Long-term cropping systems trial

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Funded by South Australian Grains Industry Trust (SAGIT) and conducted in collaboration with farmers Michael Jaeschke, Justin Wundke and Tom and Ashley Robinson.

Key findings

- Wheat grain yield was not significantly different between seeding systems or level of nitrogen, averaging 5 t/ha.
- The high nutrition treatment increased grain protein.
- The high nutrition treatments had accumulated 28 kg N/ha more soil available nitrogen compared to the medium treatments to a depth of 60 cm.

Why do the trial?

To compare the performance of three seeding systems and two nitrogen nutrition strategies. This is a rotation trial to assess the longer term effect of seeding systems and higher fertiliser input systems.

How was it done?

Plot size	35 m x 13 m	**Fertiliser**	DAP/urea (27:12) @ 90 kg/ha
Seeding date	Disc: 28th May No-till: 28th May Strategic: 28th May	**High nutrition**	UAN (42:0) @ 70 L/ha and Twin Zinc @ 0.5 L/ha 14th August
		Medium nutrition	No extra fertiliser applied
		Variety	Cobra wheat @ 100 kg/ha

This trial is a randomised complete block design with three replicates, each containing three tillage treatments and two nitrogen nutrition treatments. The disc, strategic and no-till treatments were sown using local farmers Tom Robinson, Michael Jaeschke and Justin Wundke's seeding equipment, respectively.

Figure 1. Previous crops in the long term cropping systems trial at Hart.

2000	2001	2002	2003	2004	2005	2006
Sloop Barley	Canola	Janz Wheat	Yitpi Wheat	SloopSA Barley	Kaspa Peas	Kalka Durum

2007	2008	2009	2010	2011	2012
JNZ Wheat	JNZ Wheat	Flagship barley	Clearfield canola	Correll wheat	Gunyah peas

Tillage treatments:

Disc – sown into standing stubble with John Deere 1980 single discs at 152 mm (6”) row spacing, closer wheels and press wheels.

Strategic – worked up pre-seeding, sown with 100 mm (4”) wide points at 200 mm (8”) row spacing with finger harrows.

No-till – sown into standing stubble in one pass with narrow points with 225 mm (9”) row spacing and press wheels.

Nutrition treatments:

Medium – No extra fertiliser applied post seeding.

High – Extra nitrogen and zinc were applied to the plots post seeding.

Soil nitrogen (0-60 cm) was measured on 30th May in all plots.

For the plant counts, 4 x 1 m sections of row were counted across each plot.

All plots were assessed for grain yield, protein, screenings and test weight.

Results

Soil available nitrogen to 60 cm was measured in autumn and ranged between 127 kg N/ha (no-till, medium) and 179 kg N/ha (strategic, high) between the tillage treatments (Table 1). The high nutrition treatments had accumulated 29 kg N/ha more soil available nitrogen compared to the medium treatments to a depth of 60 cm. These results are consistent with those measured in previous years, in 2011 and 2012 where the values were 28 kg N/ha and 45 kg N/ha, respectively.

Crop emergence was variable for the disc seeder, and the no-till seeder produced more consistent plant numbers. The strategic treatment has been removed from all analysis due to poor crop emergence and heavy weed burden later in the season, making these plots non-representative of the tillage treatment.

Nutiriton	Tillage	Available soil nitrogen (kg N/ha)	Emergence (plants/m^2)
High	Disc	164	178
	No-Till	166	149
	Strategic	179	-
Medium	Disc	153	124
	No-Till	127	144
	Strategic	140	-
LSD (P≤0.05)			
Tillage		ns	ns
Nutiriton		ns	ns
Tillage * Nuitrition		ns	ns

Table 1. Available soil nitrogen (kg/ha) and crop emergence (plants per square metre) for nutrition and tillage treatments at Hart in 2013.

