MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Evaluating rates of organic amendments with lime for treating acid soils

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The ameliorative effects of poultry litter, mature dairy compost, sheep manure and lucerne pellets on wheat growth in two acid soils were greater with increased application rate as expected, but their relative effectiveness with lime were not additive. Poultry litter was most effective.

Introduction

Subsoil acidity (pH<5.5 $CaCl_2$) limits agricultural production primarily via high aluminium (Al^{3+}) and manganese (Mn^{2+}) concentrations that are toxic to plants. Surface applied lime is limited in treating soil acidity at depth. Deep ripping to incorporate lime and other materials is expensive, hence cost-effective ameliorators and/or their combinations need to be identified. Using lower rates of amendments with lime could be beneficial to crop growth given combined amelioration and fertilisation effects. This study evaluated the effectiveness of different rates of four soil amendments with and without lime to alleviate subsoil acidity in a wheat crop.

Pot experiment

Soils were collected at 10-20 cm from a Dermosol from Kinglake West, Victoria and a Sodosol from Holbrook, New South Wales. The pH of the Dermosol was 4.1, with a pH buffer capacity (pHBC) of 86 $mmol_c/kg/pH$ and extractable Al^{3+} of 38 µg/g. The Sodosol had pH of 4.1, pHBC of 23 $mmol_c/kg/pH$, and extractable Al^{3+} of 9 µg/g.

Poultry litter, mature dairy compost (DC), sheep manure and lucerne pellets were used as organic amendments with C/N of 8, 10, 28 and 16, respectively. These organic amendments were identified as highly effective amendments. Each was dried at 70°C, chopped and ground to pass through a 2-mm sieve and added at rates of 2, 4, 8 and 16 g/kg soil (2.5, 5, 10 and 20 t/ha) either with lime (target pH 6) or without lime (nil). Soils received basal nutrients, were wetted to field capacity and pre-incubated for 6 weeks. Ten pre-germinated seeds of ES8 (Al-sensitive wheat genotype) were planted in each pot, and later thinned to 5 plants per pot. At 6 weeks after planting, shoots were cut off, roots extracted, and both washed and dried at 70°C. Soil from each pot was thoroughly mixed, subsampled and dried at 25°C. Soil pH and Al concentrations in 0.01 M $CaCl_2$ extracts (1:5) were determined.

Results

Root biomass increased with organic amendment addition rate and was the greatest for poultry litter and mature dairy compost (Figure 1). Lucerne pellets were also effective in the Sodosol (cropping soil) with lower pHBC and extractable Al. Shoot biomass showed similar patterns (data not shown). Lime had a dominant effect on soil pH as expected, but organic amendments had no effect on soil pH (Table 1). All organic amendments reduced the extractable Al (Figure 2) and Mn (data not shown) with greatest reduction from mature dairy compost and poultry litter. Lime reduced extractable Al below detection limits. Root biomass responses were not tightly linked with pH or Al as organic amendments have both amelioration and fertilisation effects.

Table 1 Soil pH$CaCl_2$ of Dermosol and Sodosol with four organic amendments (16 g/kg) and lime.

Organic Amendment (OA)	Dermosol		Sodosol	
	OA	OA + Lime	OA	OA + Lime
Poultry Litter	4.0	6.7	4.3	5.7
Mature DC	4.0	6.7	4.3	5.8
Sheep Manure	4.0	6.7	4.2	5.8
Lucerne Pellets	4.0	6.6	4.2	6.0
LSD *P*<0.05	0.3		0.5	

