MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Addressing subsoil acidity in the field

Rutherglen site research update (2017)

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http://www.dpi.nsw.gov.au/agriculture/soils/acidity

Reactive phosphate rock and lucerne pellets increased canola grain yield significantly probably due to increased soil pH and improved plant nutrition. Deep placement of lucerne pellets appeared to induce more accentuated symptoms of manganese toxicity at the inflorescence emergence stage. Changes of soil chemical properties under different soil ameliorants will continue to be monitored over the next three years.

Introduction

Subsoil acidity (below 10 cm) is a major constraint to crop production in the medium-high rainfall (500-800 mm) cropping zone. Whilst acidic surface soil (0-10cm) can be easily and effectively addressed with the incorporation of lime at the soil surface, amelioration of the subsoil has been ineffective. A range of soil ameliorants were tested in the field, including alkaline materials like lime, dolomite and magnesium silicate (MgSi) which react to create alkali, and reactive phosphate rock (RPR) which can increase pH and release plant available phosphorus (P) as it dissolves in acidic soil. Organic amendments, such as lucerne pellets, were also included to increase soil pH acting either as an alkali source or by enabling alkaline reactions to occur during the decomposition of organic matter. The influence of these products on subsoil acidity and aluminium toxicity, and on subsequent crop yield were investigated. The aim was to quantify the yield limitation caused by subsoil acidity and evaluate innovative soil amendments which act to ameliorate subsoil acidity at 10-30 cm.

Materials and methods

A 3-year field experiment was established in 2017 at Rutherglen, Victoria. The site had a history of more than 20 years of clover pasture, grazed and cut for hay, with no lime application resulting in very acidic soil and a high aluminium concentration in the surface (0-10 cm) and subsurface soil (10-30 cm).

There were 14 treatments arranged in a randomised block design with 3 replicates to plots 5 x 20 m in size (Table 1). The deep amendments were placed approximately 10-30 cm deep in the profile at a 50cm row spacing using the 3-D Ripper engineered by NSW Department of Primary Industries in 2016.

Table 1. Treatment description

No.	Treatment	0-10cm	10-30cm	
		Lime	Lime	Others
1	Nil control	0	0	-
2	Limed control	1.7	0	-
3	Surface lime	2.7	0	-
4	Deep lime	1.7	2.5	-
5	Deep dolomite	1.7	2.3	-
6	Deep MgSi - low	1.7	0	4 t MgSi/ha
7	Deep MgSi - high	1.7	0	8 t MgSi/ha
8	Deep RPR - low	1.7	0	4 t RPR/ha
9	Deep RPR - high	1.7	0	8 t RPR/ha
10	Deep P	1.7	0	15 kg P/ha
11	Deep P + deep lime	1.7	2.5	15 kg P/ha
12	Deep LP - low	1.7	0	7.5 LP/ha
13	Deep LP - high	1.7	0	15 LP/ha
14	Deep ripping only	1.7	0	-

Lime, superfine F70 lime (NV=98%); MgSi, magnesium silicate; P, liquid phosphate fertiliser; RPR, reactive phosphate rock; LP, lucerne pellets.

Hyola 559 TT canola was sown on 3 May 2017 at 3 kg/ha with 75 kg DAP/ha placed with the seed using a cone seeder on a 25cm row spacing, and top-dressed with 100 kg/ha of urea in August. Crop growth was monitored throughout the season with establishment density, biomass at anthesis and harvest times, grain yield and quality parameters recorded.

The soil from each plot was sampled after harvest by taking two cores (44 mm in diameter) on the rip-line and two between rip-lines to a depth of 140cm. These cores were divided into 10cm increments to a depth of 40 cm, and 20 cm increments from 40-140 cm with increments, bulked to corresponding depth with on and off the rip-line. Each soil sample was analysed for soil pH in $CaCl_2$. Air-dried soil subsamples were stored for future analysis.

Results

The application of lime to the surface soil (0-10 cm) increased soil pH significantly compared to the untreated Nil control (Figure 1). The soil pH in the subsurface remained unchanged and acidic conditions persisted for the Limed control, Surface lime, Deep ripping only, and Deep P treatments as expected. All other deep amendment treatments increased soil pH at the depth where the amendment was placed. Large increases in soil pH of the amended layer were recorded for the high rates of MgSi and lucerne pellets. The soil pH below the depth of placement was unchanged and exhibited considerable variation below 60cm.

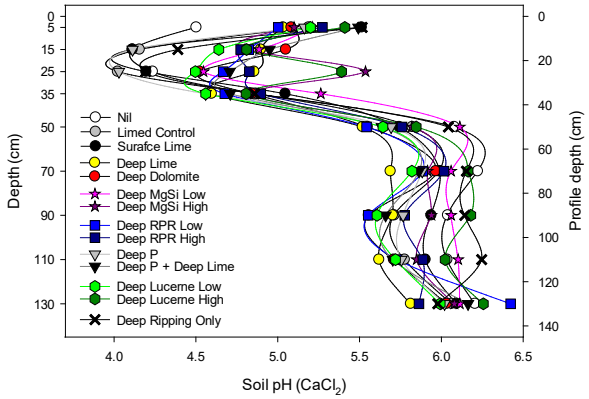

Figure 1. Profile soil pH ($CaCl_2$) under different soil amendment treatments measured post canola harvest in November 2017.

Liming the surface soil had no effect on grain yield compared to the untreated Nil control (Figure 2). Deep placement of amendments did not result in increased yield over the Limed control or the untreated Nil control with the exception of low or high RPR and high lucerne pellets which returned yield gains of approximately 0.5 t/ha compared with the Limed control. However these treatments were not significantly different from any other treatments with deep placed soil amendments. The inclusion of lucerne pellets appeared to induce more accentuated symptoms of manganese toxicity during the inflorescence emergence stage (55) compared with other treatments.

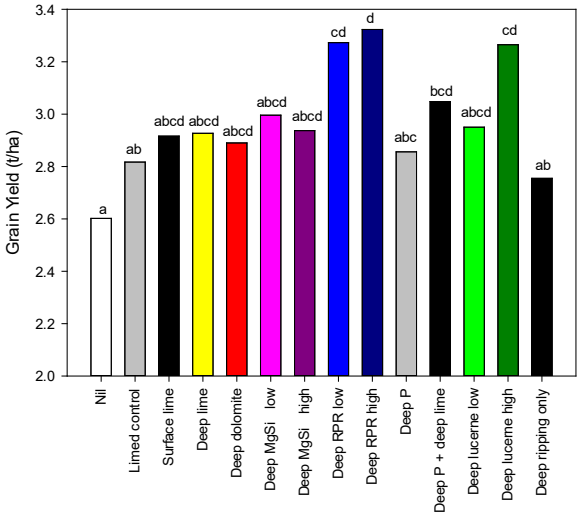

Figure 2. Canola grain yield (t/ha) under different soil amendment treatments. Bars with the same letter are not significantly different.

Conclusions

Deep placement of lucerne pellets may induce manganese toxicity due to enhanced oxygen consumption by microorganisms and poor aeration at depth. Positive results of RPR and lucerne pellets on yield may be due to both increased soil pH and improved nutrition. Therefore, interactions of these factors need to be investigated for growers to realise efficiency gains of amendments additions at depth. A wheat crop will be sown in the experiment in 2018.

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