Tillage treatment did not significantly influence the grain yield or quality of Cobra wheat in this trial at Hart in 2013 (Table 2). The average grain yield for disc and no-till treatments was 5.0 t/ha. In the previous year’s differences in grain yield have been attributed to different sowing dates for the seeding treatments. In 2013 both no-till and disc treatments were sown on the same day. This finding supports the general conclusion from the previous 12 years of this trial, which is no one seeding systems consistently yields higher than another.

Table 2. Grain yield (t/ha), protein (%), test weight (kg/hL) and screenings (%) for nutrition and tillage treatments at Hart in 2013.

Nutiriton	Tillage	Grain Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)
High	Disc	4.8	13.8	73.6	6.6
	No-Till	5.0	12.9	70.3	7.4
Medium	Disc	5.2	12.4	73.4	4.7
	No-Till	5.0	12.5	73.1	5.1
LSD (P≤0.05)					
Tillage		ns	ns	ns	ns
Nutiriton		ns	0.64	1.77	ns
Tillage * Nuitrition		ns	ns	ns	ns

Nutrition did not affect grain yield however, differences in protein and test weight were observed (Table 2). Grain protein was significantly higher (13.4%) in the higher nutrition treatments than the medium treatments (12.5%). This may be explained by the higher soil nitrogen (Table 1) in the high nutrition treatments compared to the medium. Similar observations were also seen for Correll wheat in 2011. Test weight for both nutrition treatment was below 74 kg/hL, the minimum required for the maximum grade. The medium treatment produced higher test weight (73.5 kg/hL) compared to the high nutrition treatment (71.7 kg/hL).

Photos: (left) Stephen Ball speaker at the cropping systems trial at the Hart Field Day, (top right) Justin Wundke seeding the no-till treatment (bottom right) Tom Robinson seeding the disc treatments.

Soil biology of Hart cropping systems trial

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The soil biology research is funded by a Grains Research and Development Corporation (GRDC) project DAS00111.

Key Findings

- Tillage had a significant effect on free-living nematode populations but the effects were different in different years.
- Fertiliser addition had no significant effect on nematode populations.
- Higher amounts of the crown rot fungus, *Fusarium pseudograminearum*, and stem nematode, *Ditylenchus*, in the disc than the no till treatments due to better pathogen dispersal in no-till.

Why do the trial?

This is a rotation trial to assess the longer term effect of seeding systems and fertiliser inputs on biological soil health, by analysing nematode communities. In addition we assessed changes in soil biology pre-and post-sowing and between bulk and rhizosphere soil.

Nematodes are significant pests of cereal crops, but soils also contain non-parasitic free living nematodes (FLN). These FLN, provide a wealth of information on a soil's biological status and are therefore useful indicators of soil health. Free-living nematodes are important in nutrient cycling within the soil as they feed on soil microbes (bacteria and fungi) releasing nitrogenous compounds and other compounds which are then available to plants.

The composition of nematode communities, so the presence or absence of certain species, can provide information of the microbial status of the soil. A 'healthy soil' generally has well structured, mature and stable nematode communities and the predominant nematodes will be free-living species, with a diverse range and a good balance between bacterial and fungal feeders and will also contain omnivorous and predatory nematodes.

How was it done?

This trial is a randomised complete block design with 3 replicates, each containing 3 seeding treatments and 2 nitrogen nutrition treatments (as outlined in the article 'Long-term cropping systems trial). In this soil biology study only 2 tillage treatments were analysed, disc and no-till.

The treatments were sampled pre-sowing after the initial opening rains in April 2012 and 2013. The same treatments were also sampled pre and post sowing in July 2013. Both bulk soil and rhizosphere soils were collected in the 2013 post sowing samples.

The trial was planted with wheat (Correll) in 2011, peas (Gunyah) in 2012 and wheat (Cobra) in 2013 @ 100 kg/ha.

Tillage treatments	2012 & 2013
Disc	**2012** - sown into standing stubble with Serafin Baldan single discs on 250mm (10") row spacing, closer wheels and press wheels. **2013** - sown into standing stubble with John Deere 1980 single discs at 152 mm (6") row spacing, closer wheels and press wheels.
No-till	sown into standing stubble in 1 pass with Flexicoil PD 5700 drill, narrow points with 300mm (12") row spacing and press wheels.

