Full stubble retention: effect on crop growth and growing conditions

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Key findings

- There were no significant differences in lentil grain yield among seeding system or stubble treatments.
- Stripper and conventional stubble treatments resulted in taller and more erect plants with higher pods, improving harvestability.

Why do the trial?

It is estimated that less than 20% of growers use a full stubble retention system due to risks (eg. pests and disease) and costs associated with the practice, which limit its adoption. Stubble retention however, is important for improving soil health and preventing land degradation.

The outcomes of recent research are conflicting. Various reports have shown yield decline from full stubble retention, due to reduced interception of sun light, lower soil temperatures and increased pest activity. Other research has shown that stubble retention may increase cereal and legume grain yields by improving crop growing conditions, availability of water, nitrogen or a combination of these factors. The actual outcome, however, is likely to depend on the management of stubble (level and timing of ground cover), soil type, and interactions with rainfall, soil nitrogen and fertiliser management.

In order to improve no-till cropping system performance, a better understanding of residue management and its impact on crop production is needed. The trial data presented here is the first of a three year project investigating the effect of full stubble retention compared with other stubble management methods and seeding technologies.

How was it done?

Plot size	21 m × 50 m (disc seeder) 25 m × 50 m (knife-point seeder)	**Fertiliser**	DAP (18:20) Zn 2% @ 70kg/ha
Seeding date	28th of May 2013	**Variety**	PBA Blitz lentils @ 50 kg/ha

The trial was established as a randomised complete block design with three replicates and five stubble × seeding treatments (Table 1). The disc treatment was sown using a John Deere 1890 Disc Machine on 15.2 cm (6”) row spacing. The knife-point treatments were sowing using a Flexicoil 5000 on 25.0 cm (10”) row spacing.

Table 1. Treatment details, stubble height and seeding equipment used for each treatment.

Treatment	Stubble description	Seeding equipment
Conventional/ knife-point	Harvested at intermediate height **30 cm** and stubble retained	Knife point
Baled	Harvested using stripper front and straw windrowed **5 cm high**, baled and removed	Disc
Short	Harvested at short height **15 cm** and stubble retained	Disc
Conventional/disc	Harvested at intermediate height **30 cm** and stubble retained	Disc
Stripper front	Standing stubble, harvested using a stripper front, height **~60 cm.**	Disc

Also see Figure 1.

Results

Crop establishment

There was no significant difference in crop establishment (plants per square metre) among stubble treatments or seeding system for lentils in this trial (Table 2). Both the stripper front and short stubble treatments contained the lowest plant number however; the variation in this measurement was too high to observe any statistical differences.

Table 2. Summary of crop measurements establishment (plants per square metre), plant and pod height at maturity, lodging and grain yield.

Stubble treatment	Establishment (plants/m^2)	Plant height (cm)	Pod height (cm)	Lodging*	Yield (t/ha)
Conventional/knife point	120	50.0 a	21.4 a	8-9	2.8
Baled	110	29.5 d	8.6 c	2-3	2.2
Short	96	35.4 c	13.6 b	2-3	2.6
Conventional/disc	100	42.8 b	15.1 b	8-9	2.8
Stripper	86	47.8 ab	16.4 b	7-8	2.7
LSD (P≤0.05)	ns	5.4	3.8	-	ns

**Crop lodging scored as 9 equals erect to 1 completely flat on the ground*

Plant height, pod height from soil surface (harvestability) and lodging at harvest

Plant and pod height was highest for the conventional/knife-point treatment (Table 2). This was followed by stripper and conventional/disc which was higher compared to the short and baled stubble treatments. The shorter plant height for the baled and short stubble treatments may be attributed to the lack of stubble to support the growth of lentil plants. Evidence for this was also the high lodging score for these treatments (Table 2). Overall the stripper and conventional stubble treatments resulted in taller and more erect plants with higher pods improving harvestability.

The conventional stubble treatment was sown with the disc and knife-point seeder, yielding 2.8 t/ha. Plots sown with the knife-point seeder had a greater plant height and higher pods. This was most likely a result of the disc seeder using a narrower row spacing and flattening more stubble, compared to the knife-point which was inter-row sown.

