MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Addressing subsoil acidity in the field

Cootamundra site research update (2016-2017)

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

Lime increased soil pH and decreased exchangeable Al% at 10-30 cm. There was no evidence to show the alkalinity movement below the depth of amendment placement even when applied with organic amendment. Crop yield responses due to liming effects are not anticipated for a few more years.

Introduction

A long-term field experiment was setup in 2016 to run for at least two 4-year crop rotation cycles, or one 8-year soil amendment cycle. The objectives were to a) to manage subsoil 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 and treatments

The site is located at the property of 'Ferndale', Dirnaseer, west of Cootamundra, New South Wales on a Red Chromosol soil. There were 4 crops in rotation arranged in a fully phased design. The crops are in sequence of wheat-canola-barley-pulses (faba bean or field pea, depending on the season). There were 6 treatments within each crop arranged in a split-plot design with 3 replicates. The major treatment contrasts were a) Surface vs. Deep liming and b) Deep liming vs. Deep organic amendment (OA as lucerne pellets).

The initial soil samples were taken to a depth of 100cm with a large tube (44mm in diameter). From year 2 onwards, soil samples were taken using a multi-corer (6 tubes with 25mm in diameter) to a depth of 60cm at two locations per plot, composited with corresponding depths. Seedling density, crop biomass, grain yield and quality parameters were measured for each crop every year.

Results and discussion

There was no difference in soil pH at any depth in year 1 before treatments were imposed in 2016. In autumn 2017, one year after treatments were imposed, Surface liming increased pH to 5.9 at 0-10cm. The Deep liming, with and without organic amendment, significantly increased soil pH at 10-20cm and 20-30cm (Figure 1). However, the Deep OA treatment did not increase pH as much as measured in laboratory. There was no evidence to show alkalinity movement below the depth of placement, even when applied with organic amendment. This will be monitored annually as per the experimental protocol.

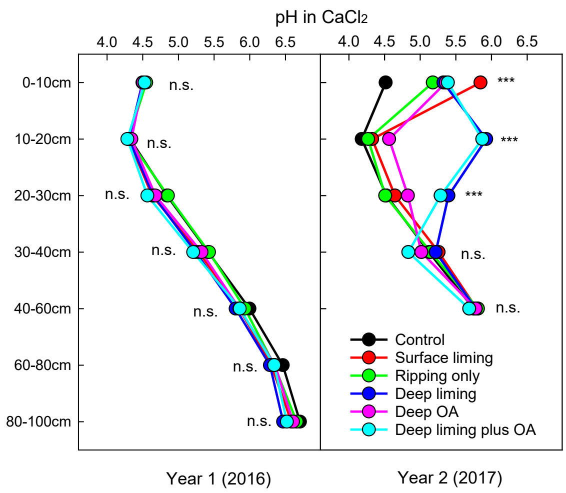

Figure 1. Soil pH in $CaCl_2$ under different soil amendment treatments in autumn in years 1 and 2.

Although lucerne pellets did not increase soil pH, it significantly reduced exchangeable aluminium (Al%) at 10-20cm and 20-30cm compared to the Control treatment (Figure 2). It is probably because the soluble organic molecules from lucerne pellets could combine with active Al^{3+} to form insoluble hydroxy-Al compounds and reduce Al toxicity to plant growth.

There was significantly more soil mineral nitrogen under Deep OA treatments with and without lime than other treatments, as lucerne pellets contained a high nitrogen content (3.15%). On average, there was an additional 100 kg N/ha of mineral nitrogen in the Deep OA and Deep liming plus OA treatments compared with the remaining treatments in autumn 2017 (Figure 3).

