Evaluation of Spading x Lime incorporation in low pH, non wetting sand

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Aim
To examine whether spading (partial-inversion tillage) can be used to manage water repellence and subsoil acidity on sandplain soil.

Background
For the past few years growers and researchers have been assessing the impact of a one-off soil inversion using a rotary spader to dilute water repellent soils and ameliorate subsurface acidity through the burial of lime.

Water repellence in soils is caused by waxes from plant residues which coat the sand particles. These waxes are hydrophobic can cause slow and uneven infiltration of water into the soil. The mixing action of a spader reduces water repellence in sandy soils by diluting the organic matter-rich repellent topsoil through the top 30cm of the soil profile and by creating subsoil seams in the topsoil that can act as preferred pathways for water movement. As a consequence of the mixing action some of the topsoil can remain slightly water repellent after spading. The fate of the buried water repellent topsoil is not yet known, and there is a risk that cultivation of this type may increase the depth of non-wetting. However it is hoped that over time, the buried non-wetting topsoil will become wettable once the waxes causing repellence have been degraded by micro-organisms.

Surface applied lime can take over a decade to significantly increase the subsoil pH below 10 cm unless the lime is incorporated. Spaders can effectively incorporate surface applied lime into acid subsoils to depths of up to 30-35cm thereby significantly speeding up the amelioration of soil acidity.

With funding from GRDC and assistance from DAFWA's Stephen Davies the Liebe group has set up a farm scale demonstration at the property of Ian and Clint Hunt investigating the merits of using a rotary spaders to incorporate lime to depth and overcome non wetting soils. The spading was conducted in May 2010 to a depth of 30cm, the trial will be continued to be monitored in the coming years.

Trial Details

Property	Hunt partners, Marchagee
Plot size & replication	22.5m x 1000m
Soil type	Deep Yellow Sand
Soil pH ($CaCl_2$)	Topsoil =5.7, subsoil=4.5
EC	0.02 dS/m
Sowing date	17/5/2010
Seeding rate	80 kg/ha Kalya Lupins
Fertiliser	17/5/10: 70 kg/ha blend of 40% MAP, 30% BigPhosMang, 30% MOP
Paddock rotation	07 Wheat, 08 Lupins, 09 Wheat
Herbicides	27/4/10: 1.66 L/ha Glyphosate450, 25 ml/ha Oxyflurofen, 17/5/10: 800 ml/ha paraquat, 2 L/ha Trifluralin, 600 g/ha Diuron, 600 g/ha simazine, 23/6/10: 500 ml/ha clethodim, 6/7/10: 150 ml/ha Diflufenican; 100 g/ha Metribuzin; 300 g/ha Simazine, 20/10/10: 800 ml/ha paraquat
Insecticide	27/4/10: 100 ml/ha cypermethrin
Growing Season Rainfall	177mm

Results

Lupin yields at the site were poor and spading actually decreased the lupin yields (Table 1). Lupin establishment on the spaded plots was poor as a result of lupins being seeded too deep in the soft soil. Coil packers were used after spading prior to seeding and again after sowing, which resulted in some furrow infill which may have exacerbated the seeding depth problem.

Table 1: Lupin yield after using a rotary spader or deep ripper to cultivate soil at Marchagee in 2010.

Treatment	Yield (t/ha)
Control	0.7
Rip	0.7
Spade	0.5
Spade+ Lime+ Dolomite	0.5

The physical soil loosening caused by spading, reduced the strength of the subsoil to a depth of 25cm (Figure 1), but the soil strength was reduced more by deep ripping (when measured on the rip line) which loosened the soil to just over 30cm (Figure 1). Lupins tend not to be responsive to deep ripping, but in other trials some of the yield benefits for cereals have been partially due to soil loosening.

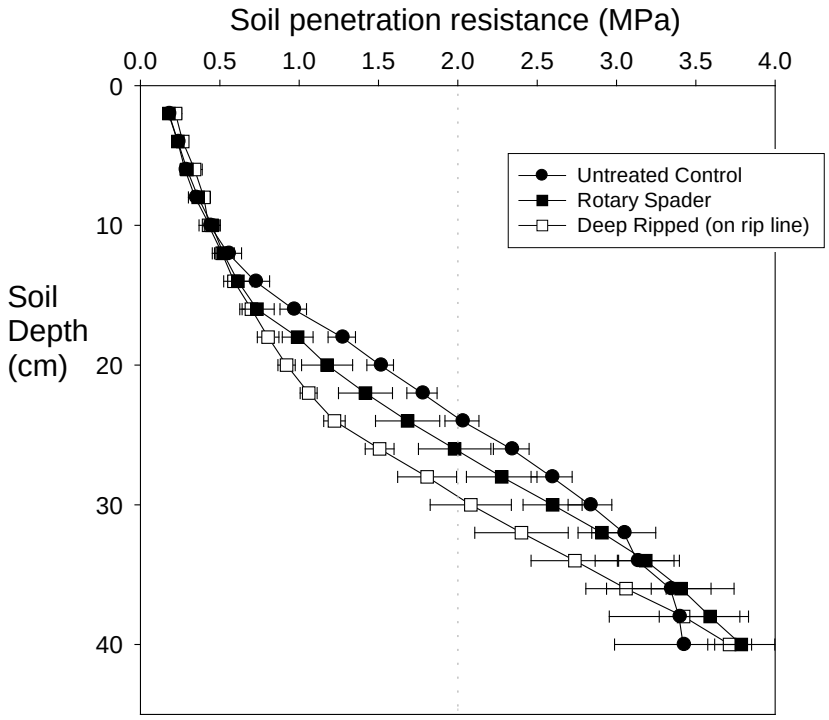

Figure 1: Impact of rotary spading and deep ripping on soil penetration resistance measured using a cone penetrometer in megapascals (MPa) in a yellow deep sand at Marchagee when the soil was wet. Note that at 2MPa or more crop root growth rates are reduced.

