MANAGING SUBSOIL ACIDITY (GRDC DAN00206)

# Alkalinity movement with different lucerne pellet sizes in an acidic subsoil

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Lucerne pellets increased soil pH at depths below their placement in a pot experiment, but lime did not. When the organic amendment was applied in combination with lime, alkalinity moved downward further and increased pH at lower depths.

## Introduction

Soil acidity is a major agricultural degradation problem around the world due to the toxic effects of aluminium ($Al^{3+}$) and/or manganese ($Mn^{2+}$), and/or nutrient deficiency on crop growth. Raising soil pH is the most common strategy to improve the productive potential of acidic soils.

It is relatively easy to increase pH in the surface soil (0-10cm) by applying soil amendments such as lime or dolomite. However, acidity in the subsoil (below 10cm) is more difficult to correct due to the relatively low solubility of liming materials and the slow movement of alkalinity down the soil profile. Some organic materials can ameliorate subsoil acidity as they increase soil pH at the depth of placement and beyond due to the movement of alkaline compounds. For this study it was hypothesised that a) the particle size of lucerne pellet affects the movement of alkalinity, and b) it is the soluble organic compounds that moves below the depth of placement and increases soil pH.

## Soil and amendments

The soil from 0-40cm was collected at 10cm increments from the long-term field site at Dirnaseer, west of Cootamundra, NSW (34°38'S, 147°49'E). The soil pH was 4.82, 4.18, 4.12 and 4.62 in $CaCl_2$ in the 0-10, 10-20, 20-30 and 30-40cm layers, respectively. The soil was sieved through a 9.5mm sieve, mixed and air-dried. Lucerne pellets with different sizes (LP1: ~20 mm, LP2: ~10 mm, LP3: ~5 mm and LP4: 1-2 mm) (Figure 1) were applied with and without addition of lime.

## Pot construction

A PVC pipe (10cm in diameter and 50cm in length) was used as pot, capped at one end. A plastic lining (9.8cm in diameter, sealed in one end) was inserted in the PVC pipe to prevent drainage. The soil profile was re-constructed by filling each pot with the corresponding soil layers to obtain 47cm soil column, every 10cm for 0-30cm, and 17cm for 30-40cm. Lime was fully mixed at a rate of 1.25 t/ha with surface soil at 0-10cm while lucerne pellets was mixed with soil at 0-5cm at 15 t/ha. Small white plastic beads were placed around the edge of each soil layer for the depth control at soil sampling.

The moderately acidic soil tolerant wheat (*Triticum aestivum*) cultivar Dart was used as the test plant. Seven seeds were sown and seedlings were thinned to 4 plants per pot 4 days after sowing. Pots were watered to field capacity every 2-3 days. Base fertiliser solution was applied every 7 days. The pots were placed in a climate controlled glasshouse (24.8/33.4±0.1°C night/day).

## Experimental design

The experiment was a randomized complete block design with 10 treatments: Control (Nil), lime (L), LP1, LP2, LP3, LP4, L+LP1, L+LP2, L+LP3 and L+LP4, replicated 4 time with 4 sampling times.

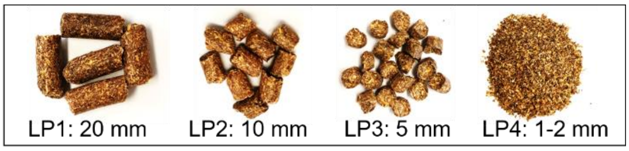


**Figure 1. Lucerne pellets with different sizes.**

Pots were destructively harvested at 14, 21, 28 and 35 days after sowing. Shoot and root dry weights were measured at each sampling time. Soil samples were collected at depths of 2.5, 7.5, 11.0, 13.0, 17.5, 22.5, 27.5, 32.5 and 40.0cm with a soil corer (2cm in diameter), oven-dried at 40°C for 72 hrs, ground and sieved through 2mm sieve for pH measurement in 1:5 0.01M $CaCl_2$.

