Stubble management and soil water in strip and disc

Amanda Cook[1,2], Craig Standley[1] and Ian Richter[1]
[1]SARDI; [2]The University of Adelaide

Location
Cleve
Crop
Hurricane Lentils
Rainfall
Av. Annual: 375 mm
Av. GSR: 250 mm
2023 Total: 288 mm
2023 GSR: 133 mm
Paddock History
2023: Hurricane lentils
2022: Maximus barley
2021: Wheat
Soil type
Red loam
Plot size
18 m x 30 m x 3 reps on 24.1 cm row spacing (disc)

Location
Buckleboo
Crop
Ballista wheat
Rainfall
Av. Annual: 349 mm
Av. GSR: 247 mm
2023 Total: 165 mm
2023 GSR: 140 mm
Paddock History
2023: Wheat
2022: Wheat
2021: Lentils
Soil type
Red loam
Plot size
18 m x 30 m x 3 reps on 19.05 cm row spacing (disc) and 22.5 row spacing (conventional plot seeder)

Key messages

- **Stripper stubble averaged 64 ± 4 cm high and conventional draper front stubble averaged 15 ± 2 cm high after the 2022 harvest at three sites (Cleve, Buckleboo and Minnipa).**
- **Unrolled stripper stubble had more established plants at 72 plants/m^2 compared to the conventional stubble (also unrolled, 27 plants/m^2) at Cleve.**
- **Stripper stubble resulted in a significant yield loss in lentils compared to conventional stubble at Cleve in 2023.**
- **One site (Minnipa) in a medic pasture in 2023 had fewer weed numbers in the stripper stubble (15 plants/m^2) than the conventional stubble (22 plants/m^2).**
- **Spray coverage at Cleve was similar in both the stripper stubble and conventional stubble when a spray air system was used to improve penetration into the stubble.**

Why do the trial?

The South Australian Drought Resilience Adoption and Innovation Hub (SA Drought Hub) workshop in August 2021 identified strip and disc strategies as a priority topic for the upper Eyre Peninsula. The workshop was attended by growers, industry organisations, farmer groups, researchers and community members.

A small handful of early adopting farmers have begun using disc sowing systems and stripper fronts for headers on the Eyre Peninsula, with the aim of retaining more stubble residue at harvest, less soil and stubble disturbance at seeding, and potentially greater rainfall infiltration over the following summer and autumn. Other potential benefits are increased harvest efficiency and improved timeliness of sowing and harvest.

As a result, AIR EP in partnership with Buckleboo Farm Improvement Group (BFIG) and SARDI Minnipa Agricultural Centre, are investigating the impacts of the strip and disc system on upper Eyre Peninsula to address questions around the benefits and risks of using these systems. In these demonstrations, soil water and potential benefits in crop production were monitored.

How was it done?

The SARDI Minnipa Agricultural Centre team and growers delivered three demonstration sites at Cleve (Bammann's), Buckleboo (Vandeleur's) and Minnipa (Oswald's), to address the following research questions:

1. Does soil water increase in strip/disc systems compared to no-till knife point systems?
2. Do strip/disc systems confer other benefits to the farming system, such as increased soil cover, better nutrition, fewer weeds, less disease and pests, higher yields or better soil health?
3. Are there impacts on the efficacy of pre-sowing herbicides in strip/disc systems compared to a conventional system?

Location
Minnipa
Crop
Self-regenerating medic pasture
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2023 Total: 280 mm
2023 GSR: 169 mm
Paddock History
2023: Medic pasture
2022: Scepter wheat
Soil type
Sandy loam
Plot size
15 m x 12 m x 3 reps on 26.0 cm row spacing (disc) grazed and ungrazed

Tall stripper stubble from harvest of the paddocks in 2022 was cut low to create conventional stubble using the MAC Zurn small plot harvester at Cleve on 28 March, Buckleboo on 29 March and at Minnipa on 6 April 2023. The plot areas were replicated strips based on the width of growers seeding machinery (12 to 18 m wide). The growers' disc seeders were used to sow the crop in 2023 at Cleve and Buckleboo.