Grain yield

There were no significant differences in lentil yield between seeding system and / or stubble treatment. Grain yield ranged from 2.2 - 2.8 t/ha with baled stubble having lowest yield and both knife point and disc conventional stubble having the highest yield.

Wind, temperature and humidity measurements

Measurements for wind speed (km/hr), temperature (ºC) and humidity (RH%) were taken throughout the growing season and all data displayed is the average data for one sampling time.


Figure 1. Lentils growing in short 15 cm stubble (left) and stripper front stubble (right).

The effect of stubble height on the relative change in wind speed between 0 and 100 cm is shown for two different sampling times in Figure 2. The data shows at 80 and 60 cm from the soil surface reductions in wind speed started to occur. The greatest wind speed reductions were observed in the 0-40 cm height zone from the soil surface. This was the case for either sampling time at low (Figure 2a) or high wind speed (Figure 2b).

These preliminary results show that as stubble height increased wind speed was reduced. Interestingly there was little difference between the baled and short (15 cm) treatments and 30cm of stubble height was required to significantly reduce wind speed. Further investigation of stubble heights will occur in 2014.

The baled and short treatments were on average 56% of the 100 cm wind speed at the 20 cm height (Figure 2b). While at the same height the conventional and stripper treatments were at least 50% better at reducing wind speed. This data shows that wind speed in the zone of plant growth will be affected by stubble height and taller stubble treatments offer plants greater protection.

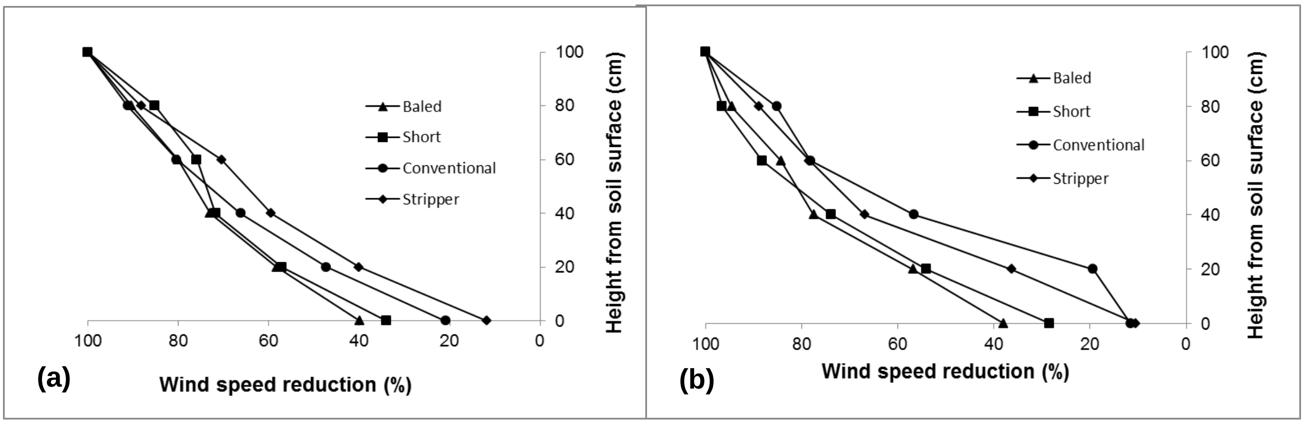

Figure 2. Wind measurements taken on a (a) a low wind speed (6-10 km/hr) and (b) high wind speed (20-30 km/hr).

Temperature and humidity measurements showed a similar trend across all stubble treatments (Figure 3). There was a 1 to 2ºC difference between the stripper and baled stubble at 40 cm however, below this height temperature differences were small. At the time these measurements were taken the crop was well established (15 - 20 cm high) and may have shaded the surface masking the effect of stubble on temperature and humidity.

