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Depth of tillage effects on deep sandplain soils

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Purpose:	To characterize the effect of various depths of ripping on crop performance.
Location:	R Harper "Velyere"
Soil Type:	Deep yellow sand

BACKGROUND SUMMARY

Mechanical (traffic) hard pans restrict the rate of root growth through the compacted layers. Depending on season, this can restrict the crop's access to soil mobile nutrients (N, S) and to deep nutrients. It can also limit crop access to deep nutrients (K) and subsoil water. Nutrient availability to crops is most important early in the season, whereas crop responses to sub-soil water often has an impact lae in the season particularly in seasons with a dry finish. Understanding the interaction of managing mechanical hard pans with season is economically important to growers particularly in how they manage nitrogen fertilizer inputs.

This trial aims at characterizing the short and long term effects of ripping a mechanical hardpan to different soil depths. The interaction with seasonal rainfall is best accomplished using simulation modelling and this demonstration can be used for validation of such models.

TRIAL DESIGN

This experiment was established at "Velyere", Dandaragan (Latitude -30.554339°, Longitude 115.728470°) in April 2016 on a deep yellow sand. The subsoil is moderately acidic (pH 4.5) and compact.

Table 1. Layout and width of large plots (over 1km long from south (left) to north (right)

				Proposed design: yellow is control			
			ripped 20/4	treat	plot	rip	N
run width	run no.	Implement	depth	1	1	Nil	farmer
6m	6 runs	Tilco by Nufab	65cm	12	2	65cm	120 N
7.5m	5 runs	Grizzly Deep Digger	30cm	10	3	30cm	120 N
				1	4	Nil	farmer
				9	5	Nil	120 N
6m	6 runs	Tilco by Nufab	65cm	8	6	65cm	60 N
				1	7	Nil	farmer
7.5m	5 runs	Grizzly Deep Digger	50cm	7	8	50cm	60 N
7.5m	5 runs	Grizzly Deep Digger	50cm	11	9	50cm	120 N
				1	10	Nil	farmer
				5	11	Nil (pipes)	60 N
				1	12	Nil (pipes)	farmer
				1	13	Nil	farmer
6m	1 run	Tilco by Nufab	65cm				
7.5m	5 runs	Grizzly Deep Digger	50cm	3	14	50cm	farmer
7.5m	5 runs	Grizzly Deep Digger	30cm	6	15	30cm	60 N
				1	16	Nil	farmer

