Very Deep Ripping with Shallow Leading Tines to Profitably Remove Deeper Compaction of Sandplain

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Key Messages

- Deep ripping to 500mm with the help of shallow leading tines gave about 1 t/ha wheat yield benefit on this deeply compacted and acid yellow sand in 2013 season.
- Additional yield of about 140 kg/ha may have come from spreading 3 t/ha of limesand before seeding and using a high N rate at seeding. The acidity status of the trial is being further studied.
- Such benefits of cropping profitability can be economically protected by investment in a controlled traffic farming (CTF) system.
- The cost of deep ripping and problems of seeding deep ripped sand can also be reduced by establishing CTF in the year of deep ripping.

Aim

Test the effect of very deep ripping to 500mm with shallow leading tines and incorporation of limesand on a very deeply compacted acid sand plain soil.

Background

Cropping machinery is increasing in size and weight to improve operational efficiencies and protect profitability of grain growing. This machinery induces subsoil compaction and the depth of compaction is increasing as the axle loads and wheel and track widths increase. Such deep compaction can especially compromise productivity of deep sands that depend on free access to the soil profile more than other soil types. Such water and nutrient supply from depth is especially important during dry periods of the growing season for profitable crop growth and yield from deep sands.

Shallow leading tine ripper design (SLT) has been shown to be more effective than single tines for the economics and effectiveness of deep ripping.

The deep compaction at the Liebe Main Trial Site in 2013 provided an opportunity to further test SLT deep ripping for better management of deep compaction. High levels of acidity and free aluminium in the profile near the site also encouraged the incorporation of limesand by ripping.

Two rates of nitrogen fertiliser at seeding were also used because deep ripped sand can need less N fertiliser due to mineralisation of deep ripped soil providing some N supply.

The early season drought in the area clearly revealed the benefits of very deep ripping to improve access to deeper moisture in the profile.

Trial Details

Property	G & H Pearse Pty Ltd, west Wubin
Plot size & replication	60m x 2.5m with 4 reps plots (split to 20m lengths for + or – 3t/ha of limesand)
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-10cm: 5.5 10-20cm: 4.4 20-40cm: 4.3
EC (dS/m)	0-10cm: 0.065 10-20cm: 0.018 20-40cm: 0.019
Paddock rotation	2010: canola, 2011: wheat, 2012: lupin
Seeding	22/05/13
Seeding rate	100 kg/ha Wyalkatchem
Fertiliser	22/05/13: 55 kg/ha DAP, 32 or 65 kg/ha urea as per protocol
Soil Amelioration	None or 3 t/ha limesand as per protocol
Herbicides	21/05/13: 1.5 L/ha Roundup 22/05/13: 2 L/ha SpraySeed 250, 118g/ha Sakura 13/06/13: 300 mL/ha Axial, 0.5% Adigor 02/07/13: 1L/ha Velocity, 1% Hasten
Growing Season Rainfall	228 mm

