Department of Primary Industries

GRDC
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MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

# Amelioration of subsoil acidity by placing organic amendments at different depths

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## Introduction

Acidic soils often reduce crop productivity, particularly in dry conditions. Soil acidity often occurs below the easily amended surface layer. It is difficult to amend acidity in subsoil with lime, due to low solubility of lime and slow vertical movement in the soil profile.

Deep ripping with lime incorporation can address subsoil acidity. However, this method may result in bands of ameliorated soil, where its effect will be confined to ripping slots due to negligible lateral movement of the lime. Furthermore, deep ripping may result in poor plant establishment associated with an uneven seed bed.

Applying lime together with alternative inorganic and organic amendments has been suggested for addressing subsoil acidity, but many of those products have yet to be properly evaluated for implementation in broad-acre agriculture.

## Materials and methods

A pot experiment was conducted to determine the effectiveness of lime, gypsum, magnesium silicate, calcium nitrate and finely ground dry lucerne pellets as organic amendment (OA). Only lime and OA effects were reported here. The soil ameliorants were incorporated into 0-10, 10-20, 20-30 cm soil depths in reconstructed soil columns. The soil was a Yellow Chromosol and collected from Holbrook at 0-10, 10-20, 20-30 and 30-40 cm as the 1st to 4th layer respectively.

Each of the top 3 soil layers were individually mixed with either lime or other amendments to achieve a target pH of 5.0 in $CaCl_2$. The 4th soil layer was not amended. The 4 layers (with or without amendment) of soil were then repacked in 10 x 50 cm PVC pots, with a sealed bottom, maintaining the order and 10 cm thickness of each layer, except for the 30-40 cm layer which in the pots occupied the last 17 cm of the pot. The amended soil layers were arranged in 8 different configurations (Table 1), including a control without any amendment in any of the layers.

Prior to sowing, the pots were watered to 100% field capacity (FC) and then watered to 80% FC through the duration of the experiment every 2-3 days. An acid-sensitive wheat (cv. Axe) was grown under glasshouse conditions with 13 hrs day length. The pots were fertigated with sufficient nutrient supply to not limit growth.

The shoots were harvested 31 days after sowing and the pots stored at 4ºC for 3-5 days for soil sampling and root washing. Plant shoot and roots were dried (65ºC) to determine dry mass per pot and in each layer, respectively. Two soil cores per soil layer were taken perpendicular to the soil column for determining soil chemical characteristics.

## Results

Lime increased soil pH only in the depth of placement ($P < 0.05$, Table 1), whereas OA increased soil pH also in the layers below its incorporation, including the 30-40 cm layer (Table 1). There was no effect above the incorporation layer which may have occurred due to capillary rise. The greater the number of layers into which OA was incorporated, the greater was the effect upon pH in lower unamended layers.

Both shoot and root biomass were not significantly improved regardless of the kind of amendment or its placement in the soil profile, even though the wheat cultivar Axe is sensitive to soil acidity. This is not surprising, however, since in a reconstructed multi-soil layered pot experiment of this duration it is possible for the roots to tend to accumulate on the side and bottom of the pots resulting in a diminishing contact with the soil. Furthermore, and more importantly, water and nutrients were non-limiting and thus it would have reduced the intrinsic effect of the stresses (i.e. pH, Al) on plant growth.

Results showed that OA resulted in a significant reduction of shoot and total root growth ($P<0.05$) compared to the lime treatment and this effect was exacerbated if OA was placed in the topsoil layers. The fine lucerne particle size and high rate of application resulted in visual discoloration of the soil layers where incorporated and it was probable that reduced (anaerobic) conditions were created. This would have contributed significantly to the lower performance of plant growth even though the pH was significantly increased with a concomitant lowering of available Al.

**Table 1: Effect of placement of lime and organic amendment (OA) on pH in $CaCl_2$ of soil layers of reconstructed soil columns of acidic soil 31 days after sowing. Colours indicate relative intensity of pH in each layer: Red = <4.2, Orange = 4.2-4.5, Yellow = 4.5-5.0, Green = >5.0.**

| Soil | Control | 1st layer | | 2nd layer | | 3rd layer | | 1st & 2nd layers | | 1st & 3rd layers | | 2nd & 3rd layers | | 1st, 2nd, 3rd layers | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| layer | None | Lime | OA | Lime | AO | Lime | OA | Lime | OA | Lime | OA | Lime | OA | Lime | OA |
| 1st | 4.6 | 5.2* | 5.1* | 4.6 | 4.6 | 4.6 | 4.6 | 5.1* | 5.5* | 5.1* | 5.2* | 4.6 | 4.6 | 5.2* | 5.5* |
| 2nd | 4.2 | 4.2 | 4.5* | 5.4* | 5.5* | 4.2 | 4.2 | 5.4* | 5.7* | 4.2 | 4.8* | 5.4* | 5.7* | 5.4* | 5.8* |
| 3rd | 4.2 | 4.2 | 4.4 | 4.2 | 4.5* | 4.7* | 5.4* | 4.2 | 4.9* | 4.6* | 6.0* | 4.7* | 6.0* | 4.7* | 6.2* |
| 4th | 4.4 | 4.4 | 4.6* | 4.4 | 4.6* | 4.4 | 4.6 | 4.4 | 4.9* | 4.4 | 4.9* | 4.4 | 4.9* | 4.5 | 5.5* |

* indicates significant differences (LSD = 0.196, at $P < 0.05$) of a pair-wise means comparison of the pH between the layer of the control pot (unamended layers pot) and the corresponding layer of the amended pots. This LSD value is a conservative statistic for pair-wise means comparisons across soil layers and treatment combinations.

## Conclusions

The incorporation of the fine ground lucerne hay pellets in the layer above the acidic layer or incorporated in the acidic layer itself was effective in amending the pH of the relevant subsurface acidic layer. However, the possible anaerobic conditions resulting from the addition of the organic amendment may have restricted the root growth, hence negative plant response to organic amendment.

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