Due to the dry start to the 2023 season the Minnipa site (red loam) was not sown to cereal as was planned but was left to regenerate with medic pasture. With the different stubbles already implemented, the opportunity was taken to measure medic regeneration and growth in those stubbles. An electric fence was erected to have a grazed and ungrazed area.

The Cleve site (red loam) compared high and low cut stripper stubble sown with the growers disc seeding system, stubble either rolled or unrolled. The high and low rolled stubble blocks were rolled using a 12.8 m steel roller post plant establishment. The site was sprayed on 18 April and then sown with Hurricane lentils @ 45 kg/ha with 50 kg/ha of MAP, using a NDF SA650 single shoot low disturbance disc system with 24.1 cm row spacing.

At Buckleboo (sandy loam, adequate moisture at seeding) a strip and disc system was compared with a conventional knife point and press wheel seeding system. The site was sown on 4 May with Ballista wheat @ 60 kg/ha with 60 kg/ha of MAP, using a 60 foot John Deere 1890 pro-series disc seeder with 19.1 cm spacing for the stripper system plots. The MAC small plot seeder was used as a conventional system with Harrington knife points and press wheels on 22.5 cm row spacings. Both systems were sown on the same morning using the same seed and fertiliser rate.

Growers prepared the sites prior to seeding with knockdown herbicides. Herbicide coverage within the two different stubbles was compared pre-sowing using a spray card. Coverage (%) was assessed using the SnapCard phone app at Cleve on 18 April, Buckleboo on 3 May and Minnipa on 31 July (grass weed control in pasture).

Initial soil sampling at the sites were taken in late March 2023. Plant emergence was measured at Minnipa on 12 July, Cleve on 29 June and Buckleboo on 26 June. Early dry matter (DM) cuts were completed on 27 July at Minnipa, and at Cleve on 29 June and Buckleboo on 8 August, 2023. Late DM and in-crop soil moisture were measured at Minnipa on 28 July, and Cleve and Buckleboo on 8 and 9 August, 2023 respectively.

Grain was harvested at Cleve on 17 October and Buckleboo on 25 October 2023, using the Zurn conventional front plot harvester with final soil moistures sampled at Cleve and Buckleboo on 20 and 21 November 2023 respectively. Minnipa final soil moistures were sampled on 16 October at medic senescence.

What happened?

At Cleve, standing stripper stubble height averaged 61 cm and the conventional stubble averaged 15 cm (Table 1). Spray coverage was similar across the stubble treatments (Table 1). The broadacre sprayer was a Miller 7380 with spray air system to improve penetration into the stubble canopy using an output rate of 45 L/ha.

Lentil establishment increased in the stripper stubble unrolled (72 plants/m^2) and rolled (63 plants/m^2) compared to the conventional stubble (unrolled, 27 plants/m^2) (Table 1). However, early dry matter was greater in the conventional stubble (Table 1). There were differences in broadleaved weed numbers with the conventional rolled stubble having higher weed numbers (wild turnip, thistle, marshmallow, wards weed) compared to unrolled (Table 1), however there were more mice holes observed in the higher stubble system. The trends in dry matter were similar to final grain yield with the conventional stubble yielding 0.49 t/ha higher than strip and disc stubble (Table 1).

Initial soil water at Cleve was 137 mm in the profile (0-90 cm) at the end of March (data not shown). Gravimetric soil water (%) in August was higher in the unrolled stubble (av. 35%) compared to the rolled treatments (av. 44%) (Table 2). After harvest there were no differences in gravimetric soil moisture between the treatments (Table 2).

Table 1. Stubble height, spray coverage, plant establishment, early dry matter, NDVI, broadleaf weeds, grain yield and harvest pod loss of lentils sown in stripper and conventional stubble at Cleve, 2023.

