Tactics for minimising frost damage on the Eyre Peninsula

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Location
Tooligie
Rainfall
Av. Annual: 385 mm
Av. GSR: 286 mm
2024 Total: 263 mm
2024 GSR: 178 mm
Yield
Yield potential: 3.9 t/ha
Actual: 3.6 t/ha
Paddock history
2024: Phenology trial sown onto 2023 canola
Soil type
Loamy sand over clay loam
Plot size
4 trials approx 200 m x 70 m, plus 2 trials approx 70 m x 70 m
Trial design
Randomised complete blocks and split plots
Soil amelioration sites
Moody, Brooker, Tooligie, Wharminda, Mangalo, Warramboo, Mt Bosanquet

Key messages

- **Combine strategies: effective frost management requires a mix of long-term approaches (for example, soil amelioration, crop selection, and phenology management) and in-season tactics (for example, hay cutting).**
- **Focus on high-risk areas: identifying and targeting frost-prone zones with appropriate strategies like reduced inputs or soil amelioration can optimise profitability while minimising losses.**

Background

Since 2021, frost research on Eyre Peninsula has been focused on helping local grain growers explore strategies to mitigate the economic losses caused by frost events. Growers and advisers are reporting that the frost damage they have been observing in recent years is now more severe than in the past. While there is a lack of in-paddock meteorological data to support or refute if frosts are more prolific in current times, practices such as sowing earlier and condensing the sowing window for the entire cropping program have dramatically increased in recent years. This has led to crops flowering earlier and more synchronously in the growing season, and this often coincides with a higher frequency of frost events, as crops are vulnerable during their critical reproductive stages.

Another contributing factor is the widespread adoption of stubble retention. While beneficial for soil health and moisture conservation, retained stubble alters how heat is distributed during frost events. By insulating the soil, stubble retention reduces the amount of heat radiated back into the atmosphere at night, which can exacerbate frost severity at the crop canopy level. As a result, growers face a complex challenge: balancing the agronomic and environmental benefits of these modern practices with the heightened frost risk they entail.

The 2024 growing season brought unique challenges that further underscored the importance of frost management strategies. Much of the region's crops were sown dry, with widespread emergence only occurring after the season-opening rains that fell in late May. This synchronous emergence led to a substantial proportion of crops flowering simultaneously, coinciding with a series of frost events from early to mid-September. These frosts caused widespread damage, though growers reported that the impact was not as severe as initially feared. It is hypothesised that drought conditions earlier in the season may have 'toughened' plants, making them more resilient to frost. However, frost damage was observed in unexpected areas, highlighting the need for continued research to better understand the interactions between environmental conditions, farming practices, and frost impact.

By improving knowledge of these dynamics, the ongoing research aims to equip Eyre Peninsula grain growers with practical strategies to reduce frost-induced yield losses. This includes investigating how to adapt farming practices to balance productivity with risk management, ensuring sustainable cropping systems in a region where frost events remain a serious challenge.

Key tools for mitigating frost damage

Long-term strategies

Identification of high-risk areas

Frost damage to grain crops often occurs in similar areas of the landscape each year, largely due to the influences of topography and soil type. Low-lying areas, where cold air tends to settle, are particularly prone to frost events. Similarly, soil types with lower water-holding capacity or reduced heat retention can exacerbate frost severity. Recognising these frost-prone areas allows growers to adapt their management strategies to minimise losses. For instance, these zones may benefit from alternative cropping systems, delayed sowing, or selecting frost-tolerant crop varieties.

However, managing frost-prone areas differently often requires growers to compromise profitability in these regions. For example, reducing input investments or shifting to less productive but more resilient crops can help mitigate risk but may also result in lower yields or revenue compared to other parts of the paddock. Despite these challenges, tailoring management strategies to account for frost risk offers the potential to improve overall farm profitability by protecting the yield potential of less vulnerable areas and reducing the economic impact of frost events.

Paired trials were conducted in 2022, 2023 and 2024 where advisers and growers identified areas of high and moderate frost risk in the same paddock, often only a few hundred metres apart. This data demonstrates the difference in yield potential from these zones and how managing areas of high frost risk differently may improve profitability (Table 1).