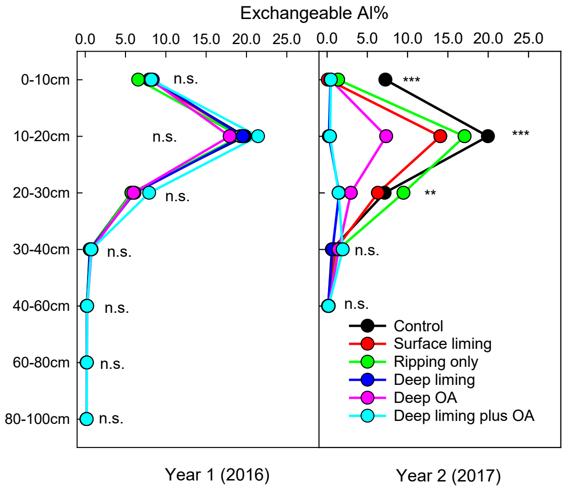

Figure 2. Soil exchangeable Al% under different soil amendment treatments in autumn in years 1 and 2.

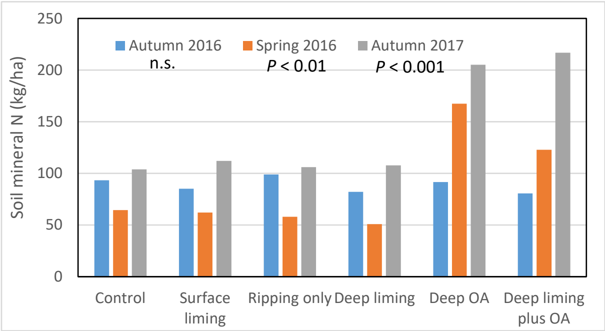

Figure 3. Soil mineral nitrogen (kg/ha) at 0-60cm in autumn and spring in year 1, and autumn in year 2.

In 2016, significant crop biomass responses were observed on wheat, barley and canola crops at anthesis in the organic amendment treatments in year 1 due to extra nutrients supplied by lucerne pellets. However, the dramatic crop biomass responses observed at anthesis on the canola and barley crops did not translate into grain yield in those treatments due to severe lodging (Figure 4).

In 2017, no significant difference was found between treatments for grain yield for any crops (Figure 4). However, both Deep OA and Deep limling plus OA treatments tended to have lower grain yield despite significantly higher mineral nitrogen at the sowing (Figure 3). Lack of rainfall during the early growing season and severe frost damage in late winter caused very low dry matter production and grain yields in canola and faba bean crops. Rainfall late in the growing season boosted the grain yield of cereal crops (Figure 4).

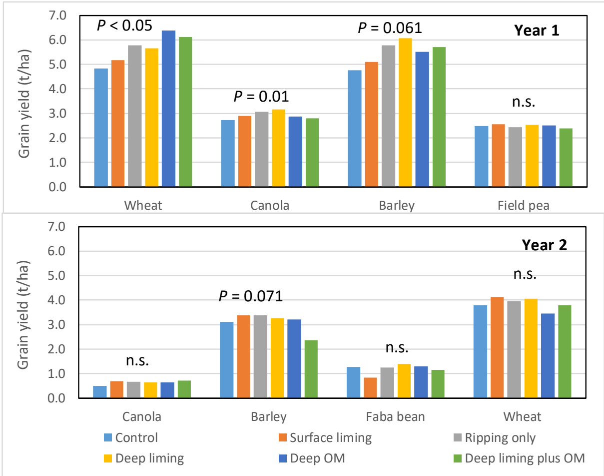

Figure 4. Grain yield (t/ha) in response to different soil amendments in years 1 and 2.

Conclusions

Deep placement of lucerne pellets did not increased soil pH as much as expected, but it did reduce exchangeable Al% significantly at 10-20 and 20-30cm. There were large crop yield response to Deep OA in year 1, but no crop response was detected in year 2, partly due to lack of soil moisture during the crop growing season. Soil chemical, physical and biological properties continue to be monitored to understand the soil-plant interactions, the factors driving the differences in crop response to the various treatments, and the long-term residual value of the amendments.

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