MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Addressing subsoil acidity in the field

Cootamundra site research update (2016-2019)

Issue 22: September 2020

Prepared by Dr G. Li (guangdi.li@dpi.nsw.gov.au)
http://www.dpi.nsw.gov.au/agriculture/soils/acidity

Lime is the most effective amendment to increase pH and reduce exchangeable aluminium. Deep placement of lucerne hay pellets had limited effect on soil pH but reduced exchangeable aluminium significantly. However, applying a large amount of organic materials could acidify soil due to nitrification over the longer term. Growers should therefore use organic amendments with caution to address subsoil acidity.

Introduction

The site was established in 2016 as a long-term field experiment and completed its first crop cycle in 2019. The experiment was fully phased with 4 crops in sequence, wheat-canola-barley-pulse. The overall objectives were to *a)* to manage subsurface soil acidity through innovative amelioration methods that will increase productivity, profitability and sustainability, and *b)* to study soil processes, such as the changes of soil chemical, physical and biological properties under vigorous soil amelioration techniques over the longer term.

Site description

The site is located at the property of 'Ferndale', Dirnaseer, west of Cootamundra, NSW on a Red Chromosol soil. There were 6 soil amendments treatments with two major contrasts, *a)* surface vs. deep liming and *b)* deep liming vs. deep organic amendment as lucerne hay pellets (LP).

Results

Lime increased soil pH to the target level one year after treatments were implemented. The soil pH increased from 4.6 to 5.9 at 0-10 cm due to surface liming, and from 4.3 to 6.0 at 10-20cm and from 4.7 to t 5.5 at 20-30cm for deep liming with and without LP treatments, respectively. The soil pH remained unchanged for the next 3 years. However, the deep LP treatment did not increase pH as much as expected from pilot laboratory and glasshouse experiments. This is likely due to the nitrification process which decreased soil pH following the initial decomposition of organic materials.

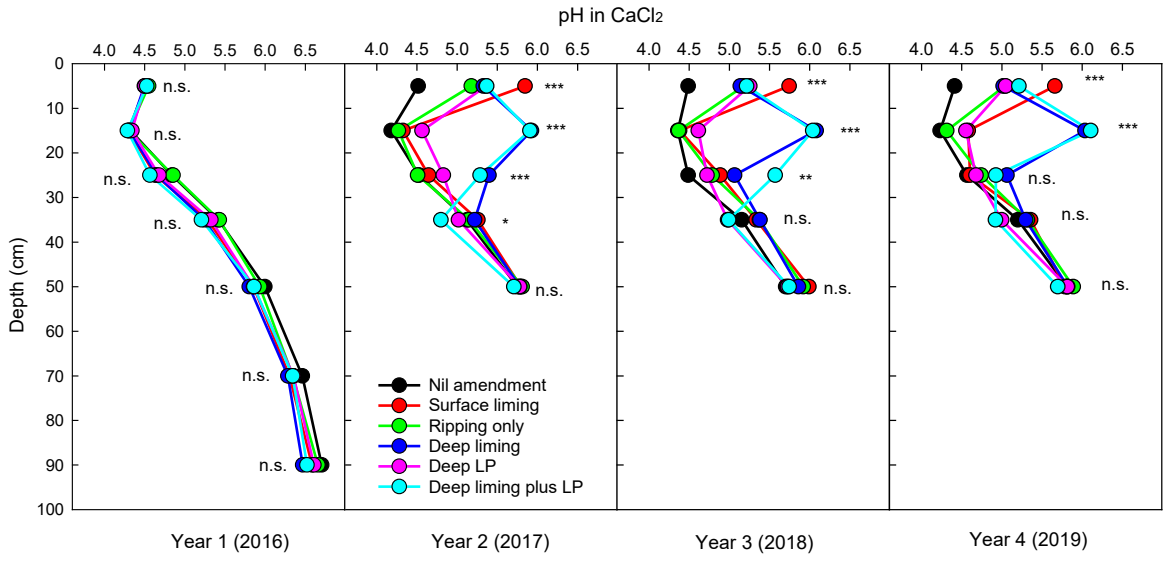

Figure 1. Soil pH in $CaCl_2$ under different soil amendment treatments at Cootamundra, NSW in 2016-2019

In fact, four years later, soil pH beyond the ripping depth was lower under the deep LP treatments even with addition of lime (data not shown). This indicated that the addition of a large amount of organic materials acidified soil below the depth where the amendment was placed. Caution is therefore required when considering applying organic amendments at depth to address subsoil acidity.

Averaged across 4 years, all soil amendments improved crop establishment by 12-19% compared with the nil control, and by 3-5% compared with the surface liming treatment. The deep LP with and without lime treatments had the greatest increase in anthesis DM, up to 16% compared with the nil treatment, and 8% compared with surface lime treatment, most likely due to increased nutrient supply from LP. By year 3, there was still up to 100kg/ha extra mineral N available to one meter depth on those treatments with LP. There was some evidence of movement of soil mineral N down the soil profile, particularly after an extremely wet year in 2016, but this did not translate to increased net acidification in those treatments. In general, all soil amendments increased grain protein content, particularly on those treatments with LP, but decreased canola oil content (Table 1).

Table 1. Relative responses (%) to different soil amendments in reference to the nil amendment and surface liming treatments at Cootamundra, NSW in 2016-2019.

Treatment comparison	Establishment	Anthesis DM	Grain yield	Grain protein	Canola oil
Treatment effect - nil amendment					
Nil amendment	0.0	0.0	0.0	0.0	0.0
Surface liming	12.0	8.8	-0.1	1.1	-0.2
Deep rip only	15.9	10.2	6.4	1.4	-0.1
Deep liming	18.7	6.7	8.8	2.4	-1.2
Deep lucerne pellet	18.1	14.9	1.7	10.4	-3.5
Deep liming plus lucerne pellet	16.3	15.5	8.3	9.2	-1.8
P-level	n.s.	<0.05	n.s.	<0.001	<0.05
$LSD_{0.05}$		5.73		1.98	1.82
Treatment effect - surface liming					
Surface liming	0.0	0.0	0.0	0.0	0.0
Deep rip only	3.9	4.4	9.9	0.4	0.1
Deep liming	3.9	1.1	10.8	1.5	-1.0
Deep lucerne pellet	4.5	8.3	4.3	9.4	-3.3
Deep liming plus lucerne pellet	3.4	8.1	8.7	8.2	-1.7
P-level	n.s.	<0.05	n.s.	<0.001	<0.05
$LSD_{0.05}$		3.58		1.65	1.61

Conclusions

Lime is the most effective amendment to increase pH and reduce exchangeable Al%. Deep placement of lucerne hay pellets had a limited effect on soil pH, but significantly reduced the exchangeable Al. However, in the longer term applying large amounts of organic materials could acidify soils through the nitrification process and this would need to be offset with additional lime to neutralise this effect.

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