Does stubble retention influence in-canopy temperature and frost risk?

Dr Cassandra Schefe[1], Michael Straight[2], Adam Inchbold[1], Nick Poole[2]

[1] Riverine Plains Inc

[2] FAR Australia

Key points

- Stubble management can influence in-canopy temperatures.
- Long stubble gets colder than short stubble.
- All stubble management treatments experienced very cold minimum temperatures; any differences in frost risk due to management in the Riverine Plains region is not yet known.

Background

The *Maintaining Profitable Farming Systems with Retained Stubble in the Riverine Plains Region* project is primarily focussed on maintaining the profitability of stubble-retained systems. However, since the establishment of the project growers have frequently asked about the influence of retained stubble on frost risk. While there is a perception retained stubble will decrease in-canopy temperatures and increase the risk and severity of frost, most frost-related research has been done in Western Australia in regions of lower yields and lower stubble loads than those experienced in the Riverine Plains region.

Additional project funding was secured from the Grains Research and Development Corporation (GRDC) during 2015 to measure the impact of different stubble treatments on in-canopy temperatures at three large-plot stubble trial sites for the 2015–17 field plot trials. This funding links the project into the GRDC *National Frost Initiative*, with all data generated being submitted into the national frost research database for review and analysis.

Aim

The aim of this work is to understand the impact of stubble retention on in-canopy temperatures and associated risk of frost in cropping environments with high yields and high stubble loads.

Method

The Corowa, New South Wales, and Yarrawonga and Dookie, Victoria, stubble management trials were chosen for this work, as they are all on a second-wheat rotation and are located on flat, relatively uniform frost-prone positions in the landscape. The treatments are listed in Table 1, along with the specific temperature monitoring that was carried out during the 2015 season (June – November) at each site. Temperature was monitored for all four replicates of each treatment, at each site.

The no-till stubble retention (NTSR) — short and NTSR — long stubble treatments at Yarrawonga and Dookie (Table 1) were chosen as long stubble was shown to decrease tillering in the 2014 Dookie trial. This may be due to decreased temperature and/or decreased light interception, and may be related to frost risk.

The in-crop temperature monitoring was carried out using Tinytags, which are battery-operated sensors that

TABLE 1 Sites, selected treatments and temperature monitoring carried out during 2015

Site	Treatments	Measurements
Corowa, NSW	• Stubble retained (NTSR) • Stubble burnt • Stubble incorporated	• Loggers (30cm height and moved to 60cm height on 9 September 2015)
Yarrawonga, Victoria	• NTSR — long stubble (38cm) • NTSR — short stubble (15cm) • Stubble burnt • Stubble incorporated	• Loggers (30cm height and moved to 60cm height on 9 September 2015)
Dookie, Victoria	• NTSR — long stubble (42cm) • NTSR — short stubble (15cm • Stubble burnt • Stubble incorporated	• Loggers (30cm height and moved to 60cm height on 9 September 2015) • Loggers at 5cm height • Loggers buried 5cm below the soil surface.

record the temperature every 15 minutes, which were downloaded at intervals through the season (Figure 1). As these sensors are un-shielded from direct sunlight, they will measure higher daytime temperatures than those recorded at a weather station, where the temperature sensor is shaded.

A weather station with a 1m deep soil moisture probe was also located adjacent to each site to provide local climatic information to support the temperature data.

The temperature data was statistically analysed using Genstat, with statistical significance determined at 5% variance. Measures of least significant difference (LSD) were used to determine which treatments were significantly different.

Results

The following results are for the temperature loggers installed at 30cm height, which were moved up to 60cm height on the 9 September 2015.

Site 1. Corowa, NSW

The overall temperature profile for the Corowa site is shown in Figure 2, with little difference clearly evident between the three stubble treatments. The amount of data presented in this graph makes it difficult to identify clear trends, however it is useful to look at the extremes of cold and heat experienced within the canopy throughout the season.

As the temperature loggers are not shaded, the recorded maximum temperatures are higher than those measured at a weather station. The minimum temperatures are also colder than those measured by a weather station, more accurately reflecting the air temperatures to which the growing plant is exposed. The coldest minimum temperature during the measuring period was -6.5°C in the standing stubble treatment at 5:30am on 4 August 2015.

