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Amelioration of subsurface soil acidity using inorganic amendments

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Introduction

Subsoil acidity is one of major constraints limiting crop yield in vast areas of Australian farming systems. The objective of the current study was to test the effectiveness of a range of inorganic soil amendments on the amelioration of subsoil acidity and agronomic performance over three years (2015-2017). Given the renewed interest in ameliorants other than lime, a novel product, magnesium silicate (MgSi), was evaluated.

Methodology

A 3-year field experiment was conducted at Holbrook, NSW on a Yellow Chromosol soil. There were 9 treatments with 4 inorganic amendments, including lime, magnesium silicate (MgSi, a blend of 70% Doonba dunite and 30% F70 superfine lime), calcium nitrate and gypsum. Lime and MgSi were applied on the surface and compared with deep placement. Gypsum was deep-placed while calcium nitrate was top-dressed each year at an equivalent nitrogen rate to urea. For all deep placement treatments, a single tyne ripper with the manual feeding system was used to deliver the soil amendment at 30 cm. The initial soil samples were taken before treatments were implemented in year 1 down to 100 cm, and the soil samples in year 3 were taken down to 60 cm using a multi-core sampler (Lowrie *et al*. 2018 in this proceeding). The site was sown into Hyola 970CL canola in 2015, EGA Wedgetail wheat in 2016 and 2017. Crop agronomic performance was monitored each year.

Results

Soil chemical properties

Both deep lime and deep MgSi treatments increased soil pH significantly at the 20–30 cm depth (P<0.001) where soil amendments were applied compared with the no amendment treatment three years after treatments were implemented (Figure 5). However, there were no significant differences in soil pH between deep lime and deep MgSi treatments at 10-20 or 20-30 cm. In the current study, the MgSi was blended with 30% of F70 lime to improve the efficiency of MgSi, and the neutralising value of the MgSi blend was assumed to be equivalent to F70 lime. There was no difference in soil pH between different ripping widths of 50 and 80 cm. As expected, deep placement of gypsum had no effect on soil acidity.

There was a significant difference in exchangeable Al% between treatments at 10-20 (P < 0.01) and 20-30 cm depths (P < 0.05) (Figure 6). The exchangeable Al% tended to be lower in the deep MgSi treatment compared with the deep lime treatment, but no significant difference was found between deep liming and deep MgSi treatments. Further research is required to explore whether MgSi is more efficient in decreasing Al toxicity than lime as claimed by Castro and Crusciol (2013).

Agronomic performance

There was a significant difference (P < 0.001) in seedling density for the canola crop in year 1, but not for wheat crops in years 2 and 3 (data not shown). In year 1, all ripped treatments had lower seedling densities, probably due to the uneven seedbed, or increased evaporation due to the ripping operation (Poile *et al.* 2012). There was a similar trend for seedling density in year 2, but not in year 3.

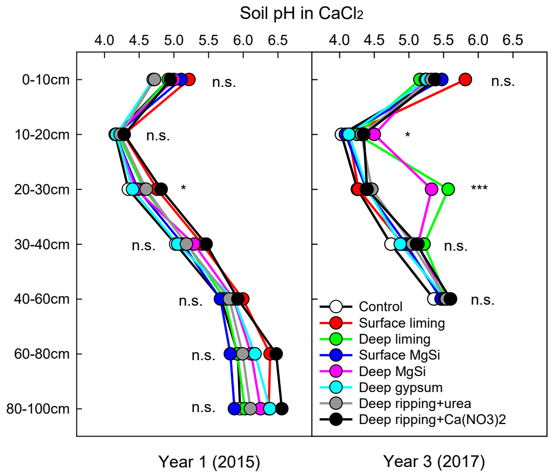

Figure 5. Soil pH in $CaCl_2$ under different soil amendments in autumn in years 1 and 3

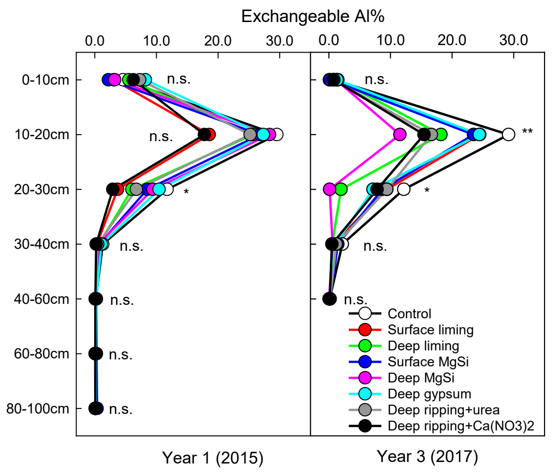

Figure 6. Soil exchangeable Al% under different soil amendments in autumn in years 1 and 3

At anthesis, all deep ripping treatments tended to have higher dry matter production for the canola crop in year 1 at $P = 0.06$, but there were no differences in anthesis DM of treatments for wheat crops in years 2 and 3 (data not shown). Canola yields from treatments including surface liming, surface MgSi and the control, had slightly, but significantly higher yield than those from deep lime, deep MgSi or deep gypsum treatments ($P < 0.05$, Figure 7). No difference was found in wheat grain yield in year 2, most likely due to ample in-crop rainfall in that year. The $Ca(NO_3)_2$ treatment in year 3 had a significantly higher yield than the other treatments and control (Figure 7), presumably due to less nitrogen volatilisation losses than would occur with urea application.

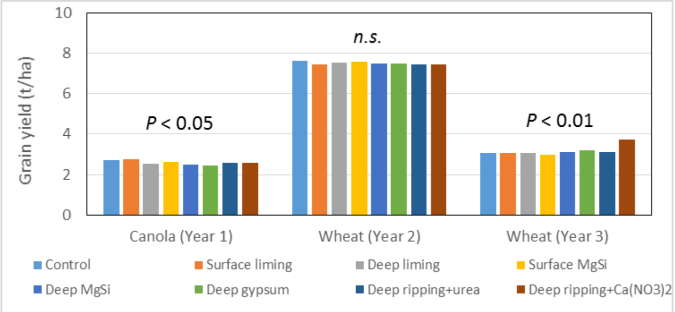

Figure 7. Grain yield (t/ha) in response to different soil amendments in years 1-3

Conclusions

The deep ripping operation had an adverse effect on canola establishment and grain yield in the establishment year, but no yield penalty was observed in the wheat crops in years 2 and 3. Deep placement of lime and MgSi increased soil pH and decreased exchangeable Al% significantly compared to the control at 20-30 cm, where the soil amendments were placed. Deep placement of gypsum had no effect on soil acidity or yield.

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