Stubble Treatments	Stubble Height (cm)	% Spray coverage	Plant Establishment (plants/m²)	Early Dry Matter (t/ha)	NDVI	Broad-leaf weeds (plants/m²)	Grain Yield (t/ha)	Harvest pod loss/ m²
Stripper stubble (high) Rolled	57	6.0	63 b	0.62 b	38 ab	5 bc	0.71 b	22 ab
Stripper stubble (high) Unrolled	64	8.4	72 a	0.65 b	42 ab	7 ab	0.72 b	16 b
Conventional stubble (low) Rolled	14	8.7	20 c	1.15 a	32 b	13 a	1.2 a	25 a
Conventional stubble (low) Unrolled	18	5.6	27 c	1.17 a	45 a	2 c	1.1 a	28 a
LSD (P=0.05)								
*Stubble*Rolling*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
Stubble	*4.1*	*ns*	*8*	*0.27*	*8.6*	*ns*	*0.08*	*6*
Rolling	*4.0*	*ns*	*ns*	*ns*	*ns*	*7*	*ns*	*ns*

Table 2. Soil moisture (%) in stripper and conventional stubble treatments at 0-90 cm in August and November at Cleve, 2023.

Stubble Treatments	Soil water in August	Soil water in November
Stripper stubble (high) Rolled	38.0	24.8
Stripper stubble (high) Unrolled	42.4	18.7
Conventional stubble (low) Rolled	32.3	23.2
Conventional stubble (low) Unrolled	45.2	20.9
LSD (P=0.05)		
*Stubble*Rolling*	*ns*	*ns*
Stubble	*ns*	*ns*
Rolling	*8.6*	*ns*

At Buckleboo, average stripper stubble height was 64 cm and conventional stubble height was 14 cm (Table 3). The conventional low cut stubble had higher sprayer coverage than the stripper stubble (Table 3).

Wheat establishment and growth of wheat was the same in both stubbles (Table 3). Weed numbers at the site were low and similar in both stubbles.

Grain yield and grain quality were the same in both stubbles (Table 3). Average grain protein was 11.9 %, screenings were 41% and 1000-grain weight was 38 g.

Initial gravimetric soil water was 46% in late March. Soil water in September was higher in the stripper stubble compared to the conventional low stubble. Soil water measured after harvest were similar in both stubbles (Table 3).

At Minnipa, average height of the stripper stubble was 68 cm, and conventional stubble was 13 cm (Table 4). Medic establishment and early dry matter was similar in both stubbles (Table 4). Low conventional stubble had higher weeds (mainly barley grass and ryegrass) at 22 plants/m² compared to 15 plants/m² in the stripper stubble (Table 4). Soil moisture content to depth at medic plant senescence was similar in both stubbles (Table 4).

Spray cards were placed within the different stubble treatments on the soil surface before grass weed spraying, with livestock having been in the paddock grazing. Spray coverage with the stripper stubble ungrazed having the highest % spray coverage, similar to the conventional low stubble grazed (Table 5).

Table 3. Stubble height, spray coverage and growth of wheat seeded into stripper and conventional stubble at Buckleboo, 2023.

Stubble Treatments	Stripper stubble (high)	Conventional stubble (low)	*LSD (P=0.05)*
Stubble height (cm)	64	14	*8*
% Spray coverage	9 b	14 a	*4*
Plant Establishment (plants/m^2)	88	94	*ns*
Early Dry Matter (t/ha)	1.5	1.7	*ns*
NDVI	0.48	0.48	*ns*
Gravimetric soil moisture to 90 cm (%) September	31	23.6	*7.5*
Late Dry Matter (t/ha)	1.9	2.1	*ns*
Tillers/plant	3	3	*ns*
Heads/plant	3	3	*ns*
Grain Yield (t/ha)	1.8	1.8	*ns*
Grain weight (hL)	80.8	82.0	*0.9*
Gravimetric Soil moisture (%) post harvest	20	24	*ns*

Table 4. Stubble height, plant establishment, early dry matter and grass weed numbers of self-regenerating medic and final gravimetric soil moisture in stripper and conventional stubble at Minnipa, 2023.

