RIPPER RESULTS AT KOOLOONONG

Kate Finger (BCG), Peter Fisher (Agriculture Victoria) and Nigel Wilhelm (SARDI)

TAKE HOME MESSAGES

- A positive yield response of 0.5t/ha (46 per cent increase compared to the control) was recorded at Kooloonong after deep ripping to a depth of 42cm on deep sandy soil.
- Inclusion plates provided no additional benefit to crop yield.
- Plant establishment can be reduced after deep ripping; consider rolling before sowing to better prepare the seedbed.
- The longevity of any yield benefit is yet to be determined; further monitoring is required.

BACKGROUND

Sandy soils are the dominant soil type in the dryland broadacre cropping zones of the Victorian Mallee and they can have several constraints limiting crop production (Nuttall, *et al.* 2003). One constraint that has received attention in recent years is subsoil compaction which reduces water infiltration and restricts root access to stored nutrients and water (Davies *et al*. 2018). Soil compaction is a natural process but exacerbated by random and frequent heavy machinery traffic within paddocks (Davies *et al.* 2018). Heavy traffic is causing layers of high soil strength at depths of 10-60cm. One remediation option is to mechanically break up the compacted layer by deep ripping.

Deep ripping involves pulling narrow tines through the soil profile at a depth of more than 30cm without inverting the soil. Advantages from deep ripping have been reported to last for about three seasons on loamy sands and sandy clay loams (Hamza and Anderson 2003). This practice has also been used in controlled traffic farming (CTF) systems where the benefits from ripping are prolonged – anecdotally reported up to 10 seasons on light sandy soils – due to the land not being re-trafficked (Bakker *et al.* 2017).

In 2018, several research and demonstration sites were established across the South Australian and Victorian Mallee regions to investigate the impact of heavy vehicle traffic and/or deep ripping on crop production. Results from a research trial at Woomelang, Victoria, were published in the BCG 2018 Season Research Results Book. This article discusses another research trial at Kooloonong, Victoria.

AIM

To determine the potential of deep ripping to alleviate the effect of soil compaction on crop yields in a deep sandy soil in the Mallee and whether controlled traffic can prolong the benefits of deep ripping on crop production.

PADDOCK DETAILS

Location:	Kooloonong
Soil type:	Deep sand to loamy sand
Paddock History:	2017 – Lupin

TRIAL DETAILS

	2018	**2019**
Crop year rainfall (Nov-Oct):	194mm	145mm
GSR (Apr-Oct):	65mm	97mm
Crop type/s:	Scepter wheat	Barlock lupin
Treatments:	Refer to Table 1	Refer to Table 1
Target plant density:	130-150 plants/m^2	40 plants/m^2
Seeding equipment:	Tine Seeder 38cm row spacing	Disc seeder 38cm row spacing
Sowing date:	7 May 2018	10 April 2019 (dry sown)
Replicates:	Four	Four
Harvest date:	10 December 2018	13 November 2019

Table 1. Treatments imposed at the Kooloonong site in 2018.

Treatment	Description
Control	Controlled Traffic Farming (CTF)
Deep ripping	A 3m wide, 9 tine AGROW plough deep ripper (with no lead-in tines), ripping to a depth between 40-45cm
Deep ripping + inclusion	Deep ripping with inclusion plates attached to the back of the tines which increase disturbance and incorporate more topsoil down to the ripped depth
Control + traffic	Control followed by traffic with an 18-tonne tracked tractor
Deep ripping + traffic	Deep ripping followed by traffic with an 18-tonne tracked tractor
Deep ripping + inclusion + traffic	Deep ripping + inclusion followed by traffic with an 18-tonne tracked tractor
Deep ripping + inclusion + annual traffic	Deep ripping + inclusion followed by traffic with an 18-tonne tracked tractor carried out each year before sowing for the life of the trial

TRIAL INPUTS

Trial site managed by grower in the same way as the rest of the paddock.

METHOD

A replicated field trial was implemented on a grower's CTF property near Kooloonong, Victoria. The grower has been on a 12m CTF system since 2012. The soil was not remediated when CTF was first adopted. Using a complete randomised block design, the trial was replicated over the mid-slope in a dune-swale system. The treatments were imposed on 6 April in 2018 under dry conditions. Ripping depth was determined by inserting a ruler into the ripped lines several times across the plots. Soil samples were taken to test for nutrients (data not shown) and soil physical condition. Crop assessments included establishment counts, crop biomass (at GS30, GS45 and GS65) and grain yield parameters from hand cuts in 2018. Yield monitor data was captured in 2018 and 2019 (at the time of printing 2019 data was not available but will be added to the online version in due course).

