Burning temperatures of harvest windrows and standing stubbles in low rainfall farming systems

RESEARCH

Amanda Cook[1], Ben Fleet[2] and Naomi Scholz[1]

[1]SARDI Minnipa Agricultural Centre, [2]University of Adelaide, School of Agriculture, Food and Wine

Key messages

- **Cereal windrow burning achieved temperatures in excess of those required to achieve high levels of weed seed mortality, except in paddocks which had 11 mm of rainfall the week before.**
- **The open paddock burn with a high stubble load had a quicker, faster burn but still achieved the necessary temperatures of 450°C for longer than 60 seconds.**

Why do the trial?

Farmers and advisers list weeds as one of the major constraints to improving the productivity and sustainability of southern Australian farming systems. Narrow windrow burning has been rapidly adopted across southern Australia as a weed management tool. The technique has been found to be very effective for controlling annual ryegrass and wild radish in WA. These weed species retain much of their seed by the time of crop harvest and a significant amount of weed seeds can be collected by the harvester and then concentrated into rows with the chaff and straw. High weed seed kill efficacy is generally achieved for annual ryegrass and wild radish at temperatures often achieved by burning narrow windrows.

Knowledge of both the threshold temperatures to kill weed seeds, and the temperatures achieved when burning crop residues in various formats are required to provide a guide to expected weed seed control of problematic weeds in low rainfall cropping systems. Unlike a whole paddock burn, this information will only relate to the fate of seed that enters the harvest windrow. The total efficacy of this method will be largely controlled by the proportion of weed seeds that can be collected by the harvester. Threshold temperatures to kill weed seeds are reported in the article '*Burning of weed seeds in low rainfall farming systems*'.

How was it done?

SARDI staff on upper EP and the staff of the Upper North Farming Systems (UNFS) group measured temperatures during burning (windrows or whole paddock) of different crops in their region. The UNFS group located farmers in their region who were narrow windrow burning or burning whole paddocks, and the EP paddocks were monitored on the Minnipa Agricultural Centre (MAC).

Over the late summer/autumn of 2016-17, temperatures were measured when burning crops by using a hand held laser type thermometer (Kestrel delta T instrument) by holding the temperature gun at full arms-length pointing at the middle of the windrow. Temperatures were recorded every 10 seconds for 240 seconds, then recorded at 300 and 360 seconds.

Wind speed, direction and air temperature (either from BOM site or using a Kestrel delta T instrument) and the height of the standing stubble were also recorded. For the whole paddock burn the same protocol was used, measurements were taken in a stationary position and due to preserving personal safety, only one set of data were recorded until 210 seconds.

What happened?

Nine paddocks were monitored for burning temperatures, most were cereal stubbles in windrows (Table 1).

Most paddocks with cereal windrows at MAC achieved temperatures greater than 450°C for longer than 60 seconds (Figure 1). The Compass barley in windrows in the airport paddock received 11 mm of rainfall in the week before, with 0.2 mm the day before burning, so despite having the highest stubble load at Minnipa, it did not achieve the target temperatures of higher than 450°C for greater than 60 seconds. Likewise, the S7 paddock burn was conducted 8 days after receiving 11 mm of rainfall at MAC and did not achieve the temperatures required for weed seed kill.

Table 1. Paddock details, crop type, stubble and weather conditions at burning in autumn 2017.

Burning date	Crop	Crop yield (t/ha)	Paddock	Burn type	Stubble height (cm)	Stubble load (t/ha)	Relative humidity (%)	Wind speed and direction (km/h)	Temp (°C)
20 March	Mace wheat	3.0	MAC S1	windrows	18	2-3	16	10 WNW	30
28 April	Mace wheat	3.1	MAC S7	windrows	19	2-3	17	9 SSE	19
26 April	Compass barley*	4.0	MAC Airport	windrows	22	2.5-3.5	38	28 SSW	16
26 April	Mace wheat*	2.8	MAC Airport	windrows	19	2-3	38	28 SSW	16
17 March	Trojan wheat	2.6	MAC S4	windrows	17	2-3	17	9 S	29
17 March	Mace wheat	3.6	MAC N5S	windrows	15	2-3	17	9 S	29
10 May	Medic and barley grass	3.7 DM hay cut	MAC N1	large plots - paddock burn (9 m x 9 m)	17	3-4	23	15 NNE	19
10 May	Mace wheat	2.9	MAC N1	windrows	17	2-3	23	15 NNE	19
9 May	UNFS Canola	2.3	Nottle Paddock 1	windrows	40	1-2	36	7 NNE	20
9 May	UNFS Canola	2.1	Nottle Paddock 2	windrows	40	3-4	27	4 NNE	21
5 May	UNFS Wheat	NA as leased	Hazels	windrows	40	5-6	36	8 NE	19
5 May	UNFS Wheat	NA as leased	Hazels	paddock burn	40	5-6	36	8 NE	19