Crop selection

Crop selection plays a crucial role in mitigating the impact of frost on grain production. Research conducted since 2021 has consistently demonstrated that barley is less susceptible to frost damage compared to wheat, making it a more reliable choice in high-risk areas (Table 2). Barley's ability to tolerate frost events better than wheat can help preserve yields, especially in frost-prone paddocks where losses can otherwise be severe. This resilience makes barley an attractive option for growers seeking to reduce economic risks associated with frost. However, it should be noted that barley is still susceptible to damage from frost and may experience both yield and grain quality reductions from frost events.

Table 1. Comparison of Calibre wheat yields at Tooligie (2022–2024) with late April sowing in moderate vs high frost-risk areas (trials conducted within the same paddock).

Year	Moderate risk zone (t/ha)	High risk zone (t/ha)
2022	5.15	0.87
2023	2.55	0.58
2024	4.46	1.77

Table 2. Grain yield comparison of wheat (Scepter/Calibre) and barley (Spartacus CL/Commodus) at Tooligie (2021–2024) with late April sowing in a high frost zone. Note: Comparisons were made between the most similar varieties available across the 4 years of trial work.

Year	Wheat yield (t/ha)	Variety	Barley yield (t/ha)	Variety	*LSD P=0.05*
2021	0.60	Scepter	1.85	Spartacus CL	*0.72*
2022	0.87	Calibre	3.65	Spartacus CL	*0.85*
2023	0.58	Calibre	1.92	Commodus	*0.87*
2024	1.77	Calibre	2.22	Spartacus CL	*0.75*

Table 3. Grain yield comparison of lentil (Highland XT) and faba bean (Bendoc) at Tooligie (2022 and 2024) with late April sowing in a high frost zone.

Year	Lentil yield (t/ha)	Faba bean yield (t/ha)	*LSD P=0.05*
2022	1.06	3.95	*1.00*
2024	0.34	1.04	*0.31*

Additionally, from these years of trials, faba beans have performed more consistently in high frost risk areas compared to lentils (Table 3). Lentils are particularly sensitive to frost during their reproductive stages, often leading to substantial yield reductions in frosty conditions. In contrast, faba beans exhibit greater tolerance and adaptability, maintaining more stable yields even when frost events occur. By selecting crop types that are better suited to the specific frost risks of their landscape, growers can enhance their ability to manage risk and maintain profitability across their cropping programs.

Phenology management

Variety phenology is another critical frost management tool. Selecting varieties that flower later can help reduce the risk of frost damage by avoiding the peak period of frost events. In highly frosty conditions, later-flowering varieties have shown a yield advantage in certain years (Table 4). For example, quick winter wheat varieties like Longsword and Mowhawk performed well in 2022–2024. Their later flowering when compared to spring wheats was enough to avoid frost damage during vulnerable growth stages. However, these trials found there was not enough differentiation amongst spring variety phenology to reliably avoid frost events in these seasons. For example, last season, there was little advantage in planting a slow to very slow spring wheat such as Denison compared to Scepter (mid-maturity) because there were only a few days difference in flowering. Mohawk however, flowered over a week later which reduced its exposure to those damaging mid-September events.

However, these trials have recorded frost events occurring as early as June and as late as the end of October. This extended frost period means that even varieties with later flowering times are not immune to frost damage, as frosts can coincide with later flowering periods or other sensitive growth stages. This underscores the importance of integrating phenology-based variety selection with other frost management strategies, as no single approach can fully mitigate the risks associated with such a broad window of potential frost events.

Soil amelioration

Much of the high-risk frost areas on Eyre Peninsula are found in regions with sandy soils. In recent years, growers and advisers have reported numerous benefits from ameliorating these soils to reduce non-wetting areas of high soil strength, as well as mixing sub-soil clay into the topsoil. These practices have also been observed to increase the temperature within the plant canopy during frost events. While this benefit does not eliminate the risk of frost damage, it has been demonstrated that it can provide a valuable mitigation effect, helping growers reduce the impact of frost in these vulnerable areas (Figure 1).

In season tactics

Hay cutting and adjusting input costs

Quite often, logistics, ease of management, or extreme frost events do not allow for high-risk frost zones to be managed differently during the growing season. In these situations, in-season management becomes critical to reducing losses from frost. Hay cutting can be an extremely effective way of driving a profit in areas where there is little chance of achieving a grain yield. However, in regions such as Eyre Peninsula, a lack of machinery and storage infrastructure, combined with high labour demand before the peak harvest period, often deters growers from adopting this practice. Consequently, many growers deliberately choose to cut their losses in frosted areas rather than pursue hay production.