RESULTS AND INTERPRETATION

Bulk density measurements in control plots indicated the entire subsoil down to a depth of 100cm was at thresholds where crop root growth can start to be restricted (>1.60g/cm^3) (Table 2). The average ripping depth across the plots was 42cm, which is likely to have reduced soil strength within that upper part of the soil profile.

Table 2. Mean bulk density measurements from the control plots at Kooloonong.

Soil Depth (cm)	Bulk density (g/cm^3)
0-10	1.50
10-20	1.71
20-40	1.70
40-60	1.71
60-80	1.71
80-100	1.71

Plant establishment for wheat in 2018 was lower in the treatments that were deep ripped +/- inclusion plates (Figure 1), but not to the extent that it was likely to impact on yield. The re-trafficked treatments after ripping had similar crop establishment to the undisturbed plots. This was probably due to the re-trafficking acting like a roller, improving soil/seed contact.

For grain yield, deep ripping +/- inclusion plates increased yield by 0.5t/ha and 0.4t/ha respectively (Figure 2). Grain yields in re-trafficked treatments were between the controls and the ripped treatments. Although using inclusion plates left the plots much rougher on the surface, the impact on grain yields was small, mixed and (on average) similar to ripped treatments without plates.

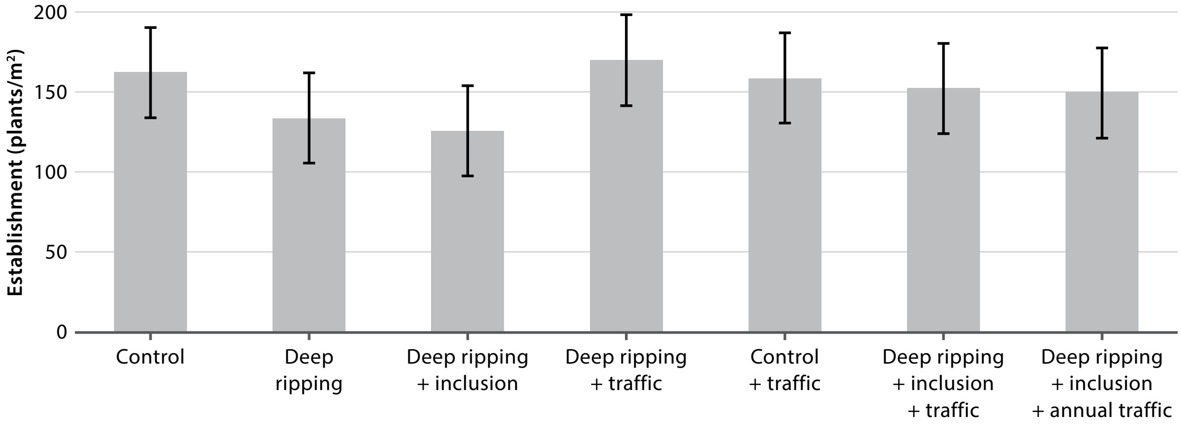

Figure 1. Wheat establishment (plants/m^2) at Kooloonong in 2018. Error bars indicate significant difference (LSD). Stats: P<0.05, LSD = 29 plants/m^2, CV = 13%.