**11 mm received between 20-27 April*

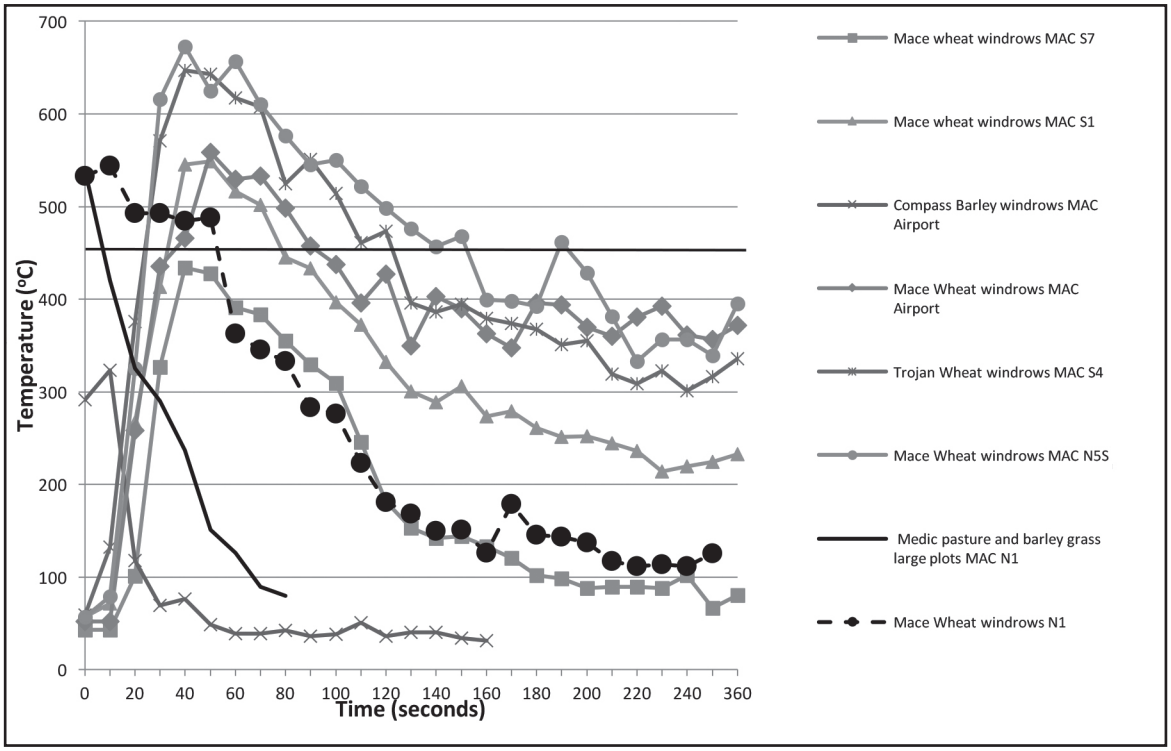

Figure 1. Burning temperatures (°C) over time (seconds) of windrows (wheat and canola) prior to seeding in 2017 at Minnipa Agricultural Centre.