Nutrition treatments	2012	2013
Medium	DAP @ 90kg/ha at seeding and no extra fertiliser applied post seeding	DAP @ 90kg/ha at seeding & no extra fertiliser applied post seeding
High	DAP @ 90kg/ha at seeding and no extra fertiliser applied post seeding	DAP @ 90kg/ha at seeding and UAN (46:0) @ 70 L/ha & Twin Zinc @ 0.5 L/ha on 14/8/2013

Three plots from each treatment were sampled and consisted of 30 cores (about 1.2 kg soil) collected with a 25 mm diameter corer at a depth of 0–10 cm. The soil was sub divided into three portions for manual nematode analysis, DNA nematode analysis and soil chemical analysis.

Several indices were also calculated to characterise nematode communities. Soil was also dried and DNA was extracted and analysed using PreDictaB tests by the SARDI's Root Disease Testing Service.

Results and Discussion

Measurements taken from the cropping systems trial in 2012 and 2013 showed tillage has a significant effect on nematode communities however, fertiliser had no effect. In 2012 the disc treatments were dominated by more fungi compared to bacteria. While the no-till treatment soils had high numbers of fungal feeders but also bacterial opportunists taking advantage of the flux of bacteria and fungi associated with the decomposition of the stubble.

The fungal pathogen, *Fusarium pseudograminearum*, the causal agent of crown rot in wheat, was the main driver of this tillage effect. Crown rot inoculum was much more abundant in the disc than no-till treatments (Table 1). The levels of this pathogen were very high and fell into the high disease risk category as determined by PreDictaB ratings (Table 1). In addition, a similar trend was observed with the stem nematode (*Ditylenchus)*, which was also more abundant in disc seeded plots (Table 1).

It could be suggested that the no-till treatments may encounter lower populations of both crown rot and stem nematode as there is greater disturbance of both soil and stubble during sowing. For disc treatments there is less soil disturbance allowing pathogen populations to proliferate.

Table 1. PreDicta B DNA quantification of (a) common fungal pathogens and (b) parasitic nematodes in the different tillage treatments at Hart, 2013. Pathogen levels are reported in terms of picograms of DNA per gram of soil, except for stem nematode which is per 100g soil, which correlates to disease risk categories. Risk categories should be used as a guide only as they may be subject to regional and seasonal differences.

(a) common fungal pathogens

Time	Tillage	Take-all	Take-all Risk	Rhizoctonia	Rhizotoctonia Risk	Crown Rot	Crown Rot Risk
Pre-sowing	Disc	2.72	*	0.58	*	1037.20	High
Pre-sowing	No-till	1.59	*	4.54	*	38.82	Low
Pre & Post-sowing	Disc	3.03	*	0.42	*	665.37	High
Pre & Post-sowing	No-till	2.25	*	4.28	*	16.40	Low
Post-sowing	Disc	2.96	*	0.00	*	93.08	Medium
Post-sowing	No-till	2.57	*	11.11	Low	8.95	Low

(b) parasitic nematodes

Time	Tillage	CCN	CCN Risk	P. neglectus	P. neglectus Risk	P. thornei	P. thornei Risk	Stem nematode	Stem nematode Risk
Pre-sowing	Disc	0.08	*	4.44	Low	10.62	Low	46.10	High
Pre-sowing	No-till	0.13	*	5.22	Low	8.54	Low	3.49	Low
Pre & Post-sowing	Disc	0.00	*	2.66	Low	5.16	Low	2.86	Low
Pre & Post-sowing	No-till	0.01	*	1.80	Low	5.01	Low	0.23	*
Post-sowing	Disc	0.00	*	2.60	Low	2.69	Low	0.90	Low
Post-sowing	No-till	0.02	*	1.69	Low	2.34	Low	0.14	*

CCN = Cereal cyst nematode
P. neglectus and P. thornei (both root lesion nematodes)
**below detection limit*