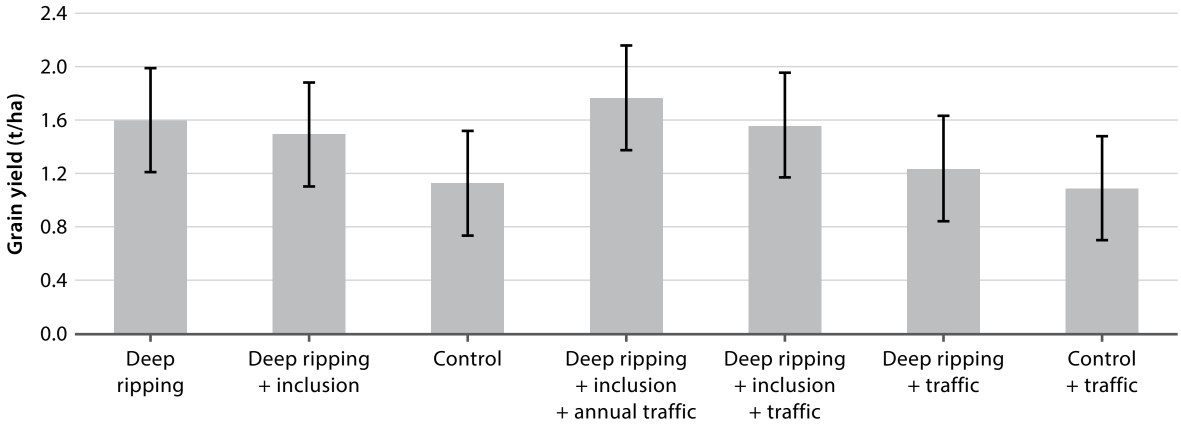

Figure 2. Wheat grain yield (t/ha) from hand harvest cuts at Kooloonong in 2018. Error bars indicate significant difference (LSD). Stats: P<0.05, LSD = 0.4t/ha, CV = 23.7%.

COMMERCIAL PRACTICE

Deep ripping in the Mallee is becoming an increasingly popular practice. While the Kooloonong trial highlights a positive yield response after the first year of deep ripping, five important factors were ticked off before putting the tines in the ground.

Responsive soil type

A link between soil type and deep ripping response is commonly reported. Sandy soils typically have the greatest response, whereas red loams and black vertosols show very few positive responses (GRDC 2009).

No other major soil constraints present

Consider if other soil constraints need addressing first – if unsure, undertake soil tests to check whether crop roots are being exposed to a hostile subsoil eg. salinity or high boron, as was discovered in a ripping demonstration site at Kinnabulla.

Adequate stored soil water

If there isn't enough stored water to support crop growth, particularly towards the end of the growing season, the plants are at risk of haying off (Davis *et al.* 2018).

Identification of compaction as an issue, and its depth

The best way to identify if there is a constraint to root growth is to measure the bulk density of the soil. Methods include using a soil penetrometer or poking a metal rod into the soil to identify the presence of a compacted zone. When using a metal rod, the bottom of the compacted layer will be where the pressure required to push the rod through the soil eases off. Note the depth where this occurs and aim to rip deeper, if possible. These tests are best performed when the soil contains some moisture.

Machinery requirements

Pulling a deep ripper requires a lot of horsepower, particularly if the soil is dry. Try timing the operation for after a summer rainfall event or using lead-in tines to make it easier to rip through the soil. Also consider following up the ripping pass with a roller over the ripped area to better prepare the seed bed, otherwise plant establishment might be adversely affected (Davis *et al.* 2018).

Several questions that remain unanswered in the Mallee environment include the longevity of any yield benefit under both CTF and non-CTF farming systems. With the cost of deep ripping upwards of $50/ha (Bakker *et al.* 2017), clear yield gains over several years will be essential to make this practice economically feasible for grain growers.

REFERENCES

Bakker D., Davies S., and Isbister B., 2017, *Department of Primary Industries and Regional Development WA* 'Deep ripping for soil compaction'. https://www.agric.wa.gov.au/soil-compaction/deep-ripping-soil-compaction

Davies S., Bakker D., Lemon J., and Isbister B., 2018, *Department of Primary Industries and Regional Development WA* 'Soil compaction overview'. https://www.agric.wa.gov.au/soil-compaction/soil-compaction-overview

GRDC 2009, *Deep Ripping Fact Sheet* 'Deep ripping not appropriate for all soil types'. www.grdc.com.au/GRDC-FS-DeepRipping

Hamza MA., and Anderson WK., 2003, *Australian Journal of Agricultural Research* 'Responses of soil properties and grain yields to deep ripping and gypsum application in a compacted loamy sand soil contrasted with a sandy clay loam soil in Western Australia', Vol 54 (3), pp 273-282.

Nuttall J., Armstrong R., and Connor D., 2003, *Australian Journal of Agricultural Research* 'Evaluating physicochemical constraints of Calcarosols on wheat yield in the Victorian southern Mallee', Vol 54 (5), pp 487–497.

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