# The impact of frost over different crop types and sowing time

*Host: Amelup Estate (Amelup)*

*By: Dan Fay, Research and Development Co-ordinator, SCF*

## KEY MESSAGES:

- **The Amelup frost trial site was subjected to 20 frost events between June and October, with the most significant events on 31 June, 24 & 25 September 2022.**
- **For TOS1 (sown 28 April 2022), all cereals were impacted by frost. Most severely impacted were the spring wheat (Scepter) and mid-spring wheat (Rockstar) at 59% and 47% damaged grains respectively. Denison wheat (long spring) was significantly less impacted with 24% damaged grains. The damage was also represented in the harvest yields.**
- **All cereals (with exception of oats) yielded higher in TOS2 (sown 6 June 2022), demonstrating the significant impact of frost on the earlier sown treatments.**
- **Oats yielded well irrespective of the time of sowing, clearly demonstrating their tolerance of frost.**
- **Canola and lupins yielded well in TOS1, demonstrating that their indeterminate flowering nature can assist with recovery from frost, especially with a soft finish. Both yielded less in TOS2, however, this was due to the cooler daytime temperatures and waterlogging impacting the establishment and early biomass production, rather than frost.**

## Background

In WA the impact of frost on grain yield is estimated to be on average $400 million dollars a year. The GRDC invested in a project led by the Grower Group Alliance (GGA) with the purpose to extend and apply the outcomes of previous Research and Development investments relating to frost, and to build knowledge that will inform grower and advisor decisions relating to pre-season planning, in-season management, and post-frost event responses.

The Stirlings to Coast Farmers-led trial at Amelup was one component of this larger extension investment. This trial aimed to assess a range of crop types and cultivars over two times of sowing, with the purpose of evaluating the frost risk of the different cultivars when planted early or late in the season, and ultimately how this affected yield.

## Methodology/Treatments

The trial site selected by Stirlings to Coast Farmers was in Amelup, in a frost-prone, low-lying area of the property, which is typified by a rolling topography, and is next to the Pallinup River which acts as a cool air sink.

A range of crop types and cultivars were assessed over two times of sowing to highlight the value to crop phenology with the optimum sowing time. The trial included three wheat varieties, two barley varieties, and one oat, lupin, and canola variety.

The first time of sowing was on the 28th of April, for the cereal varieties this sowing time would be considered early for a standard 'mid-spring' variety. Whilst the second time of sowing, 6th June would be considered 'late' and be a very conservative approach to avoiding critical frost windows.

The eight treatments were replicated three times at each time of sowing with each plot size being 10m x 2m.

Living Farm managed the small plot trial with Stirlings to Coast assisting with trial observations and assessments.

## Results and Discussion

In 2022, the Amelup site 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 the 31 of June, 24 of September and 25 of September, where temperatures fell below -3 degrees for periods of more than 4 hours.

### *Floret Sterilisation Results*

TOS1 was significantly impacted by frost, with the floret sterilisation testing showing an impact across all of the cereal treatments. The damage ranged from 59% in Scepter to 4% in oats (Table 1). Given the distributed frequency of the frost events across the site in 2022, there was a high likelihood that each crop type would be impacted by frost. Interestingly, the Denison wheat suffered significantly less frost damage than the Rockstar and Scepter wheat. Denison, which is a long spring variety, has a prolonged vegetative stage, which resulted in the flowering window (GS60-70) avoiding the most severe frost events by flowering later. Rockstar and Scepter wheat, which flower earlier in the season, were both very susceptible to frost in this trial. This was a valuable extension tool, highlighting the importance of selecting cultivars that will most effectively avoid flowering in the key frost windows for a given region.

*Table 1– Mean floret sterilisation results from TOS1 at Amelup (n=3). Letters that differ indicate significant differences between crop treatments. Heads were harvested on the 24/10/2022*

| | **Count-Damaged grain** | | **Count-Total Grain** | | **% Damaged Grain** | |
|---|---|---|---|---|---|---|
| **Denison Wheat** | | | | b | 24 | b |
| **Rosalind Barley** | 6 | bc | 27 | de | 22 | 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 |

## Yield Results

The TOS 2 yields for barley, oats, lupins and canola were largely unaffected by frost damage (Figure 1). The difference in canola and lupin yields between TOS1 and TOS2, is a result of the June time of sowing, rather than frost. In June, the canola and lupins struggled to put on biomass with the cold temperatures and some waterlogging.

