Impact of retaining stubble in low rainfall farming systems

Amanda Cook[1], Ian Richter[1] and Chris Dyson[2]

[1]SARDI, Minnipa Agricultural Centre; [2]SARDI, Waite

Location:
Minnipa Agricultural Centre, paddock S7
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2016 Total: 391 mm
2016 GSR: 268 mm
Yield:
Potential: 4.0 t/ha (B)
Actual: 2.1 t/ha
Paddock History
2016: Scope barley
2015: Grenade wheat
2014: Grenade wheat
2013: Mace wheat
Soil Type
Red loam
Plot Size
18 m x 2 m x 3 reps

Key messages

- **Barley sown into standing stubble yielded higher (between 0.15-0.33 t/ha) than cultivated or removed stubble in 2016.**
- **Standing stubble cut low (15-17 cm) resulted in the highest level of stubble being maintained into the following season.**
- **Maintaining standing stubbles may be the best option for yield and stubble carry over, but adequate nitrogen must be maintained.**
- **In 2014 and 2015 stubble management and seeding position did not impact strongly on weeds, disease or pests with relatively high stubble loads in a low rainfall farming system at Minnipa.**

Why do the trial?

The GRDC project 'Maintaining profitable farming systems with retained stubble - upper Eyre Peninsula' aims to produce sustainable management guidelines to control pests, weeds and diseases while retaining stubble to maintain or improve soil health, and reduce exposure to wind erosion. The major outcome to be achieved is increased knowledge and skills allowing farmers and advisers to improve farm profitability while retaining stubble in farming systems on upper Eyre Peninsula (EP).

The Minnipa Agricultural Centre (MAC) S7 stubble retention trial was established to determine if we could maintain or improve crop production through applying alternative weed, disease and pest control options in pasture wheat rotations in the presence of crop residues. The trial was established in 2013 with wheat and different stubble treatments imposed at harvest annually. It was sown either inter row or on row each season to determine the impacts of stubble management on crop production, weeds, disease and pests in low rainfall farming systems.

How was it done?

The replicated plot trial was established in 2013 in MAC S7 paddock within the district practice non-grazed zone. Stubble treatments imposed at harvest each season were; (i) Stubble removed after mowing to ground level, (ii) Stubble harvested low (15 cm) (iii) Stubble harvested high (30 cm) /standing (district practice) or (iv) Stubble harvested high then cultivated with offset disc in April.

In each season the trial was sown either (i) Inter row (between last season's stubble) or (ii) On row (in same position every season over the top of the previous crop rows) with a base fertiliser of DAP (18:20:0:0) @ 60 kg/ha. See previous Eyre Peninsula Farming Systems Summaries for details of the treatments imposed.

In 2016 the trial was sown on 13 May to Scope barley at 60 kg/ha, and as per previous seasons all plots were split with urea being added to one half at 40 kg/ha applied at seeding. This rate was estimated to match annual nitrogen tie up with the retained stubble loads using 5.8 kg N required per tonne of stubble to break it down (Kirby et al. 2004). Another 40 kg/ha of urea was also spread on 21 July to the urea treatments only, since there was some nitrogen deficiency present due to the seasonal conditions.

The trial was sprayed on 13 May 2016 with a knockdown of 1.5 L/ha of trifluralin, 1.5 L/ha of glyphosate and 80 ml/ha of carfentrazone-ethyl. The trial was sprayed with 750 ml/ha of imazamix and imazapyr on 20 June. The trial was scored for Rhizoctonia damage and samples for root scoring taken on 28 July. The trial was harvested on 3 November 2016.

Measurements taken during the season were stubble load, soil moisture, emergence count, grass weed counts (at establishment and at harvest), Rhizoctonia patch score and root disease score, snail numbers at harvest, grain yield and grain quality.

Data were analysed using Analysis of Variance in GENSTAT version 16 by Chris Dyson using a split plot design with a factorial (N treatment).

What happened?

Site characteristics

In 2014 soil characteristics in the 0-20 cm zone were, soil pH ($CaCl_2$) 7.9, Cowell P 28 mg/kg, phosphorus buffering index (PBI) 142 and salinity ECe 1.76 dS/m. Soil nitrogen measured in the stubble high treatment in April 2014 was 105 kg mineral N/ha in the 0-60 cm zone and in April 2015 was 134 kg/ha (0-60 cm).

At the start of 2016 soil characteristics in the 0-20 cm zone were (average of 16 treatments), soil pH ($CaCl_2$) 7.9, Cowell P 18.2 mg/kg, phosphorus buffering index (PBI) 150 and salinity ECe 1.63 dS/m. Available nitrogen (0-100 cm) without extra urea was 139 kg mineral N/ha. The additional N treatments increased mineral N/ha (0-100 cm) by 16 kg/ha to 155 kg mineral N/ha.

Predicta B tests prior to the 2016 crop predicted a high risk of Rhizoctonia disease (178 pg DNA/g soil), Yellow leaf spot inoculum was present and *Pratylenchus thornii* levels were medium risk (30 nematodes/g soil).

Yield and biomass production

Barley establishment was the same across all treatments in 2016 (average 86.1 plants/m^2), after good seeding conditions.

In 2016 the retained stubble load was higher in low standing stubble compared to the other stubble treatments, which follows the trend which has occurred in the other seasons (Table 1). Standing stubble yielded higher (between 0.15-0.33 t/ha) than cultivated or removed stubble in 2016 (Table 2). Grain yield averaged over the 2015 and 2016 seasons decreased where stubble had been removed (Table 2).