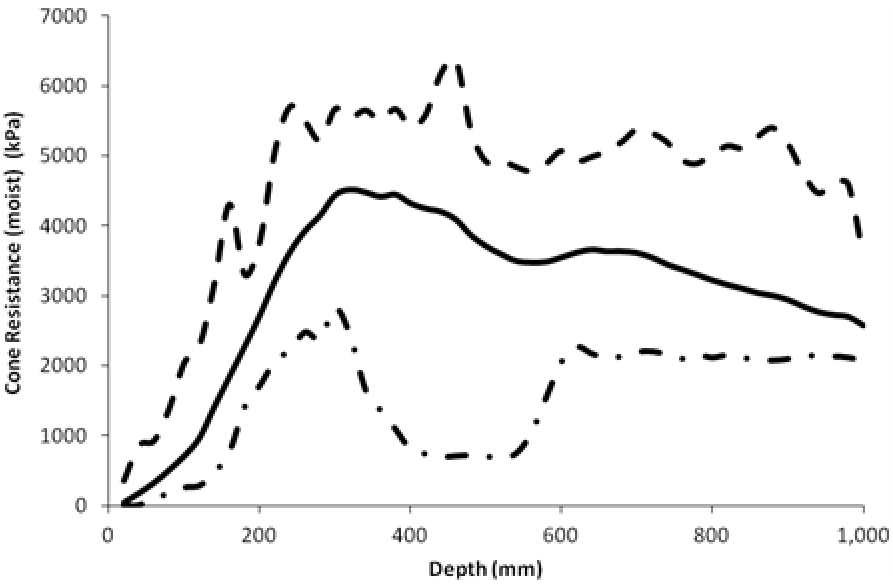

Figure 1: The range of cone penetrometer strengths at the site just before deep ripping. Solid black line represents the mean, upper dotted line indicates maximum, lower dotted line indicates minimum. The profile was moist to about 500mm depth. Strengths below 500mm have low moisture content and do not reflect the strength roots would experience in moist conditions. The range and mean values at depths less than 500mm show most of the site has moist soil strength >3000kpa, enough to stop wheat root growth.

Treatments

- Deep Ripping: Nil, 300mm Depth (SLT), 500mm Depth (SLT)
- Liming: Nil, 3 t/ha topdreseed
- Nitrogen: Low additional N (+32 t/ha Urea), High additional N (+65 t/ha Urea)

Results

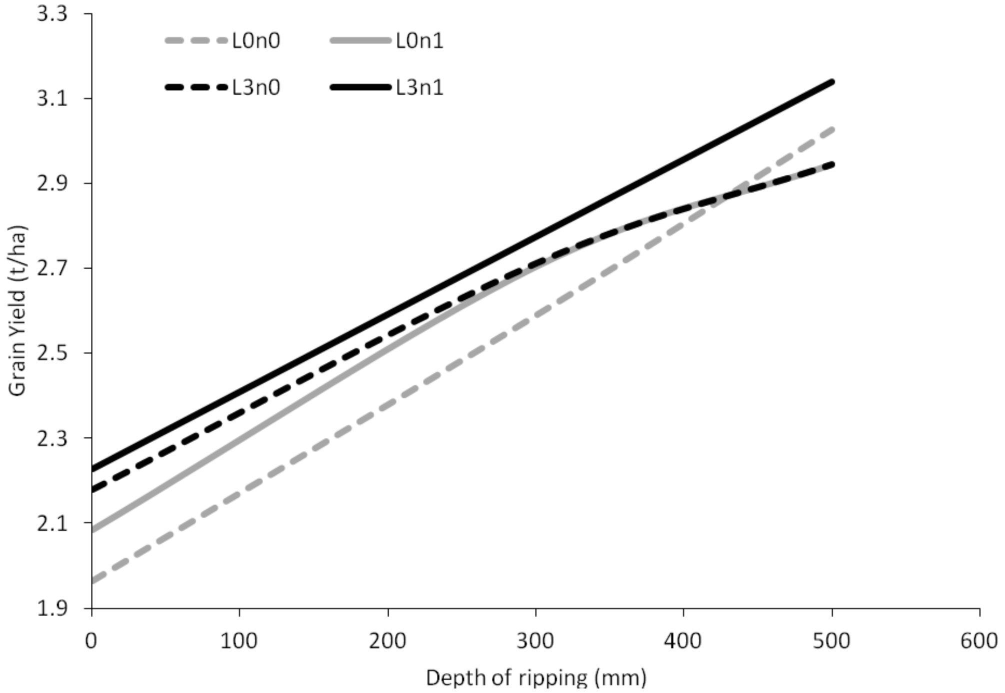

Figure 2: Grain yields of the deep ripping treatments: L0n0 = no lime and low N, L0n1 = no lime and high N, L3n0 = 3 t/ha lime and low N, L3n1 = 3 t/ha lime and high N. LSD (95%) between any 2 treatments = 150 kg/ha.

