Evaluation of Spading vs. Deep ripping vs. Mouldboard ploughing

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Aim
To compare the effects of mouldboard ploughing, spading and deep ripping on yellow non-wetting sand.

Background
Research has shown that mouldboard ploughing of some soil types can improve yields by burying the non-wetting top soil. This trial aims to compare the ability of spading, mouldboard ploughing and deep ripping to overcome non wetting soil. Inclusion of deep ripping will help determine to what extent the soil loosening effect is responsible for the yield gain compared with the topsoil burial of spading and mouldboard ploughing. If yield gains for mouldboard ploughing and spading are not significantly different from deep ripping it would be plausible to state that the yield improvement from mouldboard ploughing and spading is largely due to the removal of the compaction layer rather than other benefits.

The site chosen to conduct the trial was 2.2km long with soil varying from a yellow deep sandy earth (better sand) to pale deep sand (poor sand). The site has never been deep ripped before. Monitoring of the trial was conducted in both soil types.

Trial Details

Property	Michael O'Callaghan, Marchagee			
Plot size & replication	2.2km x 18m x various replications			
Soil type	Yellow sand			
Soil pH ($CaCl_2$)	0-10cm: 5.8	10-20cm: 5.2	20-30cm: 4.6	30-40cm: 4.6
EC	0.0985 dS/m			
Sowing date	10/6/12			
Variety	Wyalkatchem			
Seeding rate	100 kg/ha			
Soil amelioration	March 2012: 3 t/ha Lime			
Fertiliser	10/6/12: 110 kg/ha Agras 11/8/12: 20 L/ha Nachurs K-Focus			
Paddock rotation	2009 canola, 2010 wheat, 2011 canola			
Herbicides	10/6/12: 25 g/ha Logran, 1.2 L/ha Treflan 23/8/12: 1 L/ha Ester			
Growing Season Rainfall	170mm			

Results
The poor soil was deep pale brown sand with a clay content <5%. The sand had quite coarse particles so available water holding capacity is likely to be very low of the order of 30-50 mm/m. Moderate to high water repellence coupled with poor water holding and high leaching pressure severely limits crop productivity and this is reflected in low biomass (Figure 1) and grain yields (Figure 2) achieved on this soil. The better sand was a deep yellow sandy earth with a clay content ranging from <5% at the surface to roughly 5-10% at depth. Available water holding capacity for this soil is estimated to be moderately low at 60-90 mm/m. While the demonstration was not fully replicated, the repetition of the rotary spader treatment throughout the demo site enables some assessment of site variation to be made.

Biomass and grain yields of the spaded treatment were quite consistent but with a small trend toward improved crop performance in the second half of the trial (southern end). On both soil types however, the untreated control yield was substantially lower than the yields of the amelioration treatments.

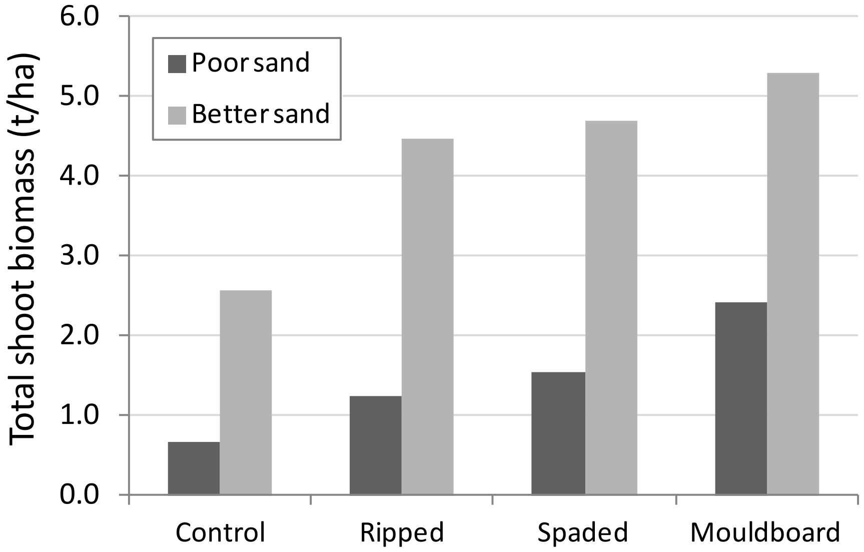

Figure 1. Whole wheat shoot biomass (t/ha) on pale deep sand (poor sand) and yellow deep sandy earth (better sand) with rotary spading (spaded), deep ripping (ripped), mouldboard ploughing or untreated (control) soil treatments.

