Impact of retaining stubble in low rainfall farming systems

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Location
Minnipa Agricultural Centre, paddock S7
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2017 Total: 281 mm
2017 GSR: 155 mm
Yield
Potential: 2.1 t/ha (B)
Actual: 0.4 t/ha
Paddock History
2017: Spartacus CL barley
2016: Scope CL 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

- **Standing stubble cut low (15-17 cm) resulted in the highest level of stubble being maintained into the following season.**
- **Stubble management and seeding position had little effect on grass weeds.**
- **Snail numbers were higher in standing stubble cut high (30 cm) and stubble removed had the lowest numbers.**
- **Stubbles can be estimated using 1.3-2.8 times the grain yield, but it may underestimate the stubble in an average season following a good year, or after a very poor season.**
- **In many low rainfall farming systems livestock are still a very important part of the farming system and the level of stubble carryover is reduced after grazing.**
- **Stubble management and seeding position have not impacted greatly on crop production, weeds, disease and pests over three years with relatively high stubble loads for low rainfall farming systems.**

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 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 in 2014-17 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. The stubble treatments imposed after harvest each season were:

i. Stubble removed after mowing to ground level
ii. Stubble harvested low (15 cm)
iii. Stubble reapt high (30 cm)/ standing (district practice)
iv. Stubble reapt high then cultivated with offset disc in April.

In 2014-17 the trial was sown either:

i. Inter row (between last season's stubble)
ii. On row (in same position every season over the top of the previous crop rows).

In 2015-16 nitrogen treatments were added:

i. Nil
ii. 40 kg/ha urea at seeding and extra depending on seasonal conditions.

In 2017 no urea was applied due to the dry seasonal conditions.

The trial was sown dry on 16 May in 2017 before a predicted rainfall front with Spartacus CL barley @ 60 kg/ha with Systiva seed treatment and base fertiliser of DAP @ 60 kg/ha treated with flutriafol. Measurements taken during the season were stubble load and snail numbers (5 April), soil moisture (16 March), grass weeds pre-sowing (15 May), crop emergence (7 June), early grass weed counts (17 August), late weed and snail numbers (12 Oct), grain yield (8 Nov) and grain quality.

See previous Eyre Peninsula Farming Systems Summaries for details of the treatments imposed.

Data were analysed using Analysis of Variance in GENSTAT version 18. Data is presented as the main effects unless the interactions were significant.

What happened?

See previous EPFS Summaries for more detailed information on previous seasons. The 2017 rainfall at Minnipa was within decile 1, so the trial information was collected in a severe drought season.

Site characteristics

In 2017 soil characteristics in the 0-10 cm layer were soil pH ($CaCl_2$) 7.8 and Cowell P 23 mg/kg. In 2017 Predicta B soil analysis indicated a high risk of Rhizoctonia disease (159 pg DNA/g soil), Yellow leaf spot inoculum was high and *Pratylenchus thornei* levels were medium risk (15 nematodes/g soil).

Average soil mineral N for depths of 0-100 cm ranged from 92 kg/ha for the no added urea treatment, to 172 kg/ha soil N for the stubble removed treatment (Table 2), with an average across all treatments of 123 kg mineral N/ha.

Yield and biomass production

Again in 2017 the greatest stubble carryover was in the stubble standing low cut treatment. The stubble fractions were separated into the standing stubble residue and the stubble on the ground. The low cut treatment had larger stubble pieces from previous seasons on the ground than other treatments.

In 2017 the trial had a staggered emergence with most plants germinating on 30 May after 6 mm of rainfall, however these plants became stressed until late June/early July when a total of 21 mm of rain fell. The dry seasonal conditions severely limited early plant growth.

In 2017 plant germination was affected by stubble management with cultivated stubble and removed stubble having the highest germination in dry conditions and high standing stubble having a lower germination (Table 2). Standing stubble cut low was not different to stubble removed for plant establishment, but plant establishment for low stubble was significantly lower than cultivated and higher than standing stubble cut high (Table 2).

Barley yields with standing stubble cut low and cultivated stubble yielded higher than the other stubble management treatments (Table 3). Stubble cut low and stubble cut high had lower protein levels, with no differences between stubble treatments for screenings (Table 3). The added urea treatment had higher grain protein and screenings in the dry 2017 season (Table 3).