Frost risk is determined by the duration and severity of frost events; the amount of time the crop experiences sub-zero temperatures, and how cold it actually gets.

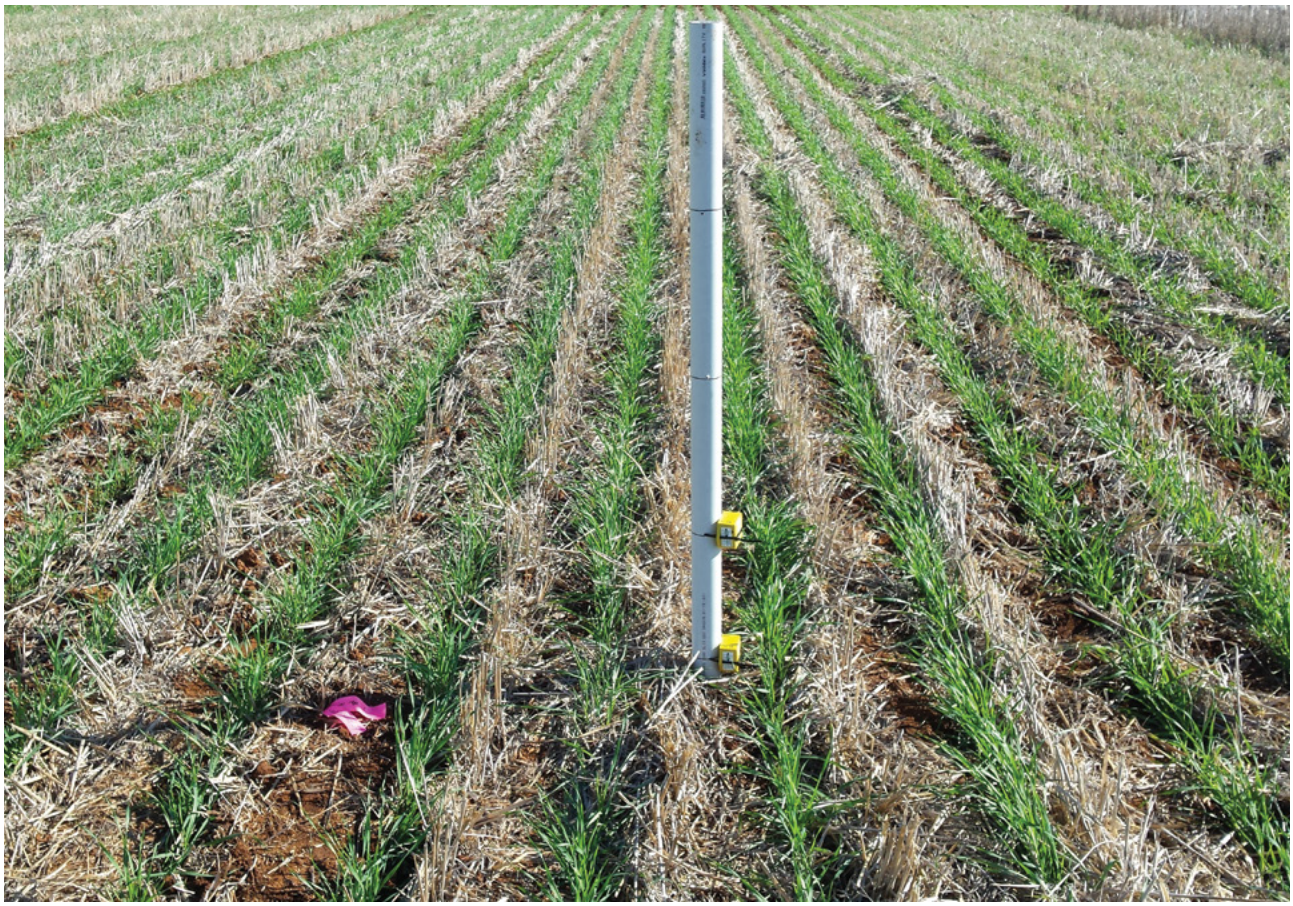

FIGURE 1 Tinytag temperature loggers installed in the NTSR — short stubble treatment at Dookie, 23 June 2015
Note: The 5cm and 30cm loggers are attached to the PVC tube, with the pink flagging tape showing the location of the logger buried 5cm under the soil surface.