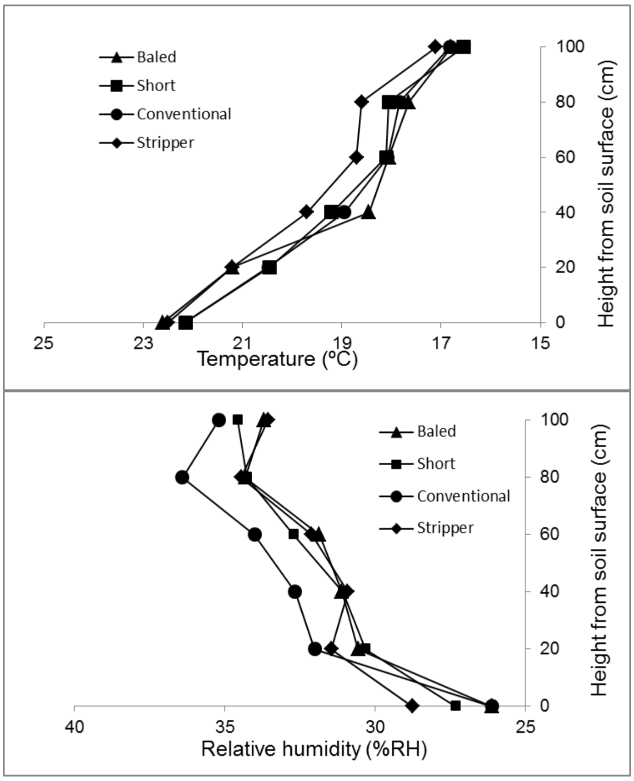

Figure 3. Temperature and relative humidity readings for stubble treatments in 2013.

Pinery stubble management trial

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Agronomic trial work conducted in 2010-2012 by the Southern Pulse Agronomy project in the Pinery region has shown that substantial yield benefits can be achieved through inter-row sowing of lentil into retained cereal stubble. Rainfall and soil type varied over the three seasons of trials, but consistencies include alkaline soil (pH 8-8.5) and shallow soil depth (20-50 cm soil over a heavy limestone layer).

A small-plot field trial was set up at Pinery in 2013 to investigate whether additional benefits can be achieved by sowing inter-row into stubble reaped with a stripper front. Wheat stubbles measured 60 cm in height and 5.6 t/ha in biomass. Stubble treatments (executed pre-sowing) included removed stubble, slashed stubble, standing stubble 30 cm tall and standing stubble 60 cm tall. The lentil variety PBA Blitz was chosen, having shown the greatest response to stubble management in previous trials. The trial was sown with a knife-point cone seeder on 10 inch (25 cm) row spacings, and rolled immediately post sowing.

Significant early insect (mandalotus weevil) damage was noted, particularly in the standing stubble treatments where more than 50% of plants had been defoliated (Table 3). However damage levels were similar in the removed and slashed treatments. This finding highlights the importance of pest protection and vigilant monitoring in retained stubble systems, which provide a favourable habitat for a wide range of insects and pests. Final grain yield showed a 58% yield advantage from sowing into slashed stubble compared to removed stubble (Table 3). No benefit was generated by sowing into standing stubble compared to removed stubble, most likely due to the increased levels of damage caused by insect pests in this treatment. As in previous seasons, standing stubble generated a significant improvement in lodging resistance (Table 3), representing potential harvestability benefits in lentil.

Table 3. Grain yield (t/ha) and lodging score (1-9) of lentils varieties sown in four stubble management practices at Pinery, South Australia in 2013.*

Stubble Treatment	Removed	Slashed	Standing 30cm	Standing 60cm	LSD (P≤0.05)
^Plant defoliation (%)	23 a	29 a	46 b	57 b	16
Grain yield (t/ha)	1.80 a	2.85 b	1.96 a	1.92 a	0.69
Lodging score*	5.0 a	4.7 a	7.3 b	7.3 b	1.5

** Lodging score: 1= prostrate, 9 = erect,*
^ % of plants with leaves defoliated due to mandalotus weevil damage

Trials will be continued at Hart and at Pinery in 2014 to further characterise the effect of stubble management on growth and grain yield of lentils. Large plot trials will be conducted at both locations, while the Southern Region Pulse Agronomy project will also be repeating small plot trials identifying the effect of stubble architecture on growth and grain yield of field pea, lentil and chickpea.