The yield response to deep ripping was relatively large and response to N rate or lime relatively small.

Table 1: Summary of treatment mean yields (t/ha). L0n0 = no lime and low N, L0n1 = no lime and high N, L3n0 = 3 t/ha lime and low N, L3n1 = 3 t/ha lime and high N. LSD (95%) between any 2 treatments = 150 kg/ha.

	Treatment Yields (t/ha)					
Depth of ripping (mm)	**L0n0**	**L0n1**	**L3n0**	**L3n1**	**Average**	**Treatment mean percentage of Unripped (%)**
0	1.96	2.08	2.18	2.23	**2.11**	
300	2.59	2.70	2.71	2.78	**2.70**	128
500	3.03	2.94	2.94	3.14	**3.01**	143
Average	**2.53**	**2.58**	**2.61**	**2.71**		

Table 2: Summary of yield response (kg/ha) increase from control treatment.

Variable	**Yield Response increase from Control (kg/ha)**
Deep Ripping (300mm)	581
Deep Ripping (500mm)	900
Increased Deep Ripping Depth (300-500mm)	319
Increased Nitrogen with No Lime	52
Increased Nitrogen with Lime	102
Increased Lime with No increased N	86
Increased Lime with increased N	137

There was a low probability of about 140 kg/ha yield response by applying lime at 3 t/ha and using the higher nitrogen rate (Table 2). We are very confident (at least 95%) of a yield response of about 580 kg/ha to ripping to 300mm and 900 kg/ha from ripping to 500mm with shallow leading tines.
The cost of very deep ripping with leading tines is about $50-75/ha, depending on conditions and tractor capability. If the price for wheat is $280/t the profit from deep ripping this deeply compacted sand is at least about $200/ha in such a season as 2013 at the trial site location.

>3000
2500-3000
<2500

	UNRIPPED					RIPPED TO 300mm					RIPPED TO 500mm				
	ROW					ROW					ROW				
Depth (mm)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
20	1	11	28	4	107	10	0	0	56	0	64	28	59	7	5
40	134	127	129	42	385	155	333	141	141	182	247	143	251	157	116
60	293	178	152	57	426	346	258	235	191	331	261	175	519	308	216
80	355	143	132	169	483	596	309	450	426	492	254	269	338	235	358
100	774	478	423	420	730	787	311	548	480	617	401	568	308	154	455
120	1346	1057	986	725	1077	924	351	831	515	1082	463	839	486	277	476
140	1608	1504	1334	1244	1263	1171	396	1211	516	1315	511	837	587	520	483