On the poor sand the biomass of the control was 0.7 t/ha compared to an average biomass of 1.25 t/ha for the ripped, 1.53 t/ha for spaded and 2.42 t/ha for mouldboard ploughing (Figure 1). Grain yield on the poor sand (Figure 2) was 0.3 t/ha for the control compared to an average yield of 0.6 t/ha for the ripped, 0.7 t/ha for spaded and 1.1 t/ha for mouldboard ploughing (Figure 2). This represents grain yield improvements on the poor sand of 100% for deep ripping, 133% for spading and 267% yield improvement for mouldboard ploughing.

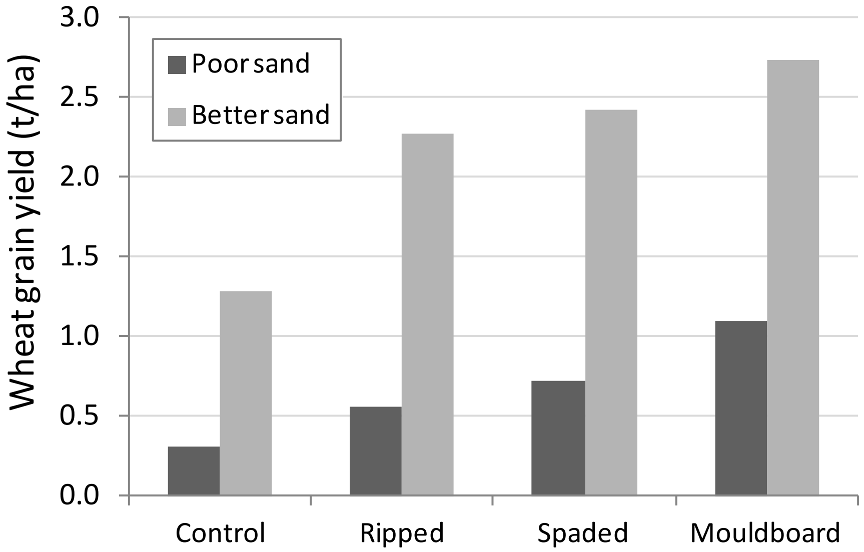

Figure 2. Wheat grain yield (t/ha) from hand cuts on pale deep sand (poor sand) and yellow deep sandy earth (better sand) with rotary spading (spader), deep ripping (ripped), mouldboard ploughing or untreated (control) soil treatments.

On the better sand the biomass of the control was 2.6 t/ha compared to an average biomass of 4.5 t/ha for the ripped, 4.7 t/ha for spaded and 5.3 t/ha for mouldboard ploughing (Figure 1). Grain yield on the better sand (Figure 2) was 1.3 t/ha for the control compared to an average yield of 2.3 t/ha for the ripped, 2.4 t/ha for spaded and 2.7 t/ha for mouldboard ploughing (Figure 2). This represents grain yield improvements on the better sand of 77% for deep ripping, 85% for spading and 108% yield improvement for mouldboard ploughing.

The higher biomass and yield of crops on the better sand compared with the poor sand is a result of improved water and nutrient holding and also likely due to less severe water repellence. The improved crop performance on the better sand is reflected in the harvest index which averaged 0.51 on the better sand compared with 0.46 for the poor sand.