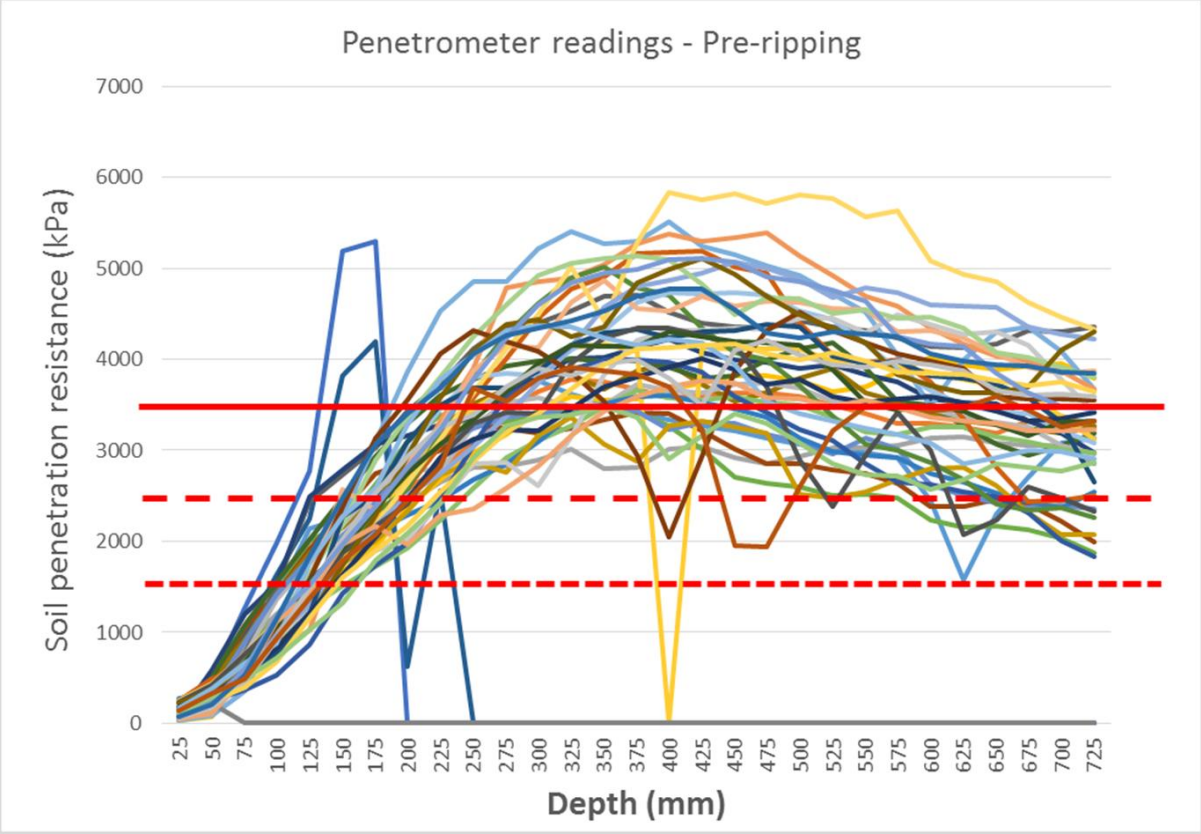

Figure 1: Pre-ripping penetrometer measurements of soil strength

Management

The trial plots were ripped on 20 April and 21 April 2016. Nufab Machinery and Brouns kindly provided a 6m Tilco by Nufab ripper to do the deepest ripping, to 65m. All other plots were ripped using Mt. Gerazim's 7.5m Grizzly Deep Digger.

The paddock was seeded on 21 May 2016 with 90 kg/ha Mace wheat.

Fertilisers applied: 100 kg/ha K-Till at sowing, 70 kg/ha NKS 21, 80 kg/ha NS 51, 50 L/ha Flexi-N, 20 kg/ha NS 51, 300 g/ha Copper
Pesticides applied:
1 L/ha glyphosate, 1 L/ha paraquat + 35 g/ha triasulfuron + 1.7 L/ha trifluralin. 1 L/ha Tigrex + 150 mL/ha alpha-cypermethrin 750 mL/ha 2,4-D ester 680 + 150 mL/ha alpha-cypermethrin 150 mL/ha tebuconazole 250 mL/ha epoxiconazole
4 weeks after sowing (4 WAS), a small plot (10 M by 2.5M) time of post seeding nitrogen trial was laid out with 3 replicates within each plots 2, 3 and 4. The 4 treatments were, 1., a nil control, 100 kg urea/ha (46 kg N/ha) 2. at 4 WAS, 3. at 8 WAS and 4. at 4 and at 8 WAS. The treatment layouts from west to east were:
On block 2. (65 cm ripping depth) 2341/1234/3412, block 3 (30 cm ripping depth) 1234/2341/4123, and block 4 (no ripping) 4123/2143/1432.

RESULTS AND DISCUSSION

The bulk cropping trial

On June 6th, in the bulk crop areas south and adjacent to the small plots (no post seeding nitrogen on blocks 1 to 4), crop biomass was estimated using a "greenseeker".

Bulk crop ratings - greenseeker

6th September - south of plots

block	depth	kg N	GS*	kg/ha
1	0	0	5	600
2	65	0	21	2520
3	30	0	11	1320
4	0	0	10	1200
5	0	120	20	2400
6	65	60	28	3360

*median net GS (9) minus base (19)

Table 2. Anthesis crop responses to depth of ripping and nitrogen

There were obvious responses to ripping depth and post seeding nitrogen

Harvester yield from main plots

rip depth cm (reps)	north t/ha	south t/ha
0 (7)	2.99	2.96
30 (2)	3.25	3.20
50 (3)	3.47	3.37
65 (2)	3.10	3.35
stdev	0.19	0.07

Table 3. Mean harvester grain yields (t/ha) for north (300 M) and south (520 M) transects taken from a yield mapping analysis

Yield differences of 2*st. dev. are significant. Within plot variability was large (st. dev. about 0.3 to 0.4 t/ha) but there is an apparent response to ripping, but not to depth of ripping. More information is needed to interpret these results.