160	1884	1848	1626	1691	1509	1587	462	1932	556	1554	518	766	568	664	492
180	2601	2171	1709	1809	1718	2914	493	2363	669	1808	493	636	518	679	544
200	2927	2371	1697	2003	1773	3344	462	2756	686	2070	487	545	503	621	550
220	4607	2457	1745	2006	2596	3672	407	3217	626	2470	507	563	520	703	549
240	4632	2362	1814	1982	3585	3737	388	3535	554	3688	558	615	524	730	545
260	4655	2444	2028	2163	3861	3654	543	3869	487	4021	610	816	452	716	543
280	4544	3043	2670	2722	3958	3514	1301	3901	435	3987	645	1161	405	707	559
300	4138	3603	3326	3395	3492	3284	2318	3532	492	3952	673	1285	368	663	538
320	3975	3617	3155	3625	2664	3073	2720	3538	825	3787	602	1549	376	717	499
340	3651	3479	2859	3495	2703	2835	2806	3508	1394	3768	581	1701	440	882	482
360	3113	3279	2594	3296	2860	2642	2854	3298	2021	3541	660	1585	441	783	443
380	2777	2964	2400	3192	2783	2461	2788	3172	2401	3310	695	1588	475	651	415
400	2539	2646	2317	2932	2680	2339	2711	2963	2448	3116	662	1585	500	568	391
420	2350	2438	2218	2791	2516	2273	2633	2789	2342	2920	625	1558	564	568	401
440	2111	2267	2065	2623	2370	2148	2486	2610	2283	2633	629	1544	585	716	524
460	1924	2201	1856	2451	2249	2013	2359	2495	2195	2424	769	1557	578	865	777
480	1827	2241	1677	2183	2113	1932	2287	2370	2120	2321	1178	1697	575	997	1023
500	1776	2297	1611	2077	2032	1885	2310	2302	2081	2251	1546	1862	601	1148	1217
520	1730	2129	1624	1975	2060	1858	2362	2199	2006	2116	1736	1913	758	1226	1387
540	1637	1977	1646	1909	2089	1796	2342	2175	1950	1961	1803	1862	1025	1306	1605
560	1557	1958	1627	1822	1957	1717	2094	2165	1870	1823	1826	1850	1364	1394	1661
580	1535	1930	1636	1774	1980	1672	2004	2075	1752	1603	1773	1790	1615	1485	1685
600	1564	1951	1652	1846	1956	1678	1993	2046	1751	1479	1814	1748	1741	1573	1676
620	1615	1961	1630	1798	2190	1695	1978	2135	1791	1511	1775	1885	1733	1888	1670
640	1794	2089	1703	1647	2549	1800	1958	2098	1843	1653	1807	2166	1787	2440	1688
660	2135	2310	1896	1593	2723	2041	2030	2082	1937	1711	1904	2466	2172	2342	1788
680	2494	2185	1955	1590	2668	1720	2466	2108	2133	1684	2195	2616	2551	2200	2034
700	2540	1841	2011	1607	2510	1846	2891	2144	2473	1694	2406	2833	3063	2414	2606
720	2402	2018	1701	1609	2174	2053	2742	2312	2773	1789	2296	3081	2899	2538	2831