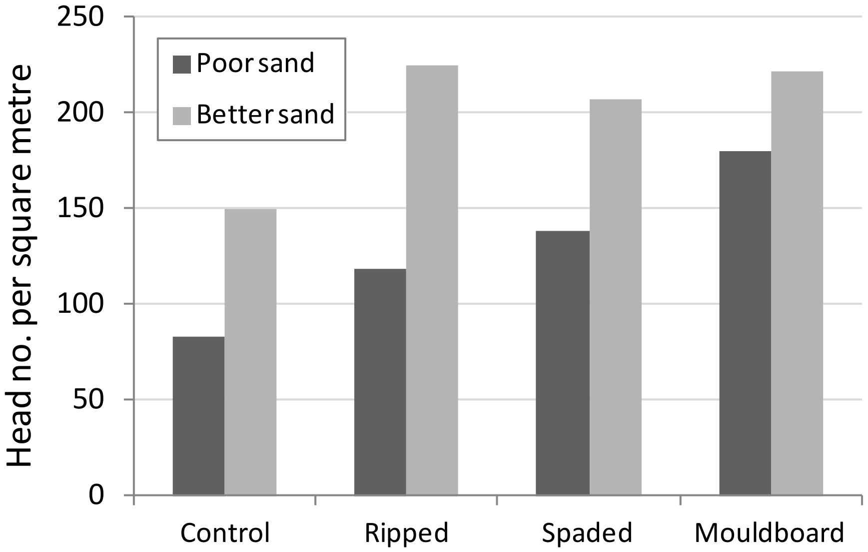

Figure 3. Wheat head density (no. heads/m^2) on pale deep sand (poor sand) and yellow deep sandy earth (better sand) with rotary spading (spader), deep ripping (ripped), mouldboard ploughing or untreated (control) soil treatments.

These improvements in crop biomass (Figure 4) and grain yield from soil amelioration are indicative of improved plant number and improved tillering, largely driven by improved nutrient access which is reflected in higher head numbers in both the poor and the better sand (Figure 3).

Figure 4: Biomass differences between treatments in poor sand, cuts represent 6m harvested row, Marchagee, 2012.

Table 1: Average machine harvest grain yield and quality results for Wyalkatchem grown in Marchagee, 2012.

Treatment	Yield	Percentage of control (%)	Protein	Moisture	Hectolitre Weight	Screenings	Grade
Mouldboard	1.52	183	12.3	8.7	78.74	1.14%	APW2
Spader	1.30	157	13.1	8.7	77.51	1.38%	APW2
Ripped	1.20	145	13.5	8.9	78.33	0.83%	APW2
Control	0.83	100	13.5	8.7	76.77	3.57%	APW2

A machine harvest grain yield benefit of 0.37 t/ha (Table 1), a 45% yield improvement was gained by deep ripping alone, showing a subsoil compaction layer was inhibiting yield in the paddock. Yield gains of 0.45 t/ha (57% gain, Table 1) were achieved by incorportating (spading) and 0.69 t/ha (83% gain, Table 1) by burying (mouldboarding) the non-wetting topsoil and it's associated organic matter and nutrients.

The tillage treatments also changed the way seeding and harvest machinery works. Tillage treatments leave softer soil for machinery to work over, therefore requiring more fuel. The mouldboarding plots required the most fuel at harvest with an average of 7.6 L/ha compared 6.1 L/ha for no tillage (Table 2). The spader used in this trial had a packer behind the spades which firms the topsoil slightly, this has some benfit in reducing erosion and producing an easier soil profile for seeding. Wheel tracks made just after spading and especially mouldboard remained in the soil all season, leaving an extremely rough area to drive across.

Table 2: Fuel usage and cost economics

Treatment	Yield	Fuel usage (L/ha)	Fuel cost ($/ha)
Mouldboard	1.52	7.6	10.64
Spader	1.30	6.5	9.10
Ripped	1.20	6.9	9.66
Control	0.83	6.1	8.54

Comments

Removal of subsoil compaction by deep ripping resulted in a 370 kg/ha (45%) yield benefit with spading giving an additional benefit of 12% (100 kg/ha) and mouldboard ploughing 39% (320 kg/ha) compared with the deep ripping treatment. Higher biomass and increased head density in the cultivation treatments are indicative of improved nutrient access and effcient use of available water through the season. Water use efficiency was 4.9 kg/ha/mm of growing season rainfall for the control treatment compared with 7.1 kg/ha/mm for ripped, 7.6 kg/ha/mm for spaded and 8.9 kg/ha/mm for mouldboard ploughing. Recent research is showing that nutrient availability is improved when top soil is buried by spading or mouldboard ploughing because nutrients become concentrated in the rootzone and less suscpetible to soil drying from evaporation, which can be the case when majority of the nutrients are on the soil surface, (Davies et al, 2012).

Acknowledgements

Thank you to Michael O'Callaghan for conducting the trial and the Department of Agriculture & Food, WA for the use of the plough and assistance with trial measurements.
The Cail Family for the use of their tractor.
Steve Davies involvement is supported by DAFWA and GRDC through the "Delivering agronomic strategies for water repellent soils in WA; DAW00204" research project.

Paper reviewed by: Nadine Hollamby, Liebe Group and Michael O'Callaghan, Farmer, Marchagee

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