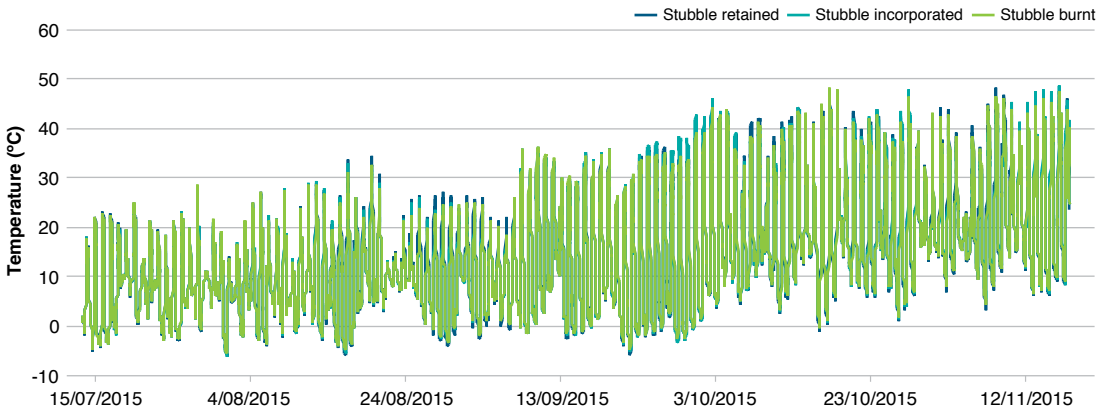

FIGURE 2 The in-canopy temperatures measured at the Corowa site from 17 July – 18 November 2015

The minimum temperatures were analysed to determine if the stubble treatments influenced the amount of time the crop experienced temperatures below zero (time threshold). As seen in Figure 3, during the period measured, the stubble retained (NTSR) treatment was exposed to a significantly longer amount of time at zero and each degree below, compared with the burnt and cultivated treatments, which largely held similar temperatures.

Site 2. Yarrawonga, Victoria

The Yarrawonga site showed a similar spread of temperatures as the Corowa site, with the coldest minimum temperature -6.4°C again measured on 4 August at 7:30am (Figure 4).

The Yarrawonga site had NTSR — long stubble and NTSR — short stubble treatments. These showed that while stubble burning lessened the time below each temperature threshold compared with the other treatments, the incorporated and NTSR — short stubble treatments recorded similar temperatures (Figure 5). The NTSR — long stubble treatment only increased the time below each temperature threshold compared with the incorporated and NTSR — short stubble treatments, at the 0, -1 and -6 °C temperature thresholds. Within the other temperature ranges there was no difference between the incorporated, NTSR — long and NTSR — short stubble treatments.

The fact the NTSR — short stubble treatment recorded similar temperatures to the incorporated treatment indicates stubble height is a significant factor in temperature regulation. The difference between the burnt and the incorporated/NTSR — short stubble treatments may be due to increased minimum temperatures in the burnt treatment before canopy closure, through greater heat absorption onto a darker surface.

