Evaluation of Spading with Lime Incorporation in Low pH, Non Wetting Sand

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Key Messages

- Spading has buried the non-wetting layer of soil in this paddock, resulting in an increase in crop yield in two out of the past three years.
- Using a spader to mix lime and dolomite into the subsoil has improved the pH of the soil and increased yield.

Aim

To examine whether deep cultivation by spading can be used to manage water repellence and subsoil acidity on sand plain soil.

Background

This demonstration was established in 2010 to assess the impact of a one-off deep soil cultivation using a rotary spader to dilute water repellent soils and ameliorate subsurface acidity through the incorporation of lime.

The trial was spaded in May 2010 to a depth of 30cm. The 'spade' on a rotary spader tyne can carry topsoil down into the subsoil and also bring subsoil up to the surface, mixing to a depth of 25-30cm. It is estimated that the rotary spader buries at least two-thirds of the topsoil with the remaining one-third left in the topsoil.
In 2011 the rest of the paddock was spaded to a depth of 34cm and lime and dolomite was incorporated giving us a side by side comparison of incorporation to depth.

Water repellence in soils is caused by waxes from plant residues which coat the sand particles. These waxes are hydrophobic and 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 lifting seams of subsoil to the surface 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 clear, and there is a risk that cultivation of this type may ultimately increase the depth of non-wetting. Current findings are mixed with severity of water repellence in the buried topsoil declining by half after 3 years at one site but no measureable change at another site after 5 years (S. Davies pers. comm.). Research to assess this further is ongoing. In poor sands with low clay content the buried topsoil and associated organic matter can hold more soil moisture than the bulk soil so it can increase the amount of water held in the root zone, albeit by a relatively small amount.

Surface applied lime in a no till system is slow to move down the profile. To significantly increase the subsoil pH below 10cm the lime must be incorporated. Spaders can effectively incorporate surface applied lime into acid subsoil's to depths of up to 30-35cm thereby significantly speeding up the amelioration of subsoil acidity.

Trial Details

Property	Hunt Partners, Marchagee
Plot size & replication	22.5m x 2000m x no replications
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-5cm: 6 5-10cm: 5.2 10-20cm: 5.1 20-30cm: 4.8
EC (dS/m)	0.022
Sowing date	08/05/2014
Seeding rate	70kg/ha Calingiri
Paddock rotation	2010 Lupins, 2011 Wheat, 2012 Wheat, 2013 Lupins, 2014 Wheat
Soil Amelioration	2010: (Spading plot only) 1 t/ha Lime and 1 t/ha Dolomite 2011: 1 t/ha Lime and 1 t/ha Dolomite
Fertiliser	08/05/2014: 42 kg/ha Agflow Extra, 18 kg/ha Muriate of Potash, 65 L/ha Flexi N 01/07/2014: 34 L/ha Flexi N
Herbicides	08/05/2014: 1.5 L/ha Spray.Seed, 2.5 L/ha Trifluralin, 35 g/ha Triasulfuron 01/07/2014: 25 g/ha Monza, 1.5 L/ha Precept

Growing Season Rainfall	240mm (April to end September)

Results

The 'spade' on rotary tynes, mixes soil to a depth of 25-30cm allowing the opportunity for mixing lime if pH is an issue. In Figure 1, a bulge in soil pH can be seen in the sub soil where surface applied lime and dolomite lime was incorporated. The bulge corresponds with the maximum working depth of the spader. There is a difference between where the bulge is in the 2010 and the 2011 spaded treatments which demonstrates that the lime/dolomite is moving down through the profile.

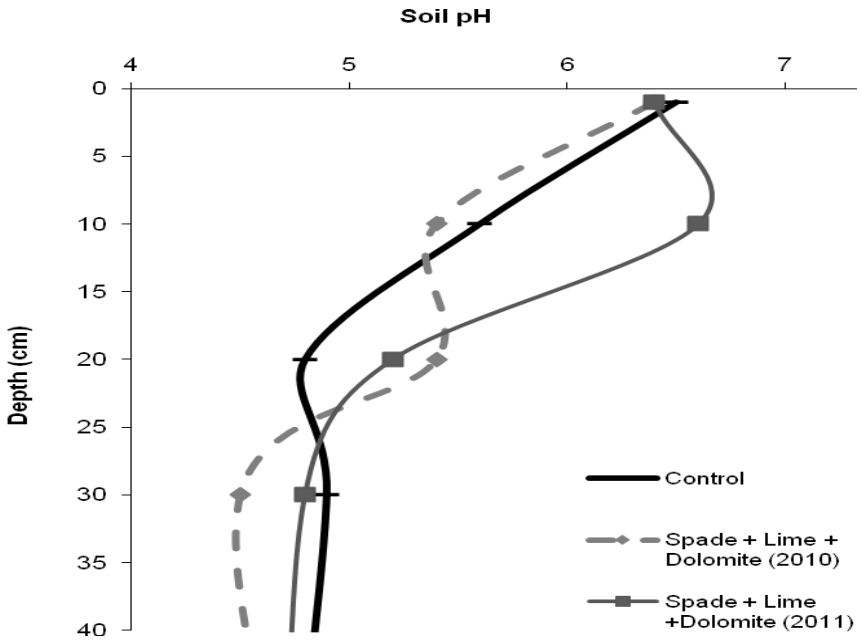

Figure1: Soil pH ($CaCl_2$) profile changes as a result of spading and incorporating lime and dolomite measured in December 2014. Note all the treatments received a surface application of 1t/ha lime and 1t/ha dolomite in 2011.