Figure 3: Soil strength (kPa) profiles in winter (taken from the west end of the northern replicates after irrigation the previous evening). Strength values are colour coded to show: little restriction to root growth (<2500) in white, significant root growth restriction (2500-3000) in grey and impenetrable to roots (>3000) in black. The crop rows are 250mm apart. Ripping tine spacing was 2x crop row space.

Deep ripping to 500mm with shallow leading tines clearly removed the major mechanical restrictions in the yellow sand profile. The deep ripping to 300mm provided some alleviation of compaction, but significant zones of compact soil still remained in the deep sand profile. Very active root growth was observed in the whole profile where deep ripping was to 500mm.

Crop growth at end of dry spell

Tetracam ADC Lite camera measurements were made in late July for canopy cover and greenness (NDVI). Site means for the un-limed eastern row (Figure 4) and Sample images (Figure 5) are shown below.

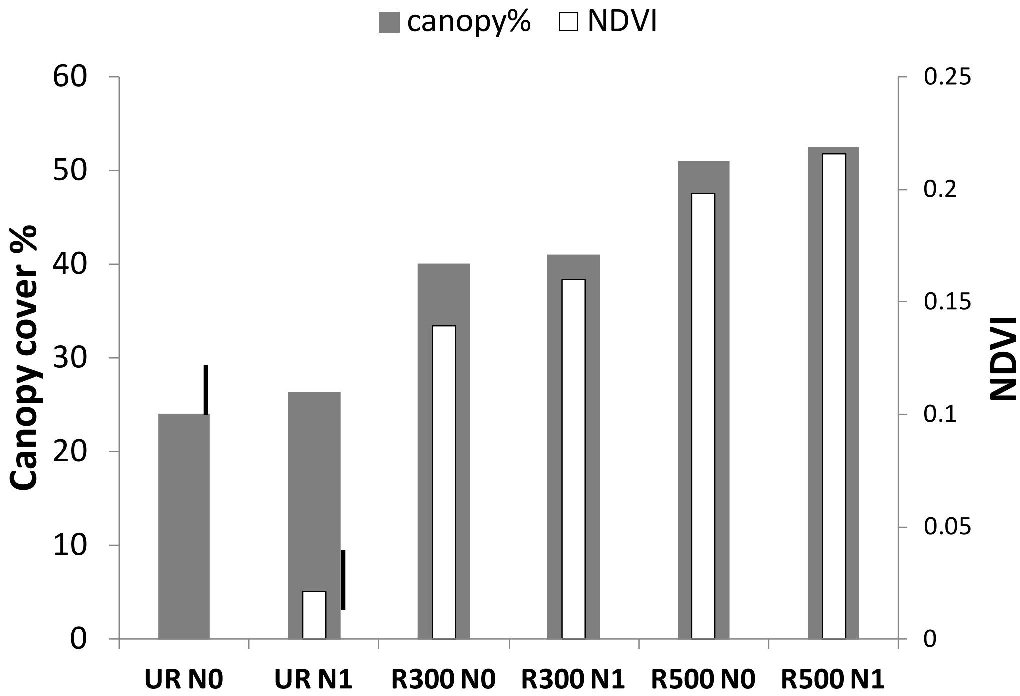

Figure 4: Canopy cover (%) and NDVI (Normalised Digital Vegetation Index) of the deep ripping treatments in late July. The NDVI means are relative to the control (adjusted to make the control =0). *UR N0* = Unripped & low N, *UR N1* = Unripped & high N, *R300 N0* = Ripped to 300mm & low N, *R300 N1* = Ripped to 300mm & high N , *R500 N0* = Ripped to 500mm & low N, *R500 N1* = Ripped to 500mm & high N. LSD (P<95%) between any 2 treatments = 4% canopy and 0.026 NDVI

Figure 4 shows the crop after very deep ripping had double the canopy cover of the unripped control at the end of July when there had been a long winter dry period. The NDVI readings (an indication of photosynthetic activity) showed a more sever difference, due to more dead tissue in the canopy of the crop in unripe soil caused by drought stress. Figure 5 below shows examples of the images used to generate the data in Figure 4.

