Effect of subsoil acidity treatments on the chemical properties of a ferrosol

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Abstract

Several options for ameliorating subsoil acidity were investigated in a field trial on a Ferrosol in the South Burnett region of Queensland. Lime inversion and surface applications of gypsum had significant effects on the chemical properties of the soil to a depth of 50 cm. Plant growth, grain yield and water extraction of three crops were unaffected by these changes indicating that depth of amelioration may have been insufficient to increase the crop rooting depth.

Keywords: Ferrosol, subsoil acidity, lime, gypsum, inversion ploughing, pH, cations

Significant acidification rates have been reported in Ferrosols under agricultural production in Queensland (1). Of particular concern is the degree of subsoil acidification which has the potential to restrict the effective rooting depth of plants, and limit their access to water and nutrients during drought periods. Various methods of ameliorating subsoil acidity have been attempted worldwide with mixed results (2, 3, 4). The aim of this work was to identify a practical method of subsoil amelioration suited to the summer legume/cereal based farming systems of the South Burnett region of Queensland.

Methods

A field experiment was established near Kingaroy in October, 1995, on a Red Ferrosol with significant subsoil acidification (pH(water)= 5.00 at 30-50 cm). Treatments are outlined in Table 1. Surface treatments were hand-spread, deep ripping treatments were applied with a prototype pnuematic lime applicator and inversion treatments included a ?square? ploughing operation.

Table 1. Treatments included in the field experiment evaluating options for the amelioration of subsoil acidity in Ferrosols.

Treatment	Abbreviation
Normal farmer practice of 1 t/ha lime applied to soil surface	FP
10 t/ha gypsum applied to soil surface	G10
Inversion ploughing operation	TIP
3 t/ha lime to surface, inversion ploughed, 1 t/ha to new surface	L3TIPL1
3 t/ha lime applied with a deep ripping tyne at 27 cm depth	RIPL3

Peanuts (cv. Virginia Bunch) were grown during summer 1995-96, followed by winter barley and a no-till crop of maize (cv. Pioneer C76) in 1996-97. Soil samples were collected from each plot in October, 1995, immediately prior to the application of treatments, and again in October, 1996. During this period 1077 mm of rainfall was recorded. At each sampling date five cores, separated into several depth increments, were taken from each plot and bulked. pH was measured on a 1:5 soil:water extract. Cations were extracted using 1M NH4Cl. ECEC was calculated from the sum of basic cations (Ca, Mg, K and Na). Significance was determined using standard analysis of variance techniques.

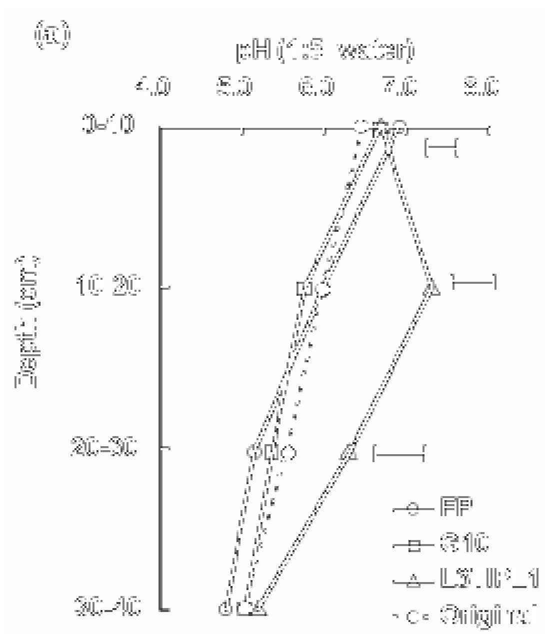
Results and discussion

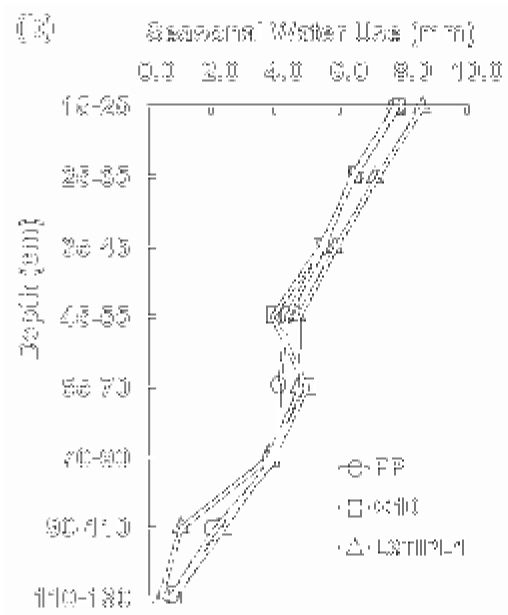
Treatments G10 and L3TIPL1 had the largest effect on soil chemical properties. The effect of treatments on soil pH is compared with normal farmer practice in Fig. 1a. FP had a small but significant (P<0.05) effect on pH in only the cultivated layer (0-10 cm), while gypsum application did not affect measured pH. The inversion of lime caused a large increase in pH, particularly at the 10-20 cm depth, however, there was no effect below 50 cm. ECEC response to the treatments was similar to that expressed by soil pH, as expected in a soil dominated by variable charge such as a Ferrosol (5). In the case of the L3TIPL1 treatment, the increase in ECEC was accounted for by exchangeable Ca.

Lime inversion caused a reduction in exchangeable K levels in the surface 10 cm only, while gypsum application did not affect exchangeable K. In contrast, surface gypsum application caused a 60% reduction in exchangeable Mg in the top 20 cm of the profile, presumably by replacement with Ca. Some of this Mg was captured by the soil?s exchange complex deeper in the profile (>30 cm depth). Exchangeable Mg was not affected by lime inversion.

Despite considerable changes in soil chemical properties measured after the first year, there were no associated responses in dry matter production, crop water use or grain yield by crops of peanut, corn or barley. Treatments had no effect on soil properties below 50 cm, and in the majority of cases below 30 cm. Since most annual crops have a rooting depth of more than 100 cm, the volume of soil which has been affected by treatments may be insufficient to improve crop root exploration. This is supported by water use data collected from the site which showed no significant differences between treatments (Fig. 1b).

Figure 1: The effect of treatments on a) soil pH(1:5 water) and b) water use for 1996/97 corn crop. Horizontal bars represent least significant differences (P<0.05).





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