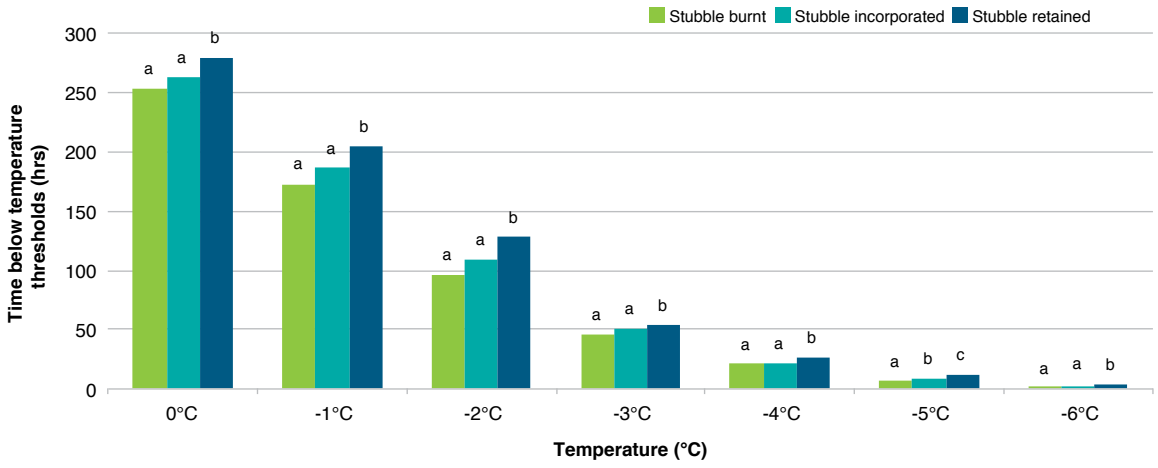

FIGURE 3 The effect of stubble treatment on the duration of in-canopy temperatures at zero and each degree below, at the Corowa site

Letters denote statistical significance between treatments at each temperature.

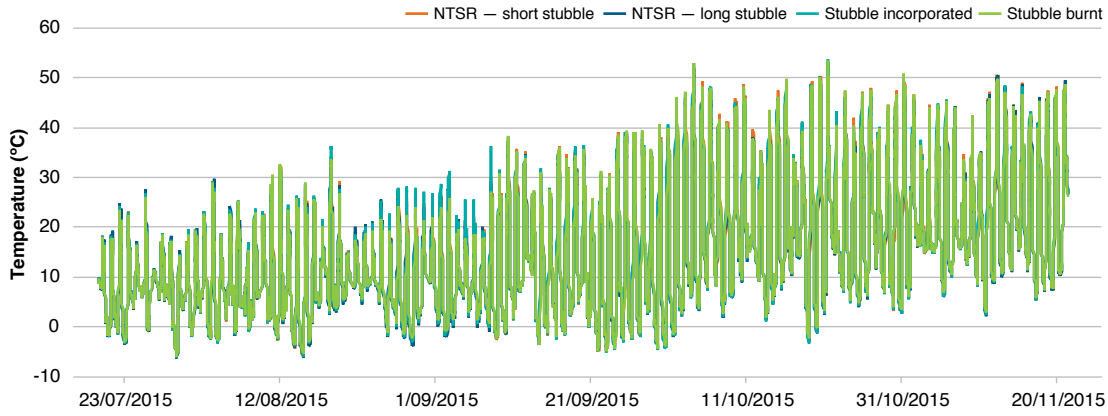

FIGURE 4 The in-canopy temperatures measured at the Yarrawonga site from 17 July – 18 November 2015

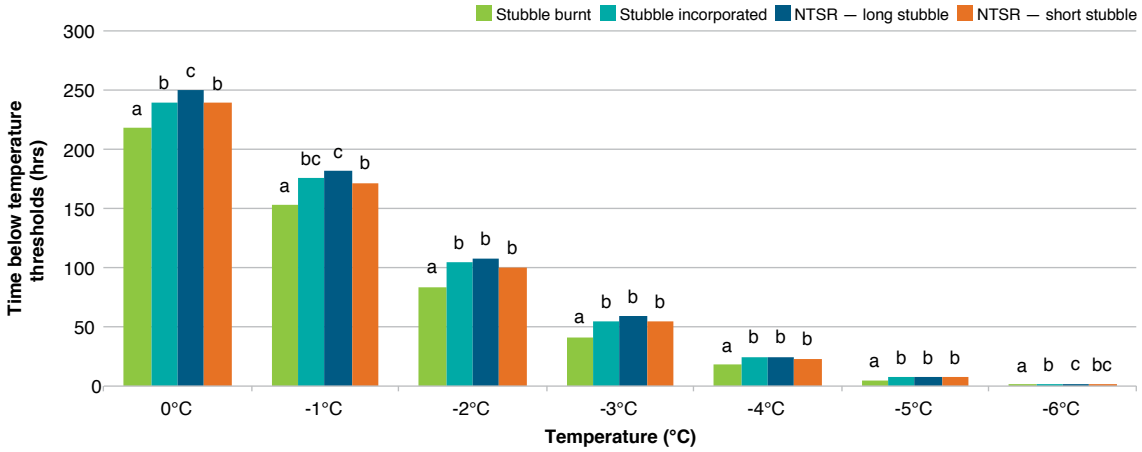

FIGURE 5 The effect of stubble treatment on the duration of in-canopy temperatures at zero and each degree below, at the Yarrawonga site

Letters denote statistical significance between treatments at each temperature.