Stubble Treatments	Stubble Height (cm)	Plant Establishment (plants/m^2)	Early Dry Matter (t/ha)	Grass weeds (plants/ m^2)	Gravimetric Soil Moisture to 90 cm after medic senescence (%)
Stripper stubble (high)	68 a	28	0.3	15 b	48.2
Conventional stubble (low)	13 b	44	0.4	22 a	45.1
LSD (P=0.05)	*2*	*ns*	*ns*	*8*	*ns*

Table 5. Spray coverage in stripper and conventional stubble of self-regenerating medic pasture in unfenced and fenced areas at Minnipa, 2023.

Stubble Treatments	Spray Coverage (%)	
	Unfenced	Livestock exclusion (fenced)
Stripper stubble (high)	11.2 b	20.4 a
Conventional stubble (low)	16.0 ab	12.4 b
LSD (P=0.05)	*5.7*	

What does this mean?

Across all sites, the stubble treatments resulted in stripper stubble of 64 ± 4 cm high and conventional draper front stubble system with stubble of 15 ± 2 cm high. Lentil establishment was higher in the stripper stubble than conventional stubble at Cleve, but plant dry matter was higher in the conventional stubble. The grower disc seeder was used to sow both stubbles so the conventional stubble system may have had poorer seed soil contact due to more stubble lying on the ground.

Rolling also improved plant establishment at Cleve. There were no differences in lentil grain yield due to rolling, however, the benefit at harvest of a flatter soil surface is often important. The improved dry matter production of the lentils in the conventional low stubble followed through to a yield improvement in lentils of 0.5 t/ha in 2023. There were no differences in % spray coverage with the different stubble systems using the Miller 7380 with spray air system with a water rate of 45 L/ha used which improved penetration into the stubble canopy.

At Buckleboo, the pre-seeding herbicide application had higher spray coverage with the conventional low cut stubble system than the stripper stubble system. There were no differences in wheat establishment, growth, tiller number, grain heads or yield due to the different stubble systems.

Self-regenerating medic at Minnipa, established better in the conventional stubble than in the stripper stubble, but there were no differences in dry matter production mid-season. More weeds were present in the lower stubble compared to the stripper treatment. The spray coverage was highest in the ungrazed high stubble compared to the other systems.

In 2023, Buckleboo had higher soil moisture in the stripper stubble compared to the conventional stubble, and at Cleve stubble unrolled treatments had higher soil moisture than rolled. Ideally to test the effect of the additional stubble retained in the stripper system on soil moisture over the summer period the stubble treatments would been established at harvest in 2022.

A new project, NGN project "Impact of stripper front and straw length on harvest efficiency, summer weed control, soil moisture retention and pest populations in the Upper Eyre Peninsula" has been funded by GRDC for two seasons. Stripper stubble and two heights of conventional stubble have been implemented directly after harvest in 2023 at Minnipa and Cleve and are ready for the 2024 growing season to monitor the effects of stubble and soil evaporation. This will provide detailed research on soil moisture, measured using in-situ 0-30 cm soil moisture probes over summer in different stubble systems.

Acknowledgements

This project is supported by the South Australian Drought Resilience Adoption and Innovation Hub, which is one of eight Hubs established across Australia through the Australian Government's Future Drought Fund. The SA Drought Hub brings together a dynamic network of primary producers, industry groups, researchers, government agencies, universities, agribusinesses, traditional owners and others to work towards a common vision to strengthen the drought resilience and preparedness of farms and regional communities in South Australia. This project received funding from the Australian Government's Future Drought Fund.

Thank you to the Oswald, Bammann and Vandeleur families for hosting the demonstration sites on their farms. Thanks to Katrina Brands, Marina Mudge, Rebbecca Tomney and Cate Scholz for their technical support and assistance in completing field work.