The time of nitrogen trial:

Table 4. Hand harvest of the crop on the small plots at anthesis

September 12th - interaction of cultivation depth by time of nitrogen						
rip depth	46 kg Nlha WAS	hd/pl	wt/pl	kg/ha	Total nitrogen %	nupt mgm/pl
0	**nil**	1.14	1.52	1821	1.41	21.4
0	**4**	1.38	1.90	2275	1.26	24.0
0	**8**	1.46	2.02	2425	1.27	25.6
0	**4+8**	1.49	2.08	2495	1.36	28.2
30	**nil**	1.39	2.42	2901	1.20	28.3
30	**4**	1.51	2.65	3185	1.30	34.5
30	**8**	1.49	2.61	3131	1.47	38.4
30	**4+8**	1.56	2.77	3321	1.54	41.8
65	**nil**	1.29	2.48	2975	0.98	24.1
65	**4**	1.58	3.14	3763	1.08	35.4
65	**8**	1.76	3.55	4262	1.21	42.7
65	**4+8**	1.66	3.33	3993	1.40	46.6
	stdev	**0.27**	**0.5**	**600**	**0.13**	**7.5**
	differences of 2*stdev are significant					

Responses to ripping depth are apparent but responses to nitrogen are marginal. The plots were hand harvested for yield components on 29 November.

Table 5. Yield component analysis of hand harvested small plot time of nitrogen trial

rip depth cm	46 kgN/ha WAS	Tops kg/ha	heads #/M^2	grain yield kg/ha	HI	tgw	grain #/hd	grain #/M^2	protein %	protein yield kg/ha
0	nil	3573	214	1693	0.48	43.7	18	3852	9.9	172
0	4	4953	284	2413	0.49	42.5	20	**5643**	10.1	245
0	8	4900	247	2340	0.48	42.8	22	**5477**	10.1	236
0	4+ 8	4918	240	2127	0.43	42.0	21	5063	10.1	216
0	stdev	881	36.3	369	0.04	1.6	3.0	806	0.7	46.1
30	nil	4987	231	2133	0.43	45.8	20	4669	11.1	236
30	4	**6791**	261	**3027**	0.45	45.9	**25**	**6595**	10.1	306
30	8	6356	251	2818	0.44	45.9	**25**	6150	9.9	280
30	4+ 8	**7062**	246	**3364**	0.48	45.3	**30**	**7445**	10.3	**346**
30	stdev	803	22.4	358	0.04	1.6	2.3	853	0.9	44.6
65	nil	6827	246	2653	0.39	46.1	23	5730	10.0	262
65	4	9124	295	3960	0.43	45.5	29	8687	9.8	387
65	8	9013	270	3422	0.38	46.5	27	7378	11.0	376
65	4+ 8	9173	295	4333	0.47	44.4	**33**	**9704**	10.9	**468**
65	stdev	1374	28.2	829	0.05	1.3	3.8	1657	0.5	74.4
Ripping significant?		yes	no	yes	no	yes?	yes	yes	no	yes
nitrogen significant?		no	no	yes	no	no	yes	yes	no	yes
	Figures in bold are greater than 2 stdev from the control - significantly different									

There was a biomass and grain yield response to both ripping and nitrogen This response was due to early season conditions as neither ripping nor nitrogen had much effect on harvest index (HI) or thousand grain weigh (tgw). At the control ripping depth, the top rate of N (92 kg N/ha at 4+8 WAS) had a lower HI and tgw suggesting there may have been some water stress during grain fill (due to lack of access to sub-soil water). Post harvest soil water profiles may show more sub-soil water left on the non-ripped plots?

In the main ripping depth trial, nitrogen effects (early season) were blanketed out with repeated topdressing of N containing fertilisers. If there was no advantage in late season water effects on yield (as indicated here) then the responses to ripping would be minimised.

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