Site 3. Dookie, Victoria

The Dookie site recorded the coldest minimum temperature of the three sites, with a minimum of -7.0°C at 8:00am on 4 August 2015 (Figure 6).

The burnt and incorporated treatments recorded similar average times below each temperature threshold at the Dookie site, while the NTSR — long stubble treatment was generally significantly colder, with more time at each minimum temperature (Figure 7). The NTSR — short stubble treatment was generally in the middle and was not statistically different to any of the other treatments at all temperature thresholds except -5 and -6°C.

Comparison of temperature recorded at different positions at Dookie

As noted in Table 1, the Dookie site was instrumented with temperature loggers at heights of 30cm, 5cm and 5cm beneath the soil surface. While data analysis of the 5cm and buried loggers is continuing, a key message to come out of this work is how the temperatures varied at the different logging positions.

As shown in the example of NTSR — short stubble in Figure 8, the 5cm loggers measured comparable temperatures to the 30cm loggers early during the season. As expected clear differences became evident as the plants grew taller (above the 5cm loggers), the 5cm loggers didn't reach the extremes of cold or heat of the 30cm loggers.

The buried loggers showed even less variation in temperature through the season (Figure 8). While the 30cm logger plummeted to -7°C on the morning of 4 August 2015, the minimum temperature recorded in the buried logger was 2.7°C, which was the lowest recorded temperature for the whole recording period.

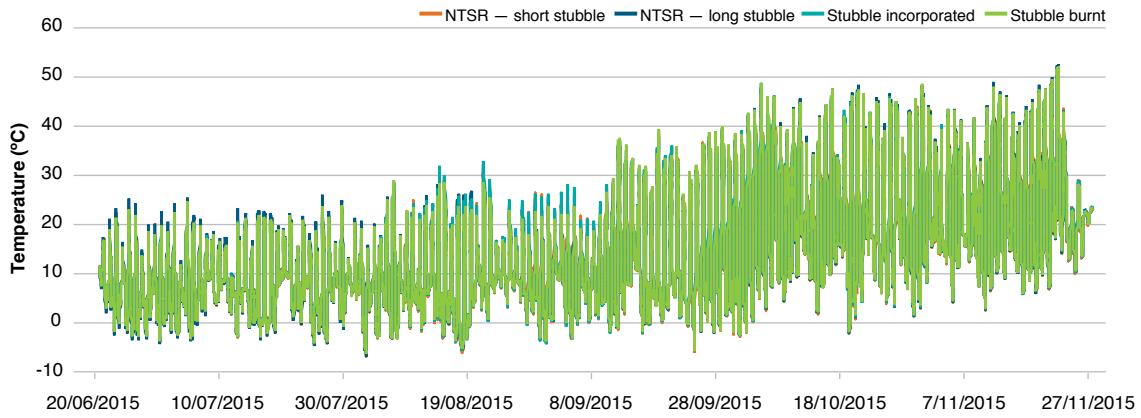

FIGURE 6 In-canopy temperatures at the Dookie site from 24 June – 24 November 2015

