Will controlled traffic improve crop production outside the wheel tracks?

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RESEARCH

Searching for answers

Location:
Minnipa Ag Centre
Paddock S7
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2015 Total: 333 mm
2015 GSR: 258 mm
Yield
Potential: 3.0 t/ha (W)
Actual: 2.7 t/ha
Paddock History
2014: Medic pasture
2013: Medic pasture
Soil Type
Calcareous red sandy loam
Plot Size
50 m x 3 m x 4 reps

Key message

- **Heavy trafficking did not reduce the grain yield of wheat in 2015 and crop development appeared faster with some trafficking.**

Why do the trial?

Adoption of Controlled Traffic Farming (CTF) in the low rainfall zone (LRZ) of the Southern Region is very low.

The GRDC-funded project 'Application of controlled traffic in the low rainfall zone' is evaluating whether or not this skepticism is justified. To help LRZ growers answer the questions and uncertainties they face when thinking about CTF adoption, the project is conducting research on four sites (R sites) across dominant soil types and agro-ecological zones in the Southern Region LRZ. These trials focus on the impact of trafficking (by heavy vehicles) on crop production and soil condition as well as monitoring how quickly LRZ soils will "self- repair" if heavy trafficking is stopped. Issues of implementing CTF and managing permanent wheel tracks are being addressed in other components of the project.

This article summarises the first season's wheat performance after increasing severity of trafficking was imposed on a red calcareous sandy loam at Minnipa Agricultural Centre. Three other trials similar in design and monitoring have also been implemented across the LRZ – on a deep sand at Loxton (SA), a brown loam near Swan Hill (Vic) and on a deep red earth at Lake Cargellico (NSW). All these trials will be maintained for at least the five year life of the project.

How was it done?

The trials were designed and implemented to be the same at all four sites. Each trial consists of five treatments replicated four times:

1. Control (no heavy vehicle trafficking).
2. One pass of a 30 tonne vehicle prior to seeding when soil was dry.
3. One pass of a 30 tonne vehicle prior to seeding when soil was moist.
4. Three passes of a 30 tonne vehicle prior to seeding when soil was moist.
5. Deep ripping (to loosen any historical trafficking).

These passes were conducted with 50% overlap of the load bearing wheels to ensure even coverage and will not be re-imposed.

The trafficking treatments simulate the effect of compaction caused by trafficking of heavy vehicles, with three passes when the soil is moist as an extreme (soil is always softer when wet so compacts more for the same vehicle weight). A deep ripping treatment was included because we cannot be sure if there is still compaction from previous trafficking in our control areas and the ripping was designed to disrupt any of this historical compaction. Trials were located on farms with soils typical for their district and where wheel track patterns for the previous five years (at least) were the same and were identifiable. The trials are being sown and managed with the farmers' equipment. Treatments were imposed under the wings of the farmer's seeder so that the whole trial could be seeded and managed without any heavy vehicle trafficking occurring on these treated areas. All plots were cored after the imposition of treatments and are being regularly assessed for soil physical and chemical condition.

At Minnipa, trafficking treatments were imposed in April 2015 with a 20 tonne single axle chaser bin, with the wet passes and deep ripping following 30 mm of rainfall. Deep ripping was imposed under moist conditions with a narrow profile straight leg ripper to 30 cm on 50 cm row spacings. Scepter wheat at 50 kg/ha and with 60 kg/ha of DAP was sown without prior cultivation on 25 May into marginal seeding conditions. The farm's Horwood Bagshaw precision seeder (knife points) was used and the trial was sown as part of the whole paddock and managed similarly. The trial was laid out so that two treated plots were sown in each pass, one under each wing of the seeder.

Table 1 Grain yield and yield components of Scepter wheat after trafficking and deep ripping at Minnipa in 2015.

	Grain yield (kg/ha)	Establishment (plants/ m²)	Heads per plant	No of grains per head (g)	1000 grain weight	Grain protein (%)
Control	2602*	124	2.30	43.4	21.8	15.7
One pass on dry soil	2742	122	2.44	41.6	22.2	15.3
One pass on wet soil	2548	127	2.37	41.5	20.0	15.9
Three passes on wet soil	2488	100	2.60	44.2	22.8	16.1
Deep rip	1976	84	2.10	45.3	25.1	14.0
LSD (P=0.05)	*244*	*16*	*ns*	*2.4*	*2.8*	*1.0*

** Control is the average of 13 plots: extra quadrats were taken from the seeder runs between treated plots for grain yield only*

Crop performance was monitored at establishment, for early and late dry matter production and at maturity (grain yield, quality and yield components). Soil in every plot was sampled for moisture, fertility and physical condition pre-sowing and will continue to be monitored. Grain harvest was conducted by hand to avoid trafficking from a header on treated plots.

Crops will continue to be sown and managed with farm equipment for the next three years, with rotation options to be the same as the rest of the paddock. Trafficking treatments will not be re-applied.