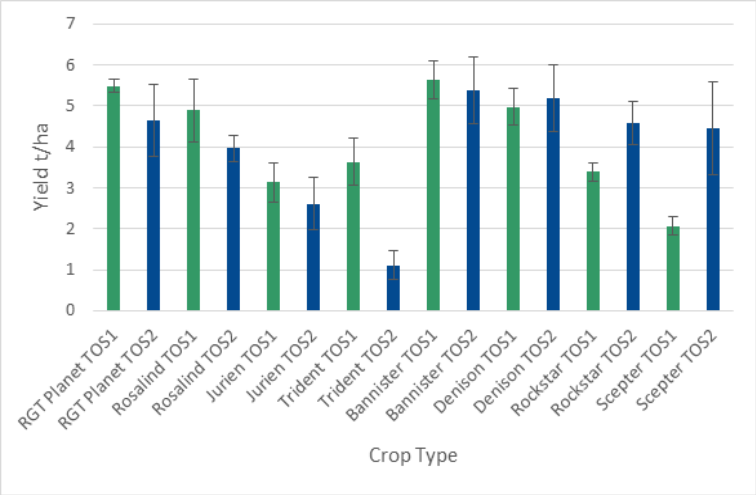


*Figure 1- Mean grain yield results from the frost trial site. (n=3).*

All barley and wheat varieties yielded higher in TOS2 than they did in TOS1. This highlights the benefit of seeding these varieties later in the season to avoid high frost-risk windows. Although June 6 would be considered a very late and sub-optimum time of sowing, any loss in yield potential, in this case, was made up for by reduced frost damage.

A key learning is that Bannister oats yielded well irrespective of the time of sowing. Oats have a natural level of frost tolerance that allows them to produce a viable seed even when subjected to numerous frost events. The adaptability of oats to the time of sowing, and inherent frost tolerance makes oats a viable crop option for frost mitigation.

## Conclusion

The critical risk period for frost in cereals is between GS61 and GS71 (flowering), where yield impacts are particularly severe. Frost during this flowering period causes sterilisation to the floret, resulting in bleached heads, and florets where grain development will not occur. As a result, frost during the flowering period is most directly linked to yield loss.

As demonstrated well in this trial, slow-maturing wheat varieties such as Denison can be utilised on frost-prone paddocks to minimise the risk and impact of frost events. The quick and mid-maturing spring varieties of wheat (i.e., Scepter and Rockstar) when sown early are very frost prone as demonstrated by the treatments sown on the 28th of April (TOS1), which were severely damaged by frost.

Alternatively, shorter spring varieties of both wheat and barley can be seeded later in the season to delay flowering beyond a point in the year where frost events are less prevalent. Whilst this trial showed that there was no yield penalty resulting from the delayed sowing date in the cereal varieties (soft finish), June sowing of wheat and barley has a potential to expose the crop to heat stress, and drought risk. On a more localised scale, however, delayed sowing on the reliably frost-prone areas of the farm could be a beneficial risk mitigation technique. This would effectively balance the on-farm risk of frost versus late season heat/drought stress.

Using different cultivars of cereals with differing maturity lengths is another option. By spreading out the flowering window, the risk of a complete wipe-out due to a serious frost event is greatly reduced.

Finally, planting crops such as oats, which have a high frost tolerance or lupins and canola which have a longer flowering window can effectively reduce frost risk. In this trial, both the oats and the lupins were minimally affected by frost, irrespective of the sowing date. These crop types can also be strategically planted in frost-prone areas to reduce the operation's overall frost risk.

## Acknowledgments

Grateful acknowledgement to project lead GGA as well as GRDC (and the levy paying growers) for continued investment in the project.