MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Addressing subsoil acidity in the field

Rutherglen site research update (2015-2019)

Issue 21: September 2020

Prepared by J. Condon (jcondon@csu.edu.au), S. Moroni and A. Zander
http://www.dpi.nsw.gov.au/agriculture/soils/acidity

The yield response at the establishment year was due to nutrient response. However, adding nutrient without addressing acidity was not effective in overcoming deleterious effects of acidity. The amelioration of soil acidity by organic matter addition in the form of lucerne pellets does not persist.

Introduction

A range of soil ameliorants were tested in the field over three years, including lime, dolomite, magnesium silicate (MgSi), and reactive phosphate rock (RPR), phosphorus and lucerne hay pellets (LP) as an organic amendment. The aim was to quantify the yield limitation caused by subsoil acidity and evaluate innovative soil amendments which act to ameliorate subsoil acidity.

Treatments

The experiment was established at Rutherglen, Victoria on a Yellow Chromosol. There were 14 treatments arranged in a randomised block design with 3 replicates to plots 5 x 20 m in size. The deep amendments were placed at approximately 10-30 cm deep in the profile at a 50 cm row spacing in March 2017 using the 3-D Ripper machine. Canola crops were grown in 2017 and 2019 and a wheat crop was sown in 2018. Soil chemical changes and yield responses to soil amendments were monitored over 3 growing seasons.

Results

Soil amendments had a significant impact on soil pH (Figure 1). In the year of establishment (2017), soil pH increased greatly at 10-30 cm where the amendments were placed although many were not significantly different to the control. MgSi resulted in rapid pH increase at 20-30 cm due to the relatively high solubility compared to other inorganic pH amendments. The high soil pH on the MgSi treatment was maintained over next two years. In contrast, the initial pH increases on the LP treatment apparent in 2017 had disappeared by 2019 where there was no significant difference in pH between the LP treatment and the surface limed control.

Lime and dolomite are relatively slow to react. By 2018, soil pH increased significantly at 10-20 cm on those treatments relative to the control, deep ripping only and surface lime treatments only (Figure 1b). This effect increased again in 2019 for deep lime only (Figure 1c). There was no apparent lasting pH benefit of the deep placement of dolomite. The RPR treatments had a similar soil pH profile as deep lime treatment in 2017. But by 2018 and 2019, the soil pH in RPR treated soil was lower than that on deep lime treatment, though the high rate of RPR had higher pH at 20-30 cm than the LP treatments, but no difference from the MgSi treatments. The pH on the deep P with lime treatment was significantly greater than that on the deep P treatment. The soil pH between rows of amendment placement remained unchanged compared with the control throughout the experiment (Figure 1).

Table 1: Grain yield (t/ha) in 2017-2019

Treatment[A]	2017[B] Canola	2018[C] Wheat	2019[C] Canola
Nil control	2.74a	1.55 (0.38)	1.40 (0.10)
Limed control	2.90a	1.18 (0.16)	1.21 (0.03)
Surface lime	2.95a	1.38 (0.40)	1.32 (0.10)
Deep ripping only	2.84a	1.36 (0.09)	1.13 (0.04)
Deep lime	3.02a	1.50 (0.65)	1.14 (0.16)
Deep dolomite	2.97a	2.07 (0.17)	1.26 (0.05)
Deep MgSi (low)	3.03a	1.70 (0.29)	1.17 (0.06)
Deep MgSi (high)	2.99a	1.75 (0.24)	1.22 (0.04)
Deep RPR (low)	3.34bc	1.69 (0.22)	1.19 (0.03)
Deep RPR (high)	3.41c	1.36 (0.17)	1.11 (0.05)
Deep P	2.91a	1.19 (0.36)	1.15 (0.23)
Deep P + lime	3.09ab	1.50 (0.04)	1.38 (0.08)
Deep LP (low)	3.00a	1.42 (0.18)	1.31 (0.08)
Deep LP (high)	3.32c	1.27 (0.62)	1.18 (0.10)

[A] Lime, superfine F70 lime (NV=98%); MgSi, magnesium silicate; RPR, reactive phosphate rock; P, liquid phosphate fertiliser; LP, lucerne pellets.
[B] Means marked with different letters are significantly different at $P < 0.05$.
[C] Values in parentheses are standard error of means.