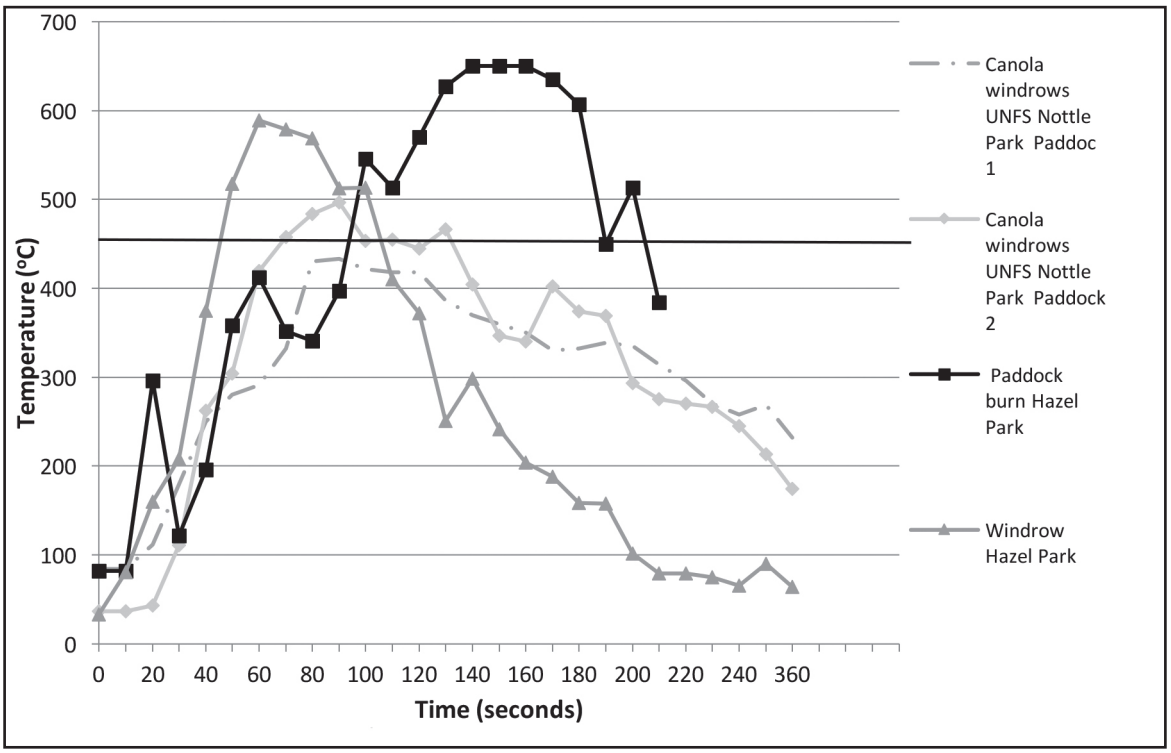

Figure 2. Burning temperatures (°C) over time (seconds) of windrows (wheat and canola) prior to seeding in 2017 in the Upper North, SA.

The medic pasture and barley grass plots (9 m x 9 m) were burnt as a whole paddock burn situation (replicated 8 times). The medic and grass plots did not achieve the high temperatures required for weed seed kill, however further measurements in other medic paddocks and at different dry matter levels are required to make more robust conclusions.

The UNFS canola paddock (Nottle) had been raked twice, so the windrows were low and scattered with very little standing stubble around the windrows, and these windrows didn't achieve the temperatures of greater than 450°C for longer than 60 seconds needed for weed seed kill (Figure 2).

Hazel's paddock was heavy wheat stubble with high numbers of grass weeds, especially ryegrass. The open paddock burn had flames that travelled fast and immediately behind the fire front cooled off relatively quickly; therefore any weed seeds on the soil surface that did not burn directly were not likely to suffer any damage.

Previous burning measurements in windrows at MAC taken in 2015 and 2016 show that with higher stubble loads after a good growing season, temperatures of 450°C for 60 seconds or greater are being achieved. A time interval of 40 seconds with temperatures of 450°C or greater would result in some mortality of seeds, but not a total weed seed kill.

What does this mean?

Recent research under controlled conditions (using a kiln) on the temperatures required to kill weed seed species commonly found in SA cropping regions showed temperatures greater than 450°C for 60 seconds of exposure resulted in high mortality for most weed species (*Burning of weed seeds in low rainfall farming systems*, Fleet *et al.* EPFS Summary 2017).

The results from the paddock burning measurements, using a hand held temperature gun, showed that, when dry, in most situtations temperatures achieved when burning narrow harvest windrows were likely to achieve good control of the weed seeds collected in the harvest row. Total control of weed seeds across the paddock using these methods will depend on the proportion of the weed seeds that can be collected by the harvest operation.

Acknowledgements

SAGIT for funding this research as part of the S416 – Burning of weed seeds in low rainfall farming systems project. Thank you to Ruth and Damien Sommerville, Matt Nottle, Barry Mudge, Hannah Mikajlo, Jake Hull, Wade Shepperd, Ian Richter, Rochelle Wheaton and Brett Hay for their involvement in data collection.

References

Burning of weed seeds in low rainfall farming systems, Fleet B, Kleemann S and Gill G. Eyre Peninsula Farming Systems 2017 Summary.