High-risk frost zones can also be managed by reducing input costs, but this requires the ability to identify these zones and determine which inputs can be minimised. Although this approach demands effort, it offers growers a way to optimise profitability by reallocating resources to areas with higher yield potential while limiting losses in frost-prone zones.

Table 4. Grain yield (t/ha) of wheat varieties with varied phenology at Tooligie, two sowing times in 2023 and 2024.

Maturity	Variety	2023-late April TOS	*2023-mid-late May TOS*	*2024-late April TOS*	*2024-late May TOS*
Quick spring	Vixen	0.3	1.8	0.9	2.0
Quick-mid spring	Calibre	0.6	2.4	1.8	2.0
Slow- very slow spring	Denison	0.3	2.3	1.8	1.6
Quick winter	Mowhawk	2.4	2.1	2.8	2.3
Mid-slow winter	DS Bennett	1.3	1.0	1.3	0.5
LSD P=0.05		*0.9*	*0.9*	*0.8*	*0.8*

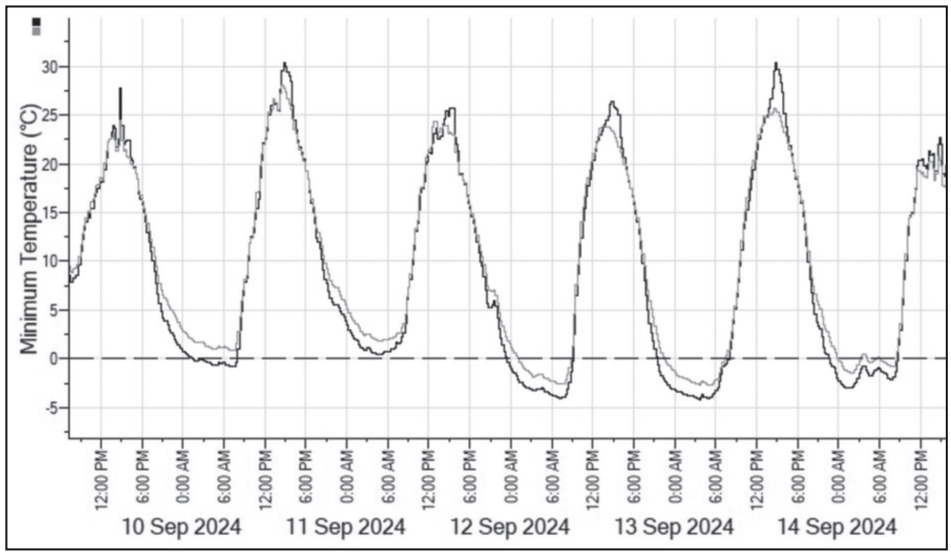

Figure 1. Example of diurnal temperature variation over consecutive frost events at Tooligie. Temperature of ripped soil in grey and control strip in black.

Nutritional amendments

In alignment with work conducted in Western Australia, it was found that once plants have adequate access to their nutritional requirements, there is no additional benefit from applying higher levels of nutrients such as copper and potassium. This finding underscores the importance of ensuring sufficient baseline nutrition but suggests that over-application of these nutrients is unlikely to provide further frost protection or yield benefits. Growers should focus on meeting standard nutritional needs rather than investing in excessive amendments, which may not yield a return under frost-prone conditions.

Conclusion

Frost management on Eyre Peninsula requires a multifaceted approach that integrates long-term strategies, in-season tactics, and a deep understanding of local conditions. By addressing factors such as topography, soil type, crop type selection, and phenology, growers can reduce the economic impact of frost events. In-season tactics like hay cutting and input cost adjustments provide practical options when frost risk cannot be managed pre-emptively, while nutritional amendments ensure plants meet their basic requirements without unnecessary expenditure.

The addition of soil amelioration practices, particularly in sandy soil regions, offers promising benefits, not only for general soil health but also for mitigating frost impacts. Although no single strategy can fully eliminate the risks associated with frost, combining these approaches creates a robust framework for resilience and profitability.

Ongoing research and collaboration with growers remain vital for refining frost management strategies and addressing new challenges as they arise. By leveraging a combination of innovative practices and local knowledge, Eyre Peninsula grain growers can better manage the complexities of frost risk while maintaining sustainable and profitable cropping systems.

References

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