The extra nitrogen applied this season did not increase grain yield but increased grain protein from 10.0% to 10.9% (Table 2). Screenings were high in all treatments (average 22.8%) with the addition of extra nitrogen increasing screenings from 20.0% to 25.5% (data not presented).

In 2015 there were no differences in wheat yield or grain quality due to the treatments applied. In the 2014 season there was a 0.17 t/ha wheat yield advantage due to removing or cultivating the previous season's stubble (Table 1) which resulted in the decision to add extra nitrogen as a treatment. There was a 0.08 t/ha yield advantage in 2014 by inter row sowing rather than placing the seed on row (Table 1).

Table 1 Plant establishment and grain yield and quality of wheat as affected by stubble management, seeding alignment and initial stubble loads in 2014 and 2015

2013-2015 stubble treatments	2014 stubble load (t/ha)	2014 plant establishment (plants/m^2)	2014 yield (t/ha)	2015 stubble load (t/ha)	2015 plant establishment (plants/m^2)	2015 yield (t/ha)
Stubble standing high	3.4	91	2.40	5.8	65	1.19
Stubble standing low	3.8	102	2.45	6.9	71	1.28
Stubble cultivated	3.4	94	2.58	4.3	45	1.26
Stubble removed	0	94	2.62	0	73	1.20
LSD (P=0.05)	*ns*	*ns*	*0.08*	*ns*	*14*	*ns*
Inter row		98	2.55		65	1.24
On row		92	2.47		62	1.22
LSD (P=0.05)		*ns*	*0.06*		*ns*	*ns*

Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments.

Agronomic factors

Weeds: Early grass weed numbers on 22 July were low (average 1.2 barley grass/m^2 and 0.5 ryegrass/m^2). Cultivation had slightly increased grass weed numbers (2.2 barley grass/m^2 and 1.2 ryegrass/m^2) but removing stubble reduced grassy weed numbers (0.3 barley grass/m^2 and no ryegrass) (data not presented).

Disease: In 2016 there were severe symptoms of Rhizoctonia as the trial was planted to a fourth cereal crop, and also barley shows greater visual symptoms of the disease. There were no differences detected between treatments for Rhizoctonia seminal root score. Rhizoctonia disease symptoms (Rh patch score) were greater with removed stubble, and this treatment also had the highest crown root infection. Cultivation had the lowest Rh patch score and lower crown root infection.

Pests: In 2014, there were no differences in snail numbers at harvest (average 1.7 snails/m^2). In 2015 snail numbers progressively decreased from 2.0 snails/m^2 in high standing stubble through low and cultivated stubble to only 0.5 snails/m^2 in removed stubble (data not presented).

Table 2 Establishment, grain yield and quality of barley as affected by stubble management and seeding alignment in 2016

2013-15 stubble treatments	2016 stubble load (t/ha)	Plant establishment (plants/m^2)	Early dry matter (kg/m^2)	Seminal root score (0-5)	Crown root infection (%)	Rhizoctonia patch score (1-5)	2016 yield (t/ha)	Protein (%)	2015 and 2016 mean yield (t/ha)
Stubble standing high	4.28	88.1	0.56	3.19	67	0.89	2.14[a]	10.5	1.66 [a]
Stubble standing low	5.07	85.0	0.52	3.19	65	1.19	2.24[a]	10.2	1.76 [a]
Stubble cultivated	3.95	82.1	0.50	3.27	55	1.15	1.99 [b]	10.6	1.62 [ab]
Stubble removed	(data removed from analysis)	89.1	0.47	3.19	70	1.65	1.91 [b]	10.5	1.56 [b]
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*6*	*0.37*	*0.14*	*0.40*	*0.10*
Inter row	4.29	84.1	0.52	3.19	64	1.22	2.11	10.3	1.68
On row	4.58	88.1	0.50	3.24	64	1.22	2.02	10.6	1.62
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*0.28*	*ns*
No extra N	4.24	86.9	0.49	3.22	64	1.35	2.06	10.0	1.64
*60 kg/ ha N	4.63	85.3	0.53	3.20	64	1.09	2.08	10.9	1.66
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*0.20*	*ns*	*0.28*	*ns*

*Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments *N treatment applied from 2015*

What does this mean?

Standing stubble cut low (15-17 cm) resulted in the highest level of stubble being maintained into the following season. The standing stubble treatments (both high and low) yielded higher (between 0.15-0.33 t/ha) than the cultivated and removed stubble treatments this season. Maintaining standing stubbles may be the best option, but adequate nitrogen must be maintained as there was a 0.17 t/ha yield decline in 2014 with maintained stubbles compared to removal or cultivation.

The removal of stubble decreased the mean grain yield over the 2015 and 2016 seasons, however stubble removal may be considered in systems if pest levels like snails are high, or stubble borne disease carryover is an issue. The results this season have shown continuous cereal systems have a higher risk of not achieving potential yield due to issues with diseases or weeds. Cultivation may lower the impact of Rhizoctonia in systems, however rotations with grass free break crops may be a better option to lower disease inoculum levels.

In previous seasons, stubble management and seeding position had little effect on grass weeds. In 2016 cultivation had more early grass weed geminate and stubble removal had the least.

Overall the results from this research at Minnipa indicate standing stubble may be the best option for maintaining stubble levels and have a slight yield advantage. Stubble management and seeding position have not impacted highly on weeds, disease and pests over three years with relatively high stubble loads in low rainfall farming systems.

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