better option for late planting compared to wheat, typically if feed grain prices are suitable (GRDC, 2016). Early (Early April - Mid May) planting has various benefits such as producing higher yields, lower protein levels and larger grain size, often meaning it is likely to achieved malt quality. Early grazing is also a suitable option as it often produces a good grain crop when grazed before stem elongation (GS31). Ensuring the sowing window for each

variety/phenotype is matched, a mix of varieties are sown to provide some variation in the flowering window, and the timeliness of sowing has a significant benefit to the production capacity of the barley crop in both yield and biomass for feed. Late (Mid May onwards) plantings often lead to maturing in hot dry weather, which reduces yield, grain size and malting quality. TOS3 in all three years had reduced grain yield between 0.5-1 t/ha for most varieties. Across all three years of this project, earlier time of sowings produced the highest grain yields, however; seasonal conditions each year were very diverse, therefore decision making from this project should be treated with caution.

## INTELLECTUAL PROPERTY

## APPLICATION / COMMUNICATION OF RESULTS

The trial reports were communicated through the UNFS Annual Compendium in 2019, 2020 and 2021, which can be found here: <https://unfs.com.au/resources-2/>

In 2019, ABC Rural radio visited the site on 25<sup>th</sup> July and interviewed Ruth Sommerville at the trial. The trial was visited and discussed at the Members Expo on 1<sup>st</sup> August 2019, with 110 members and industry attending. During the expo, the Booleroo School Ag Students (12 students and 1 teacher) attended the site to learn about trials and Time of sowing. On 11<sup>th</sup> September, UNFS held the Eastern Hub crop walk and on the 5<sup>th</sup> February a summary of the trial was presented in summarized form at the dealing with The Dry Forum with approx. 90 growers.

In 2020, The trial was visited numerous times throughout the season. Two official site visits were held in 2020 at the Time of Sowing trial. Due to the unfortunate events of COVID19, the UNFS Annual Members Expo was cancelled. Several smaller events (with attendee restrictions) went ahead including a Spring Walk (19/10/2020) in which 31 attended. Other events included the Booleroo/Melrose Hub Event (22/6/2020) in which 17 attended and the SAGIT visit (18/8/2020) in which 8 attended. Updates of the trial were also posted on twitter, Facebook and the UNFS newsletter.

In 2021, The site was visited as part of the 2021 UNFS Annual Members expo with approximately 90 attendees, the UNFS Eastern Spring Crop Walk (approx. 15 attendees) and by various UNFS hub groups throughout the year. The site was always available for visits by farmers at their discretion with a site map available. Brief trial updates were also included in the UNFS newsletters and posted on the UNFS Facebook and Twitter pages. A summary video was uploaded to the UNFS Youtube and put on social media channels at the end of the project.

## POSSIBLE FUTURE WORK

It would be interesting to explore the use of PGRS to reduce head loss in barley in the lower rainfall zone. Work in the Mallee has demonstrated that this practice can be detrimental to yields for crops under 4 t/ha in seasons with unfavorable finishes.