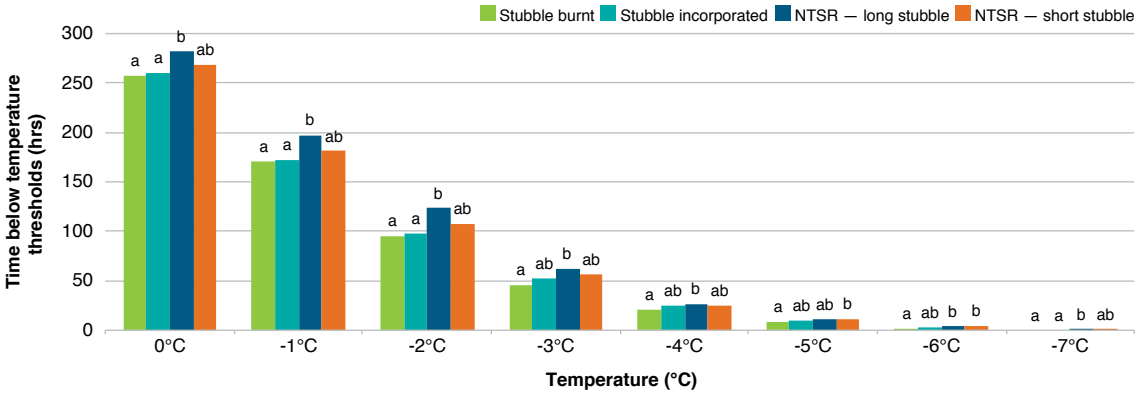

FIGURE 7 The effect of stubble treatment on the duration of in-canopy temperatures at zero and each degree below, at the Dookie site

Letters denote statistical significance between treatments at each temperature.

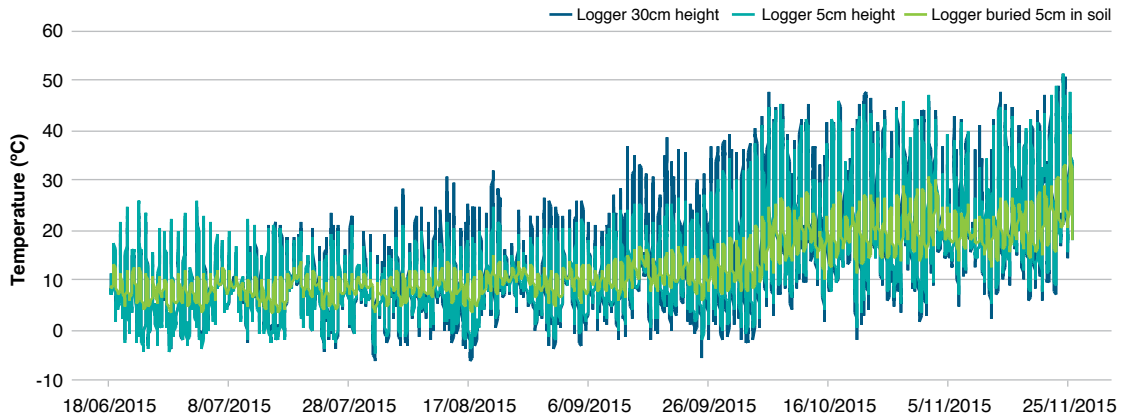

FIGURE 8 A comparison of recorded temperatures when temperature loggers were positioned 30cm above the soil, 5cm above the soil and buried 5cm below the soil surface in the NTSR — short stubble treatment at the Dookie site

Observations and comments

As a general comment, the NTSR — short stubble treatment (15cm high) seems to offer an acceptable compromise in terms of frost risk management between retaining stubble and other management practices (burning and incorporation) — a theme which continues with the plant growth and yield measurements recorded (and reported in other sections of this publication). The NTSR — short stubble treatment seemed to provide all the benefits of full stubble retention (NTSR), while being easier to manage and less likely to cause issues at sowing than the NTSR — long stubble (38–42cm). While statistically significant differences in minimum temperatures were measured when stubble was retained or retained high (NTSR — long stubble) at all three sites, the physiological importance of this difference on the plant's exposure to frost is as yet unknown, due to the lack of frosts during flowering. Rather than extreme frost events; there were extreme heat events during October 2015.

For the 2016 season all three sites have temperature loggers 5cm above the soil surface, and all monitoring started immediately post-sowing. This approach is being employed to better understand the influence of stubble on near-surface temperatures and the effect on plant establishment and early vigour. As temperature monitoring will be carried out for both the 2016 and 2017 seasons, at the end of the project we will understand more about the role of stubble management on frost risk in the Riverine Plains region.

Acknowledgements

This project is funded by the Grains Research and Development Corporation (GRDC). Many thanks to the *GRDC National Frost Initiative* team for advice on frost temperature monitoring, frost damage assessment and statistical support. Thanks also to the farmer co-operators Tomlinson Ag, Telewonga Pty Ltd and the Ludemann Brothers.

Contact

Dr Cassandra Schefe Riverine Plains Inc

T: (03) 5744 1713

E: extension@riverineplains.com.au