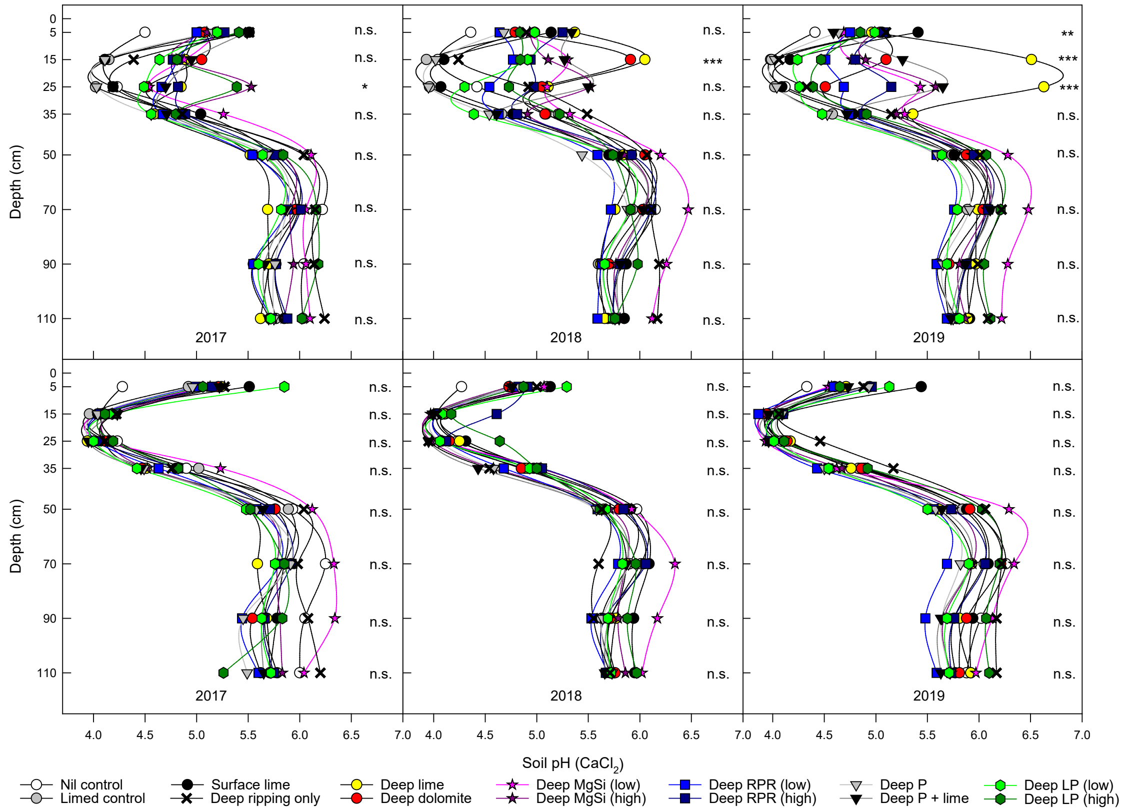

Figure 1. Soil pH on the amended row (top graphs) and between the amended row (bottom graphs) at Rutherglen in 2017 (a, d), 2018 (b, e), 2019 (c, f). *, *P* = 0.07; **, *P* = 0.05; *, *P* < 0.01; n.s. no significant between treatments.**

In 2017, canola yield was significantly greater for RPR and LP (high) treatments (Table 1). The RPR and LP (high) treatments resulted in 0.5 t/ha more grain than the control due in part to significantly larger seed size. In 2018, there were no difference in wheat grain yield between treatments (Table 1) although visual differences in crop growth were apparent at early tillering with LP and RPR treatments. However, the drought conditions diminished the difference in early growth due to limited available water and frost event at flowering. In 2019, there were no significant differences in yield between treatments (Table 1). The poor crop performance was largely due to poor crop establishment following an intense rainfall event at emergence which destroyed surface soil structure and inundated emerging seedlings.

Conclusions

Amelioration of acidity with the addition of nutrients resulted in increased yield in the year of establishment, but not in years 2 and 3 due to drought and frost in 2018 and a storm event in 2019. The amelioration benefits from deep placement of lime, RPR, MgSi remains to influence plant performance into the future. How long these benefits last is unknown.

Acknowledgements

The project is funded by NSW Department of Primary Industries with financial support from GRDC (DAN00206, 2015-2020). The cooperation of land owner is much appreciated.

Project partners and contacts

Organisation	Key contact	Telephone
NSW Department of Primary Industries	Dr Guangdi Li Dr Ehsan Tavakkoli	02 6938 1930 02 6938 1992
La Trobe University	Prof Caixian Tang	03 9032 7416
Charles Sturt University	Dr Sergio Moroni Dr Jason Condon	02 6933 2914 02 6933 2278
CSIRO Canberra	Dr Peter Ryan	02 6246 5053
FarmLink Research	James Holding	02 6980 1333
Holbrook Landcare Network	Kylie Durant	02 6036 3181
Riverine Plains	Jane McInnes	03 5744 1713
Southern farming Systems	Lisa Miller	03 5265 1666