In 2011 the whole trial was top dressed with 1 t/ha lime and 1 t/ha dolomite, this second application was not incorporated, but through the soil pH analyses carried out in December 2014 it has shown an increase in pH in the subsurface soil (10-20cm) which has led to an increase in yields over the control treatments as shown in Table 1 and Figure 2.

Table 1: Crop yields sown at Marchagee, incorporation of 1 t/ha lime and 1 t/ha dolomite using a rotary spader was carried out in 2010 and 2011 respectively.

Treatment	2014 Wheat Yield (t/ha)	2012 Wheat Yield (t/ha)	2011 Wheat Yield (t/ha)	2010 Lupin Yield (t/ha)
Control (No tillage)	1.57	0.8	1.3	0.7
Deep Ripped	1.58	1.0	1.4	0.7
Spade	1.67	1.0	1.5	0.5
Spade + Lime + Dolomite (2010)	2.15	1.2	1.7	0.5
Spade + Lime + Dolomite (2011)	2.26	-	-	-

Crop yields have been collected in 2010 - 2012 and again in 2014 and are displayed in Table 1. In 2010, the year the spading was conducted, spading caused yields to decrease compared to the control as a result of the lupins being sown too deep and sand-blasted due to the lack of soil cover, greatly reducing plant numbers. In 2011 and 2012 spading (no lime or dolomite) increased yield by 0.2 t/ha above the control however, in 2014 the increase in yield was only 0.1 t/ha.

The farmer observed the infiltration of rainfall has improved due to spading. Using the spader to mix lime through the soil in an attempt to ameliorate soil acidity has improved yield beyond the initial gain of spading alone. The addition of lime and dolomite increased yield by an additional 0.2 t/ha compared to spading in both 2011 and 2012 and increased yield by 0.48 t/ha in 2014, which is the greatest increase in yield to date.

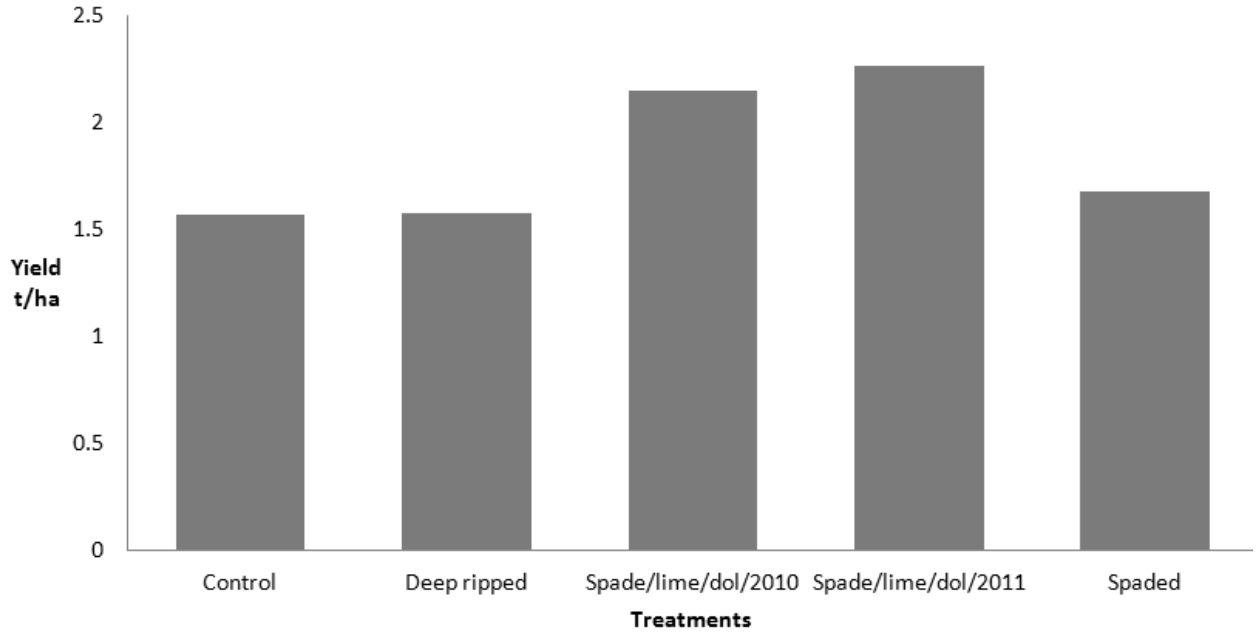

Figure2: Wheat yield at Marchagee across all treatments in 2014. Note: All treatments were top dressed with 1 t/ha lime and 1 t/ha dolomite in 2011, bringing the total lime and dolomite on the spaded 2010 treatment to 2 t/ha lime and 2 t/ha dolomite.

Comments

Over the life of the trial the Hunt's have observed a difference over the treatments with the spading/lime/dolomite treatment attaining the desired results, leading them to full adoption of the practice in 2011 when they implemented the treatment over the rest of the paddock. The Hunt's are still reaping the benefits of adopting this method of incorporation to deal with the two issues that the paddock was presenting.

The implementation of this practice has been proven to attain increased results in yield but it is not without its own issues as the Hunt's experienced in 2010. Wind erosion risk is at its maximum in the first year with limited stubble cover allowing erosion which impacted final yield in 2010. Spading has the added benefit of reducing compaction in a similar method to deep ripping by physically breaking down any compacted layers in the top 30cm, although this benefit may only last a few years if a controlled traffic system is not implemented to sustain the benefit. In this demonstration there was no lasting impact of deep ripping or spading on their own on crop yield, indicating that the cultivation benefit of these has disappeared, however, the improved soil pH from incorporated lime and dolomite appears to be showing longer lasting benefits.

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