Stubble dry matter after harvest was higher in the stubble standing cut low, sown inter row with extra N applied in the previous two seasons (Table 4). The standing stubble treatments tended to have higher retained stubble loads (Table 4).

Agronomic factors

Weeds: In 2017 there were no grass weeds germinated before seeding on 16 May. Grass weed numbers counted on 17 August showed lower barley grass numbers compared to ryegrass, but management treatments had no influence (Table 2).

Table 1. Stubble loads and grain yield as affected by stubble management, seeding alignment and nutrition at Minnipa 2013-16. *Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments.*

2013-17 Stubble treatments	2014 stubble load (t/ha)	2014 wheat yield (t/ha)	2015 stubble load (t/ha)	2015 wheat yield (t/ha)	2016 stubble load (t/ha)	2016 barley yield (t/ha)
Stubble standing high	3.4	2.40	5.8	1.19	4.3	2.14 a
Stubble standing low	3.8	2.45	6.9	1.28	5.1	2.24 a
Stubble cultivated	3.4	2.58	4.3	1.26	4.0	1.99 b
Stubble removed	-	2.62	-	1.20	0.6	1.91 b
LSD (P=0.05)	*ns*	*0.08*	*ns*	*ns*	*0.6*	*0.14*
Inter row		2.55		1.24	3.3	2.11
On row		2.47		1.22	3.6	2.02
LSD (P=0.05)		*0.06*		*ns*	*ns*	*ns*
*No extra N				1.22	3.3	2.06
*60 kg/ha N				1.25	3.6	2.08
LSD (P=0.05)				*ns*	*ns*	*ns*

**N applied as 2015 and 2016 treatment, not applied in 2017 due to dry seasonal conditions.*

Table 2. Stubble loads, establishment, pest and weed numbers in barley as affected by stubble management, seeding alignment and nutrition in 2017. *Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments.*

2013-17 Stubble treatments	Total soil N kg/ha for 0-100cm*	Stubble load (t/ha)	Standing stubble load (t/ha)	Stubble on ground load (t/ha)	Snails pre sowing (snails/m²)	Barley establishment (plants/m²)	Early in-crop barley grass (plants/m²)	Early in-crop ryegrass (plants/m²)
Stubble standing high	100	4.38 a	1.58 a	2.80 b	18.1a	96 c	2.7	9.9
Stubble standing low	120	4.60 a	0.93 c	3.68 a	7.1 b	109 b	2.9	8.6
Stubble cultivated	105	3.03 b	1.39 b	1.64 c	11.9 b	123 a	2.9	13.3
Stubble removed	172	1.43 c	0.15 d	1.28 c	1.2 c	116 ab	2.2	3.7
LSD (P=0.05)	*	*0.42*	*0.21*	*0.80*	*6.0*	*12.0*	*ns*	*ns*
Inter row	125	3.47	0.96	2.51	11.1	109	2.2	6.9
On row	127	3.25	1.06	2.19	8.1	114	3.2	10.9
LSD (P=0.05)	*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
*No extra N	92	3.36	0.98	2.38	9.1	113	1.8	6.1
*60 kg/ha N	149	3.36	1.05	2.32	10.1	109	3.6	11.7
LSD (P=0.05)	*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

**Samples bulked for soil nutrient analysis so no replication for statistical analysis*

Table 3. Dry matter, weed number, grain yield and quality in barley as affected by stubble management, seeding alignment and nutrition in 2017. *Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments.*

2013-17 Stubble treatments	Late dry matter (t/ha)	In-crop late ryegrass (plants/m²)	2017 Barley yield (t/ha)	Protein (%)	Screenings (%)
Stubble standing high	0.83	1.3	0.37 b	13.9 ab	9.0
Stubble standing low	0.89	1.4	0.41 a	13.7 b	8.8
Stubble cultivated	0.93	1.1	0.42 a	14.1 a	8.9
Stubble removed	0.73	0.6	0.36 b	14.3 a	9.0
LSD (P=0.05)	*0.12*	*ns*	*0.02*	*0.3*	*ns*
Inter row	0.87	1.0	0.39	14.0	9.3
On row	0.82	1.1	0.39	14.0	8.6
LSD (P=0.05)	*ns*	*ns*	*ns*	*ns*	*ns*
*No extra N	0.86	0.9	0.39	13.9 b	8.5 b
*60 kg/ha N	0.83	1.2	0.39	14.1 a	9.3 a
LSD (P=0.05)	*ns*	*ns*	*ns*	*0.1*	*0.8*

Table 4. Final stubble dry matter (t/ha) after harvest 2017.