Analysis of variance was conducted using GenStat Release 18.1. The least significant difference at $P \leq 0.05$ was computed and used for comparing the means of treatments.

## Results and discussion

At the first two sampling times, the addition of lucerne pellets had a negative effect on plant growth (Figure 2). Shoot and root dry weight of plants were significantly lower soils treated with lucerne pellets compared to the control soil up to 28 days after sowing. The LP4 treatment had the least root growth at all depths. At the final harvest (35 DAS), however, plants grown in L+LP3 treatment had the highest shoot and root dry weights.

Lucerne pellets increased soil pH at all sampling times, not only at the layer of placement, but also at the soil layers beneath. In contrast, lime only affected soil pH at the layer of placement. The combination of lime and lucerne pellets increased soil pH more than that of lucerne pellets alone at all depths (Figure 3).

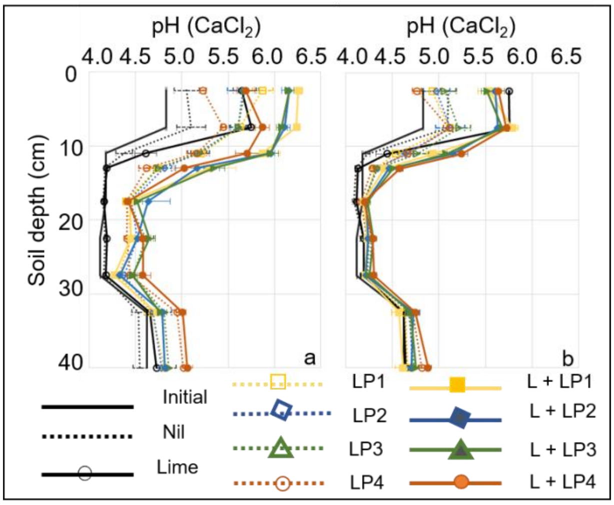


**Figure 3. Soil pH changes throughout soil column sampled a) 14 and b) 35 days after sowing.**

The finer the particle size of lucerne pellets, the greater was the increase in soil pH at depths. However, lucerne pellets with the finest particle (1-2mm) had a negative effect on root growth.

This result indicated that when lime and organic materials were applied together, lime alleviated acidity at the amended layer allowing highly soluble alkalis from the organic matter to move down the soil profile and increase soil pH at all sampled depths.

## Conclusions

Lucerne pellets increased soil pH at layers below their placement, but lime did not. When the organic amendment was applied in combination with lime, it allowed alkalis to move downwards and thus increased pH at depths. We concluded that the incorporation of lime with lucerne pellets with size ~5 mm was the best amelioration strategy to increase subsoil pH from 10-30cm of the soil profile and improve plant growth.

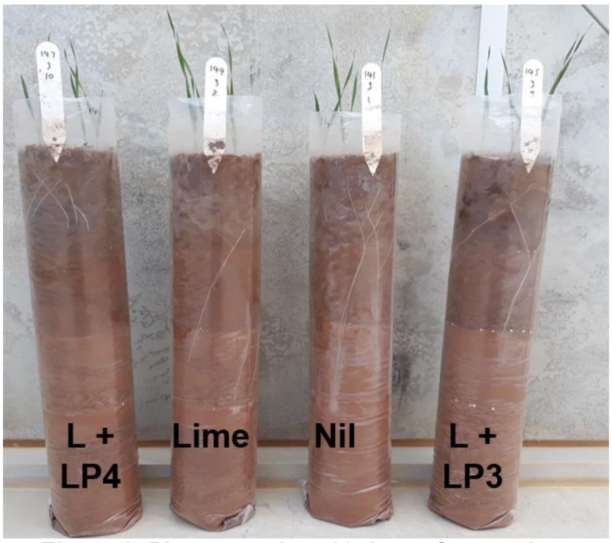


**Figure 2. Plant growth at 10 days after sowing.**

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