

Multiple frosts at Tooligie in 2021 caused losses of grain yield and quality across a range of varieties

Rhaquelle Meiklejohn¹, Andrew Ware¹ and Michael Hind²

¹EPAG Research, ²Bates Agricultural Consulting



Location
Tooligie Hill
Tim Zacher
Lock/Murdinga/Tooligie Ag Bureau

Rainfall
Av. Annual: 331 mm
Av. GSR: 250 mm
2021 Total: 335 mm
2021 GSR: 225 mm

Yield
Potential: 2.5 t/ha (wheat)
Actual: 1.8 t/ha (F3 barley)

Paddock history
2021: Chief CL wheat
2020: Lupins
2019: Canola

Soil type
Sand

Plot size
1.5 m x 10 m 3 reps, with no gaps between plots or around trial

Trial design
Randomised complete block

Yield limiting factors
Frost - high impact

- **High biomass production in this environment was achieved and may have been useful for grazing or hay production as an alternative to grain.**

Why do the trial?

Frost events over the past four years have caused extensive crop damage and financial loss in large areas of Central and Eastern Eyre Peninsula. Frost damage through this time appears to be affecting similar areas at both a district and paddock level.

Anecdotal evidence suggests that damage from Eyre Peninsula frost events can still occur late in the growing season and that utilising strategies such as growing longer season varieties that flower later to avoid frost isn't an effective management strategy.

Telemetry based, in-paddock weather recording stations, that instantly report climatic conditions are still relatively new technology. Their use in frost prone areas over the past four years has highlighted more frost events in these areas than previously thought.

In 2021 a site was established in the Tooligie area to test whether planting varieties or mixtures of varieties with differing phenology would mitigate frost damage. To monitor the timing of frost events during the season. Multiple temperature loggers were positioned throughout the trial.

How was it done?

On 26 May 2021 eight varieties/ varietal mixtures were sown in an

area that had experienced frost damage in previous years. The trial was sown without any gaps between plots and without any bare area around the trial to avoid corridors within the trial which allow unusual air flow.

Treatments were six wheat varieties that differed in phenology: Vixen (quick spring), Mace (quick-mid spring), Scepter (mid spring), RockStar (mid-slow spring), LR Dual (mid-slow spring awnless), Denison (slow spring); a mixture of Vixen and Denison and one barley variety (Spartacus, very quick spring).

Four temperature loggers were installed prior to the crop reaching stem elongation and recorded temperature at 15-minute intervals in different positions within the trial:

- 1.2 m above ground (standard BOM height)
- 1.2 m above ground with screen (BOM standard)
- 5 cm below ground (soil temp)
- Crop height (moved fortnightly to match plant growth)

The trial was sown at 200 plants/m² and fertilised with 60 kg DAP/ha + 100 kg urea/ha. The site received a pre-emergent herbicide application of 1 L trifluralin/ha and 118 g Sakura[®]/ha. Post-emergent weeds were controlled with 750 ml MCPA LVE/ha + 100 ml Lontrel[®]/ha. The trial was harvested on 10 December 2021. Extra care was taken at harvest to capture all grain, regardless of size. Grain samples were carefully cleaned in lab prior to grain testing.

Key messages

- **In frost prone areas of Eyre Peninsula, relying on Bureau of Meteorology (BOM) stations as a record of frost events may see many events pass without notice.**
- **Barley and slower maturing wheat varieties were able to produce some grain yield in an extremely frosty environment, whereas earlier maturing wheat varieties almost failed.**
- **Frost affected grain quality of all varieties in 2021.**