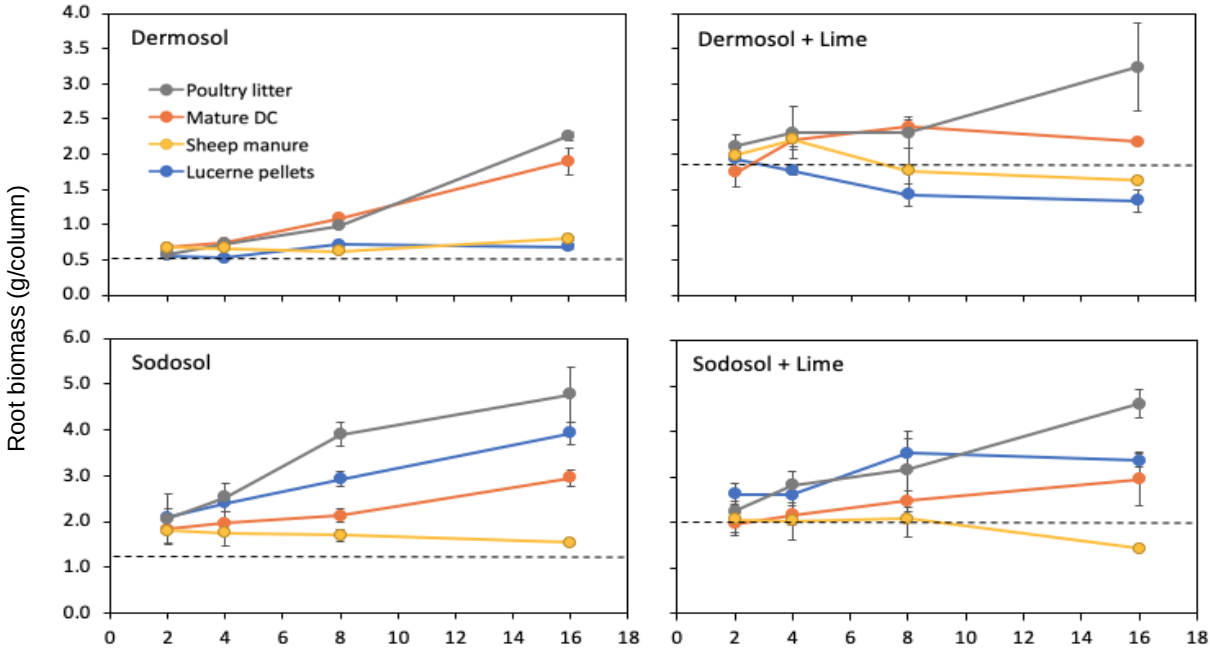

Figure 1 Root biomass of ES8 wheat after 6-week growth in Dermosol (top) and Sodosol (bottom) with four organic amendments at 2, 4, 8 and 16 g/kg (left) and combined with lime (right). Dashed lines show root biomass of non-amended soils (left) and those with lime (right).

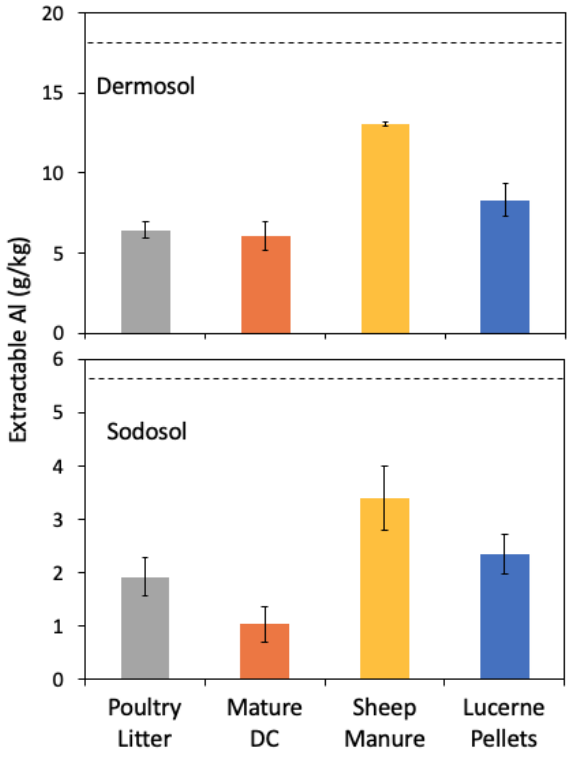

Figure 2. Extractable soil Al after 6-week growth of ES8 wheat in Dermosol (top) and Sodosol (bottom) with four organic amendments (no lime). Dashed lines show initial Al concentrations.

Key messages

- Effects of lime and organic amendments on wheat root growth were not additive.
- Using lower rates of organic amendments with lime is not likely to be effective and feasible.
- Organic amendments can effectively reduce the Al and Mn toxicity.
- N and/or P availability may have limited wheat growth with sheep manure and lucerne pellets.

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