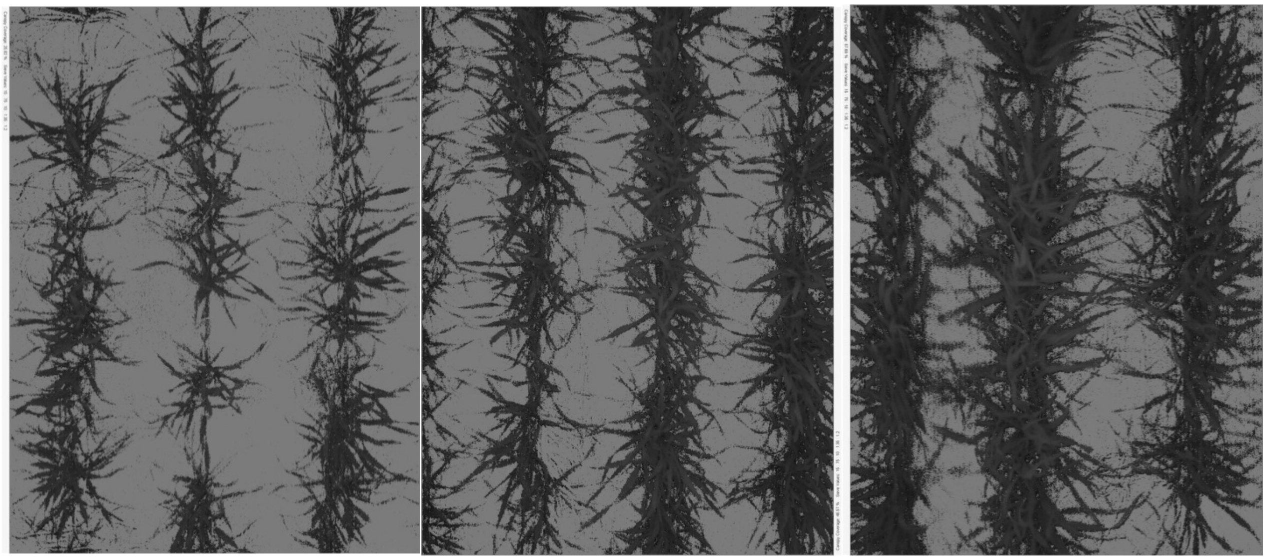

Figure 5: Images from the Tetracam camera used to calculate % canopy cover. Left = Unripped, centre = Ripped to 300mm, right = Ripped to 500mm.

Root weights collected in August soil samples

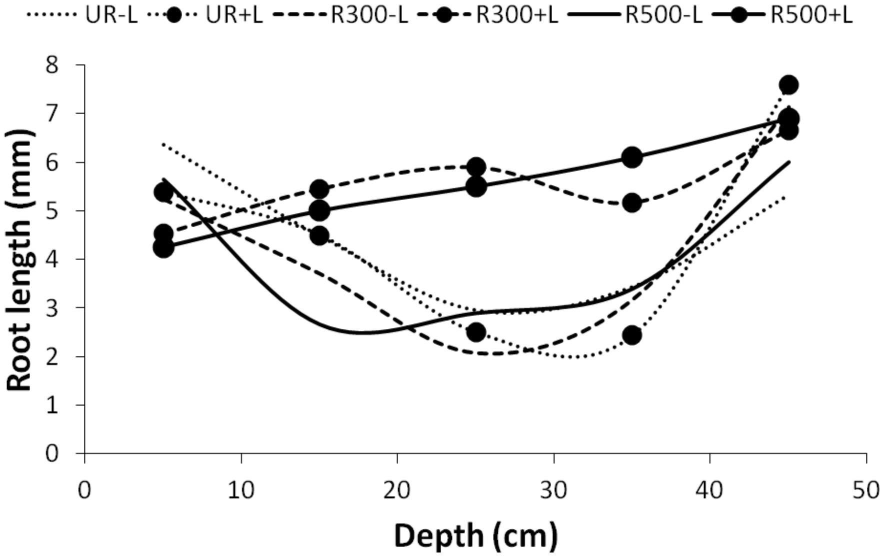

Figure 6: Mean dry root weights from the soil samples within the ripline zones used for pH measurement. Some of the differences in root weight are just 'noise' in the data due to insufficient replication. The reduced root growth at 15mmin unripped soil and root growth in macropores in the un-limed, un-ripped soil at 250-450mm depth is supported by observations of soil faces in soil pits. *UR-L* = Unripped & no lime, *UR+L* = Unripped & limed, *R300-L* = Ripped to 300mm & no lime, *R300+L* = Ripped to 300mm & limed, *R500-L* = Ripped to 500mm & no lime, *R500+L* = Ripped to 500mm & limed.The trends in the data support the visual evidence of better root growth in the subsoil with deep ripping to 500mm and perhaps some improvement with lime for ripping to 300mm.
The complete study of soil pH and exchangeable aluminium levels of the trial site is still being completed.

Comments

The major economic effect at this trial site in the first season is from deep mechanical disturbance by very deep ripping with shallow leading tines, a little of this may have been due to extra nutrition from soil mineralisation by deep ripping. Any benefits from mineralisation would be lost in the subsequent seasons and more benefits may be found from the soil neutralisation and correction of Al toxicity as more of the limesand is activated. At a wheat price of $280/ha profit from very deep ripping may be about $200/ha if the deep ripping costs $50-75/ha. These large profits are best protected by investment by controlled traffic farming (CTF). The CTF system is best set up at the same time as deep ripping to reduce ripping costs and enable easier seeding when more running is on firm tramlines.

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