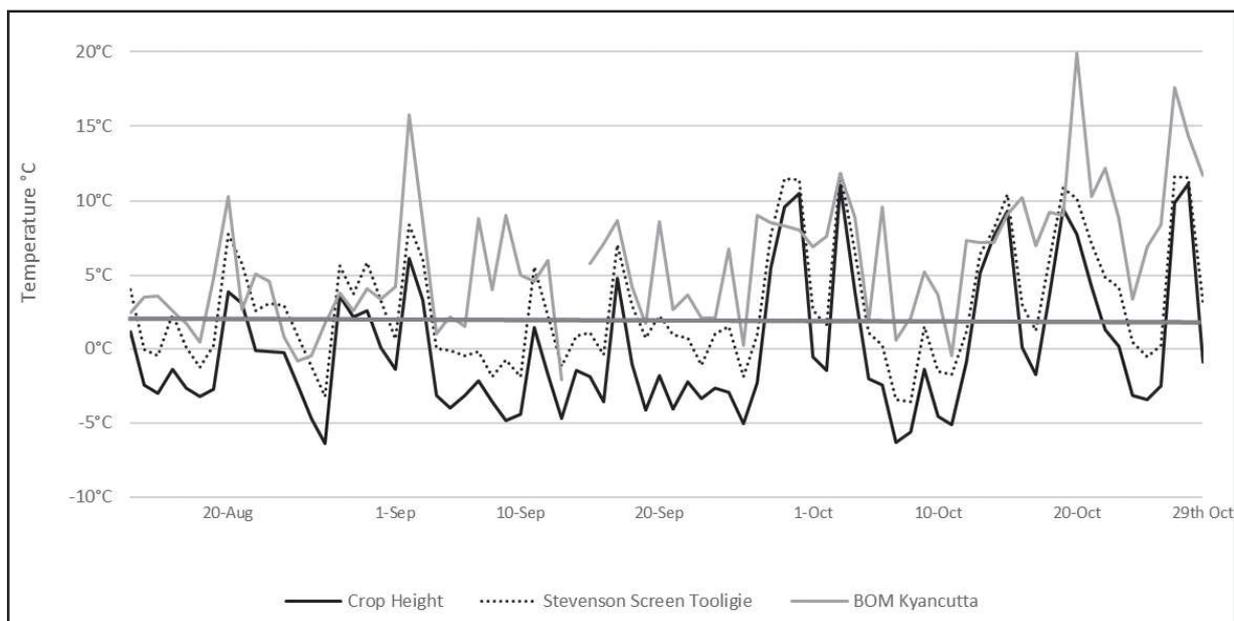


Figure 1. Minimum temperatures from BOM Kyancutta and from the Tooligie trial site (in Stevenson screen and at crop height) from mid-August to end of October 2021. Thick horizontal line denotes the minimum threshold for frost damage (2°C) in Stevenson screen.

Table 1. Biomass in October, grain yield and quality of wheat and barley at Tooligie in 2021.

Variety	Biomass (t/ha) 19 Oct	Grain Yield (t/ha)	Grain Delivery Grade
Spartacus	5.3 ab	1.84 c	F3
Denison	5.6 ab	1.56 bc	Undeliverable
RockStar	6.6 b	0.62 ab	Undeliverable
Scepter	5.8 b	0.60 ab	AUW1
Mixture	5.8 b	0.56 ab	AGP1
Mace	6.8 b	0.31 a	Undeliverable
LR Dual	3.9 a	0.31 a	FED1
Vixen	5.6 ab	0.27 a	FED1
LSD ($P=0.05$)	1.38	0.80	

Temperature during the season, growth stages, biomass, yield, and grain quality were measured. Results were analysed in GenStat version 19.

What happened?

The loggers recorded 38 possible frost events (where minimum temperature fell below zero) at crop height throughout the vulnerable stages of crop growth (stem elongation to late grain fill), see figure 1. Within this same timeframe, Kyancutta BOM station only recorded a minimum temperature below zero on four days. Temperature at crop height was generally 2.2°C lower than with the screened logger, 1.2 m above the ground; and was almost always lower than the BOM records. However, the relationship between temperatures at crop height at Tooligie and Kyancutta BOM records was not sufficiently consistent for BOM records to be in indicator of temperatures at Tooligie, 90 km away (Figure 1).

Spartacus barley and Vixen wheat were the earliest to flower (18 September), and Denison wheat the last to flower (25 September).

Spartacus and Denison yielded 1 t/ha more than the faster maturing wheat varieties. Yields of the fastest maturing variety Vixen and the mid to late maturing variety RockStar were similar and very low.

Test weights of Denison, RockStar and Mace were below receival standards.

Biomass of cereal varieties in mid-October varied between 3.9 and 6.6 t/ha, with biomass of LR Dual being lowest.

What does this mean?

The frequency and severity of frosts between stem elongation and grain fill at that site made it very hard for any variety to escape frost damage, regardless of its maturity type. Higher yields were achieved by a very fast maturing barley or a slow maturing wheat but yields of each of these were still well short of water limited yield potential and grain quality was poor.

Biomass production of between 3.9-6.6 t/ha indicated that grazing or hay production may have been more profitable than grain production, but these options

come with added workloads and machinery/infrastructure costs that may not suit all businesses.

It was only through recording temperatures at the site during the growing season that the frequency and severity of frosts in the area could be accurately measured. This information may be more useful for planning frost risk mitigation strategies in future seasons than BOM records from a distant station.

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