Frost – The Facts

The aim of this demonstration was to show a range of strategies that minimise frost risk.

Summary

Frost events will occur when temperatures at the soil surface are below 0°C. These conditions often occur when a cloudy day is followed by a windless cloud free night. Cereal crops are at the greatest risk of damage when there is a frost during flowering however, damage can be done any time between late stem elongation and late grain fill.

Frost can be reduced in two ways by encouraging the heat storing ability of the soil and promoting air movement. Agronomic management practices such as sowing varieties of different maturity dates or using a chemical protectant could also be used to reduce the risk of frost.

Background

The year 2004 seemed to be the year for breaking weather records, including frost. A record total of 14 frosts were recorded at Longerenong in May, by comparison, just 18 frosts were recorded for the entire three months of winter. A record October minimum of minus 3.1 degrees was recorded at Longerenong on October 16, four days after a record maximum of 38 degrees.

Conditions that favour frost development generally occur when a high pressure system moves in quickly in the wake of a cold front. The highest risk is when a cloudy day is followed by a clear windless night. Cereal crops are considered to be most susceptible to frost damage during flowering, although damage can occur at any time between late stem elongation and late grain fill.

To-date, most frost avoidance measures have involved site selection, growing tolerant crops, and/or delaying flowering time. However, other frost avoidance agronomic practices are now being investigated.

Key points

Frost can be reduced in two ways:
1) increasing soil heat with bare, firm, dark soils; and
2) increasing air movement.

Adding clay to the surface can increase heat storage by improving the water holding capacity of the soil. Clay can also darken the soil allowing more heat to be absorbed from the sun.

Bare soil - bare soil allows maximum heat from sunlight to penetrate and warm the soil during the day and allows its subsequent release at night, which buffers the crop from cold temperatures. Any gains may, however, be offset by yield reductions due to other factors, such as evaporation or surface run-off.

Crop features – the physical features of a crop may be associated with the level of frost damage. Thinner crop canopies, produced by increasing row spacing, lower seeding rates and/or reduced nitrogen applications, exposed more soil for potential heat storage and release.

Variety blends – a blend of two varieties of different maturities will result in at least half of the crop being at a different stage of maturity during a given frost event. Differences in height and plant growth habit may create a more undulating canopy and possibly allow more warm air to rise up through the canopy and mix with cold air around the crop heads. If this practice is to be adopted, varieties need to have the same quality standard for delivery purposes.

Frost can cause more damage to crops deficient in trace elements that strengthen plant cells, such as copper and manganese.

Trials conducted on frost management have identified little difference in crop risk between conventional and minimum tillage systems.

The yield penalty from some of the agronomic practices listed above need to be weighed up against the potential reduction in frost damage.

Method

BCG conducted a demonstration at the 2004 Birchip main site titled 'Reducing frost risk' to demonstrate a range of strategies that minimise frost risk. Management strategies in the demonstration trial included:

- Comparing frost susceptibility of three cereals sown on the same date (wheat, barley, triticale).
- Wide row sowing (36cm) vs narrow row sowing (18cm).
- Mixing seed of two wheat varieties with different maturity dates: Krichauff early and Yitpi mid season.
- Using a possible chemical protectant 'Envy'. Envy is a water emulsifiable polymer concentrated for use on plants to reduce transpiration, offering protection from climate extremes.

Table 1. Cereal yields in a demonstration trial at Birchip with different frost avoidance strategies.

Treatment	Wheat (t/ha)	Barley (t/ha)	Triticale (t/ha)
18cm + chemical protectant	1.35	2.10	1.55
18cm - chemical protectant	1.48	2.05	1.15
36cm + chemical protectant	1.37	1.74	1.42
36cm - chemical protectant	1.45	1.75	1.28
18cm Krichauff + Yitpi mix	1.52		

Although this is not a replicated trial, there seems to be no obvious difference in wheat yields with the different frost management strategies. Barley sown with the narrow row spacing yielded higher than the barley sown at the wide row spacing. Triticale produced higher yields when the chemical protectant treatment was applied. Based on visual assessment, the Krichauff and Yitpi blend showed no frost damage.

As the treatments in this trial were not replicated, further investigation is required to confirm the results. The temporary weather station located at the Birchip main research site did not record any daily minimum temperatures less than zero degrees during either September or October. Therefore, the trial was not exposed to extreme minimum temperatures during the critical flowering stages.

While frosts may never be eliminated, the above methods are examples of on-farm management strategies that may help to reduce the risk of frost damage.