What happened?

Trafficking on dry soil had little visual impact on the soil but three passes on wet soil depressed the soil surface by at least 5 cm. Deep ripping left the surface more cloddy than the control with the surface raised by at least 10 cm.

Despite the parallelogram design of the Horwood Bagshaw Precision seeder, sowing depth varied markedly between extreme treatments. Three trafficking passes on wet soil reduced sowing depth from 54 mm in the control to only 25 mm due to the tightness in the surface layers. Deep ripping resulted in sowing depth averaging 103 mm because the profile was so loose and the variability in placement was also higher. Seeding depths in the single pass treatments were similar to the control.

Emergence was slower after three passes or deep ripping but similar to the control after single passes. Final plant populations were also similar in the control and single pass treatments (averaging 124 plants/m²) but were reduced to 100 plants/ m² after three passes and to only 84 plants/m² after deep ripping (Table 1).

Once plants started to tiller, the crop after a single pass on wet soil appeared the most vigorous and by mid-tillering had produced nearly 50% more biomass per hectare than the control (which averaged 458 kg DM/ha). Growth after a single pass on dry soil or after three passes on wet soil was similar to the control. Plants after deep ripping were fewer and weaker, resulting in 60% less biomass than the control. Nutrient analysis of these whole shoots showed that levels of all essential elements were in the adequate range and similar for all treatments except for deep ripping which had higher calcium, magnesium and manganese levels than the control but lower (but still adequate) zinc.

A single pass on wet soil also appeared to speed the time to flowering while deep ripping delayed it, relative to the control. At a stage when the controls had one third of their heads emerged, the crop after three passes on wet soil had nearly 50% of heads emerged but deep ripping had only 10%. By flowering, shoot biomass was similar in all treatments (at approximately 6,500 kg DM/ha) except after deep ripping, which was 22% less than the control.

Despite the late sowing and dry spring (only 33 mm of rain in September and October) the controls averaged 2.6 t/ha, which was very similar to the yields with all trafficking passes. Only the crop after deep ripping yielded less than the control, at 2.0 t/ha (Table 1). Yield components were very similar for all treatments (Table 1), except grain size was better after deep ripping. All trafficking treatments resulted in very similar crops to the control at maturity. Plants after deep ripping were too few to match the grain yield of the other treatments despite larger grain size. Grain proteins were all high in the trial and similar to the control except for deep ripping which was nearly 2% lower than the control.

Deep ripping did not fully achieve our aim of investigating crop production with compaction completely removed from the top 30 cm of soil because the farm seeder did not adequately compensate for the loosened profile and seeding depth was double the control. This severely reduced establishment and wheat growth throughout the season. The end result was that wheat after deep ripping yielded 600 kg/ha, or 30% lower, than the control. This detrimental impact of deep ripping appeared to be largely due to the reduced plant numbers caused by deep sowing. We expect that in future seasons, the deep ripping treatment will be a more rigorous examination of the impact of removing historical compaction on crop production because the profile will continue to settle with time.

What does this mean?

Consideration of CTF can be divided into two broad components. One is the operational and logistical impacts of conducting all field operations on permanent, unseeded (and hence compacted) wheel tracks with equipment which has matching path and axle widths. There are potentially both positive (e.g. better traction, more timely operations) and negative (e.g. weed nursery and erosion risk) impacts of permanent wheel tracks. This aspect of CTF is being considered by this GRDC funded project but not as part of the four R sites. The R sites are focused on investigating the other major component of CTF which is whether crop production will improve if heavy vehicle traffic is removed from the cropped area of LRZ paddocks, because the heavy vehicles are causing compaction which is detrimental to plant growth. The case in medium and high rainfall zones is that there are clear net benefits from both components and cropping can be expected to be more productive and profitable under a CTF system in these two zones. The case for the LRZ has not yet been made, chiefly because it has not been fully investigated before in this zone.

In this trial, in the first year of crop production following implementation of these trafficking treatments, wheat has produced similar yields to the untrafficked control, despite sowing depth being shallower after the most extreme trafficking which resulted in a lower plant population. These early results suggest that wheat is relatively insensitive to the compaction caused by heavy vehicles on this red calcareous sandy loam in a low rainfall environment, compared to the existing conditions in the paddock. In fact, early growth of wheat was best after one pass on wet soil and development was more rapid after trafficking, suggesting that some extra compaction may have actually benefited wheat growth. This trial will be continued for the next three years at least and we will continue to monitor the impact of trafficking imposed in 2015 on subsequent crop production and soil condition. In future seasons, we are hoping the deep ripping treatment will allow us to assess whether current levels of compaction in the paddock are already restricting crop production.

Harvest data from the other three R sites are still being processed. When all are completed, a comparison will then be made of the impact of trafficking in four typical, but very different low rainfall environments.

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Soils

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