Amelup Frost Trial – Crops sown end of April significantly frosted

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In WA, the impact of frost is estimated to be, on average, $400 million dollars a year. Stirlings to Coast Farmers is currently managing a frost trial as part of a larger, GGA-led GRDC investment. Overall, the investment focuses on planning for frost, utilising the agronomic tools currently available and assisting with post-frost identification and recovery. The aim of this trial, in particular, is to assess a range of crop types and cultivars over two times of sowing (TOS) with the purpose of evaluating the frost damage when planted early or late in the season, and ultimately how this impacts on yield and quality.

The trial is located in Amelup in a particularly frost-prone area, where the farmer experiences regular frost events, and 2022 was no exception!

The Trial Design

The following crop types and varieties were trialled across two times of sowing (28 April and 6 June 2022):

- Wheat: Denison, Rockstar (Slow-mid) (Mid) and Sceptre (a Short-mid).
- Barley: Rosalind (Short-Mid), and Planet (Mid)
- Oats: Banister
- Canola: Trident TT
- Lupins: Jurien

For the cereals, the first TOS could be considered relatively early for a standard mid-spring variety, while the second time of sowing could be considered a late and very conservative approach to avoiding critical frost windows.

What can impact frost severity?

We often think of frost resulting from a particular cold spike where temperatures drop below zero degrees and cause catastrophic damage. However, frost events can often be more subtle and localised (and as a result hard to measure).

The severity of frost is often impacted by a series of factors, such as when light rain has fallen in the hours prior to a frost event, or when there has been a prolonged period of absence of wind. It appears that these scenarios lead to an increased presence of a Pseudomonas species bacterium found in rain or dust and this bacterium acts as a frost nucleator, causing plant tissue to freeze at 'warmer' freezing temperatures, in a shorter exposure time than when these bacterium are not present.

Similarly, a heavy stubble load from the previous season's crop can increase frost severity. This is the result of a two-fold effect; the stubble can increase the level of Pseudomonas (living on decaying crop residues) and the ice nucleic proteins produced by them, and the substantial stubble cover maintains a cooler soil temp, reducing the heat bank effect of the soil.

More research is being undertaken in WA currently to better understand the role of the Pseudomonas bacteria in regard to frost damage.

Frost in Amelup, 2022

The Amelup trial site was chosen for its frostiness! It is in a low-lying area of the property, which is typified by a rolling topography and sits next to the Pallinup River which acts as a cool air sink. The site in 2022 growing season was subjected to 20 frost events between July and October. These 20 events varied in severity; however, there were three particularly significant events, occurring on 31 June, 24 September and 25 September.

The critical period for frost in cereals is between GS60 and GS70 (flowering), where yield impacts are particularly severe. Frost during the flowering period results in bleached heads and florets, causing sterilisation of the floret and lack of grain development. This is directly linked to yield loss.

TOS 1

Buffer	RGT Planet	Bannister	Rosalind	Scepter	Rockstar	Denison	Buffer	Buffer	Trident	Jurien	Buffer
Buffer	Bannister	Scepter	Rockstar	Rosalind	Denison	RGT Planet	Buffer	Buffer	Trident	Jurien	Buffer
Buffer	Denison	Rosalind	Bannister	Rockstar	RGT Planet	Scepter	Buffer	Buffer	Trident	Jurien	Buffer

Figure 1. Trial design and layout for the first time of sowing at Amelup.

TOS 2

Buffer	Jurien	Trident	Buffer	Buffer	Rockstar	Denison	Scepter	Bannister	RGT Planet	Rosalind	Buffer
Buffer	Jurien	Trident	Buffer	Buffer	Rosalind	Bannister	RGT Planet	Scepter	Denison	Rockstar	Buffer
Buffer	Jurien	Trident	Buffer	Buffer	Scepter	Rockstar	Rosalind	Denison	Bannister	RGT Planet	Buffer

Figure 2. Trial design and layout for the second time of sowing at Amelup.

Impact of frosts on TOS1

TOS1 was significantly impacted by frost, with the floret sterilisation testing showing an impact across all the cereal treatments. The damage ranged from 59% in the Scepter to 4% in the oats (Table 1). Given the frequency of the frost events across the site, there was a high likelihood that each crop type would be somewhat impacted by frost. Interestingly, the Denison wheat cultivar suffered significantly less frost damage than the Rockstar and Sceptre wheats. Denison, which is a long spring variety, has a prolonged vegetative stage, which resulted in some avoidance of the critical frost window (GS60-70) coinciding with frosts, by later flowering. Rockstar and the Sceptre wheat flowered earlier in the season coinciding with the peak frost period.

It again highlights the importance of selecting cultivars that will most effectively avoid flowering in the key frost windows for your area.

TOS2 appears to have been somewhat impacted by late frosts but not as significantly as TOS1 and floret sterilisation from TOS2 is still being analysed. This data, and the grain yield and quality data will be reported on in the SCF Trials Review Booklet, to be released in early 2023.

Frost Mitigation Methods

Frost management is a tricky subject as it is largely reliant on risk mitigation across your whole program, rather than pulling a specific agronomic lever. As a result, frost mitigation should be considered as a farming system issue rather than a specific agronomic constraint. The best management for frost risk is avoiding having all your eggs in the one basket. When we talk about agronomic management to mitigate frost damage, the primary aim is to avoid this critical flowering window occurring during the period you are most susceptible to frost conditions. This can be managed by being aware of the maturity class of your chosen cultivar. Having an awareness of the approximate time it takes a cultivar to reach flowering and the factors that trigger the flowering to occur, and then planning sowing dates accordingly, aids in avoiding flowering in frost windows.

Splitting seeding dates of crop types can be an effective way to manage risk. For example, by planting a particular variety, such as Sceptre wheat, across two seeding windows (i.e., late and early) it will prevent the total wheat crop from being susceptible to the same frost event, as the critical flowering window will be split.

Alternatively, you can use multiple maturity class cultivars across your program to spread out your frost risk profile by spreading out the flowering window. This can be achieved by either using differing varieties of spring wheats with different season lengths, such as Vixen (short) and Denison (long), or by mixing and matching wheat types, such as Sceptre (spring), and Illabo (winter type), or Bennett (winter), where the vernalisation requirement of the winter types like Illabo, and the true winter wheat like Bennett, will naturally stagger the flowering period.

Other options include strategically minimising risk by reducing inputs in frost prone areas to reduce the overall economic impact in the event of frost damage. This can be done by taking a similar approach to input strategies as you would with planning for rain deciles. Another option is to avoid planting susceptible crop types in particularly frost prone areas of your property. In these parts, oats and/or pasture may be better options.

The GGA frost investment will be continuing in 2023 with pre-seeding frost planning workshops scheduled for early 2023. If you are interested in attending a workshop, please register your interest with Dan Fay by email dan.fay@scfarmers.org.au.

	Count-Damaged grain		Count-Total Grain		% Damaged Grain	
Denison Wheat	8	b	34	b	25	b
Rosalind Barley	7	bc	28	de	25	b
Bannister Oats	3	c	85	a	4	c
Rockstar Wheat	14	a	30	cd	47	a
RGT Planet Barley	5	bc	27	e	20	b
Scepter Wheat	18	a	31	bc	59	a

Table 1: Floret sterilisation results from TOS 1 at Amelup. Letters indicate significant differences between on treatments. Heads were harvested on the 24/10/2022