MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

Charles Sturt University Component

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Charles Sturt University is one of the research partners in this major GRDC funded project, led by NSW Department of Primary Industries. This is an overview of the research by the Charles Sturt University team over four years.

Subsoil acidity issues

Crop production in southern New South Wales is strongly constrained by surface and subsoil acidity, which in many cases are a direct result of soil acidification brought about by agriculture.

Although Al and Mn toxicity are the major constraints in acid soils and can severely restrict plant growth, they are not the only ones (Table 1).

Acid soil sensitive plants, such as canola and barley, grown in soils where the subsurface and or the subsoil is acidic, develop small and shallow root systems (Figure 1). Such poorly developed root systems restrict access to moisture and nutrients, particularly nitrate, from the subsurface soil thereby severely reducing the yield potential of the plant.

Liming can easily ameliorate soil acidity by increasing soil pH, eliminating Al toxicity and possibly reducing Mn toxicity. However, the current practice of only liming the soil surface layer does not result in amelioration of subsurface acidity.

Lime will only ameliorate the pH in the soil layer in which it has been incorporated and therefore can eliminate acid soil related stresses in that layer only. Liming of the lower acidic layers is a slow process, requiring the repeated application of lime to the surface layer for the alkalinity to move down the soil profile and ameliorate the subsurface acid layer. Thus, the combined use of liming with acid soils tolerant cultivars would provide, in the interim, maximised crop growth.

Therefore, there is a need to find alternative agronomic approaches and amendments to ameliorate soil acidity that develops at depth.

Photo by Sergio Moroni

Figure 1. Differential response of Al tolerant (Dayton) and Al sensitive (Kearney) grown in limed (L, pH$_{CaCl_2}$ 5.7) and unlimed (U, pH$_{CaCl_2}$ 4.2) acid soil.

Table 1. Major constrains to plant growth under acid soils conditions

Decrease in		
metal cation concentration	⇨	Mg, Ca and K deficiency
P and Mo solubility		P and Mo deficiency
Inhibition of		
metal cation uptake	⇨	Mg, Ca and K deficiency
root growth		Reduced nutrient and water uptake
Increase in		
leaching	⇨	Nutrient deficiency
H^+ concentration		H^+ toxicity
Al^{3+} concentration		Al^{3+} toxicity
Mn^{2+} concentration		Mn^{2+} toxicity

Key research objectives

Over the duration of the project the Charles Sturt University team will conduct a major field experiment and a series of laboratory and controlled environment experiments to determine the following:

- What is the mechanism by which selected organic and/or inorganic amendments ameliorate an acid soil?
- What is the level of tolerance to soil acidity among cereals, canola and pulses varieties currently available in the market?
- What is the interaction between crop and acid soil and soil amendments?

Lab/glasshouse experiments

- Quantifying responses of crop varieties in acid soils
- Quantifying the effectiveness of amendments in PVC columns with stratified acid soils layers
- Quantifying the crops and soil amendment interactions in acid soils

Field experiment

A subsoil acidic site at Rutherglen will be used to quantify the ameliorative effect of lime, lucerne pellets, rock phosphate and magnesium silicate in the subsoil on crop performance and soil improvement.

Table 2. Soil treatments at the Rutherglen field site

ID	Treatment	Description
1	Nil amendment	Control, no amendment
2	Rip only	Ripping to 30cm
3	Surface liming	Surface liming to pH5.5
4	Surface liming	Surface liming to pH5.0
5	Deep liming	Deep liming to pH5.0 to 30cm
6	Deep dlomite	Deep dolomite to pH5.0 to 30cm
7	Deep MgSi (High)	Deep MgSi at 8 t/ha
8	Deep MgSi (low)	Deep MgSi at 4 t/ha
9	Deep RPR (High)	Deep phosphate rock at 8 t/ha
10	Deep RPR (low)	Deep phosphate rock at 4 t/ha
11	Deep phosphorus	Deep P at 15 kg/ha
12	Deep lime+P	Deep liming + P at 15 kg/ha
13	Deep lucerne pellet1	Deep lucerne pellet at 15 t/ha
14	Deep lucerne pellet2	Deep lucerne pellet at 7.5 t/ha

Photo by Sergio Moroni

Figure 2. Pot experiment at the glasshouse facilities at Charles Sturt University

Photo by Sergio Moroni

Figure 3. Canola crop at the Rutherglen field site

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