2013-17 Stubble treatments	Position	On row	On row	Inter row	Inter row
	Nutrition	No extra N	60 kg/ha N	No extra N	60 kg/ha N
Stubble standing high		2.5 bc	1.9 cde	2.5 bc	2.1 bcd
Stubble standing low		2.8 b	2.4 bc	2.5 bc	4.4 a
Stubble cultivated		1.4 def	1.3 def	1.8 cde	2.1 bcd
Stubble removed		1.1 ef	0.9 f	0.8 f	0.6 f
Stubble Treatment x Position x Nutrition LSD (P=0.05)	*0.83*				

Disease: Rhizoctonia inoculum levels were high in 2017, however disease symptoms were not visual due to drought stress and limited plant growth. Some spot form of net blotch was detected in the trial this season.

Pests: In 2017 in a non-grazed paddock and after a wet summer/ autumn period the pre-sowing snail numbers were greater in the high cut stubble treatment compared to cultivated stubble or low cut stubble, and the lowest snail numbers were in the stubble removed treatment (Table 2).

The GRDC Stubble Management Fact Sheet (2011) predicts wheat stubble loads or volume can be estimated using 1.3-2.8 times the grain yield, and can start causing issues in farming systems from 3-4 t/ha dry matter. Table 5 shows the non-grazed stubble loads at Minnipa follow this estimation except in an average season following a very high yielding season, as in 2016 the stubble load was higher than predicted, and very low seasons (decile 1) where the 2017/2018 stubble load is also higher than predicted.

What does this mean?

Standing stubble cut low (15-17 cm) resulted in the highest level of stubble being maintained into the following season. Low cut standing stubble and cultivated stubble yielded higher this season, despite cultivated and removed stubble having better plant establishment. The removed stubble treatment resulted in an extra 50 kg mineral N/ha over the average N level which equates to $49/ha, costed using urea at $450/ tonne. There were no differences due to sowing position in 2017, and little difference in the extra nitrogen treatment with only 0.2% higher protein and 0.8% higher screenings in a dry season. Maintaining standing stubbles is 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.

In 2017, as in most previous seasons, stubble management and seeding position had little effect on grass weeds. Initial snail numbers in 2017 were highest in standing stubble cut high (30 cm) and stubble removed had the lowest numbers. Removal of stubble decreased 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.

Estimated stubble yield of 1.3-2.8 times the grain yield can be applied within ungrazed low rainfall farming systems, however this may underestimate the stubble in an average season following a good year, or after a very poor season, possibly due to higher carry over and lower breakdown of stubble from the previous season. In many low rainfall farming systems livestock are still a very important part of the farming system and the level of stubble carryover is reduced after grazing.

Overall, 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.

Table 5. Actual stubble loads and predicted stubble loads for 2014-2017 at Minnipa.

2013-17 stubble treatments	2014 stubble load (t/ha)	2014 wheat yield (t/ha)	Predicted stubble load 1.3-2.8 of grain yield	2015 stubble load (t/ha)	2015 wheat yield (t/ha)	Predicted stubble load 1.3-2.8 of grain yield	2016 stubble load (t/ha)	2016 barley yield (t/ha)	Predicted stubble load 1.3-2.8 of grain yield	2017 stubble load (t/ha)	2017 barley yield (t/ha)	Predicted stubble load 1.3-2.8 of grain yield (t/ha)	After harvest 2017/2018 stubble load (t/ha)
Stubble standing high	3.4	2.40	3.1-6.7	5.8	1.19	1.6-3.3	4.3	2.14	2.8-6.0	4.38	0.37	0.5-1.0	2.3
Stubble standing low	3.8	2.45	3.19-6.9	6.9	1.28	1.7-3.6	5.1	2.24	2.9-6.3	4.60	0.41	0.5-1.2	3.0
Stubble cultivated	3.4	2.58	3.35-7.2	4.3	1.26	1.6-3.5	4.0	1.99	2.6-5.6	3.03	0.42	0.6-1.2	1.7

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