The subsoil acidity at the site is on the verge of becoming a problem with a subsoil pH below 20cm of 4.5, lower than the target level of 4.8 or more (Figure 2) although the topsoil pH was above the target pH of 5.5 or more. Spading on its own can alter the pH through the burial of higher pH topsoil (Figure 2), this is often accompanied by a decrease in the topsoil pH as more acidic subsoil is brought to the surface as has been seen at other sites. However incorporation of lime and dolomite using the spader significantly increases the pH of the top 20cm to 6.4, which should greatly enhance the amelioration of the acidity below 20cm and should prevent the subsoil acidity worsening to a point that it induces aluminium toxicity that typically occurs when the pH <4.5.

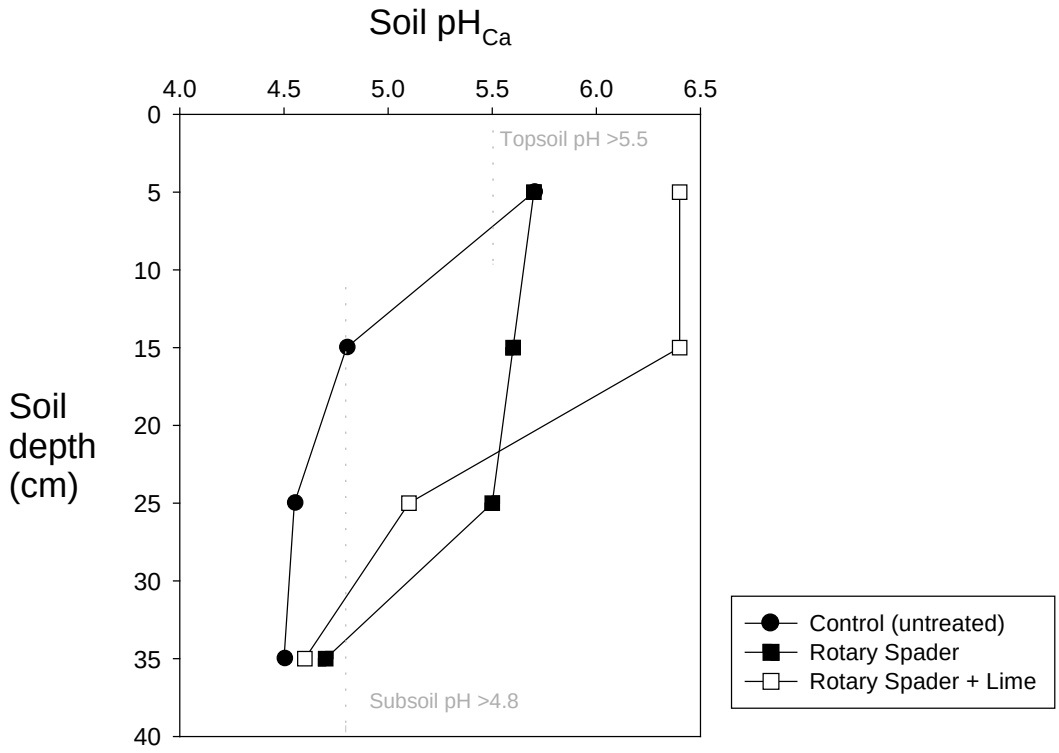

Figure 2: Impact of rotary spading and lime application on soil pH ($CaCl_2$). Target pH levels for topsoil (pH>5.5) and subsoil (pH>4.8) shown as dashed lines.

Comments

This trial highlighted some of the difficulties that can occur when seeding soils that have been loosened by tillage implements such as rotary spaders or mouldboard ploughs. Maintaining a good seeding depth can be difficult and it is important to firm loosened soils prior to seeding. Some growers have successfully established cover crops in the first year after loosening, using very simple techniques such as broadcasting cereal seed and pressing it into the soil using coil packers or something similar to avoid the seeding depth problem. This trial also demonstrates how rotary spaders can be used to incorporate lime into acid subsoils allowing for more rapid amelioration of subsoil acidity. It will be interesting to monitor whether this gives greater benefits in the future as the untreated soil continues to acidify and more acid-sensitive crop types are grown on the site. In general it is preferable to seed a cereal cover crop in the year a soil is spaded or mouldboard ploughs, as cereals are more tolerant of sandblasting than lupins, which is a risk with these techniques. It is recommended that soils only be spaded or ploughed when wet, and a cover crop sown immediately to reduced the risk of wind erosion.

Acknowledgements

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Paper reviewed by Stephen Davies, DAFWA

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