FutureSOILS

Soil acidity and declining soil organic carbon (SOC) affect more than half of the agricultural soils of southern and central NSW, and threaten the viability and resilience of farming systems.

Liming practices of recent decades have often been ineffective in managing soil acidity. Low lime rates and poor incorporation has increased pH in the 0-5 cm shallow surface soil layer, but the soil below continued to acidify, affecting plant performance.

Field research conducted by NSW DPI has indicated that maintaining the 0-10 cm soil above pH_{Ca}>5.5 enables gradual removal of acidity in layers below 10 cm.

- What are the most effective methods to increase soil pH to the desired targets or prevent soil acidification?
- How important is incorporation for effective acid soil management?

The FutureSOILS project aims to answer those questions for growers and build new online tools to help growers make decisions about lime application.

The project is funded by the Australian Government's National Landcare Program; the work is a collaboration between NSW DPI, the Australian National University, FarmLink, Holbrook Landcare Network, Central West Farming Systems and Incitec Pivot Ltd. Three farmers from Burrumbuttock, Grenfell and Trundle are also involved.

Burrumbuttock field trial

The trial was established in 2020. The following treatments were applied to achieve specified soil pH targets:

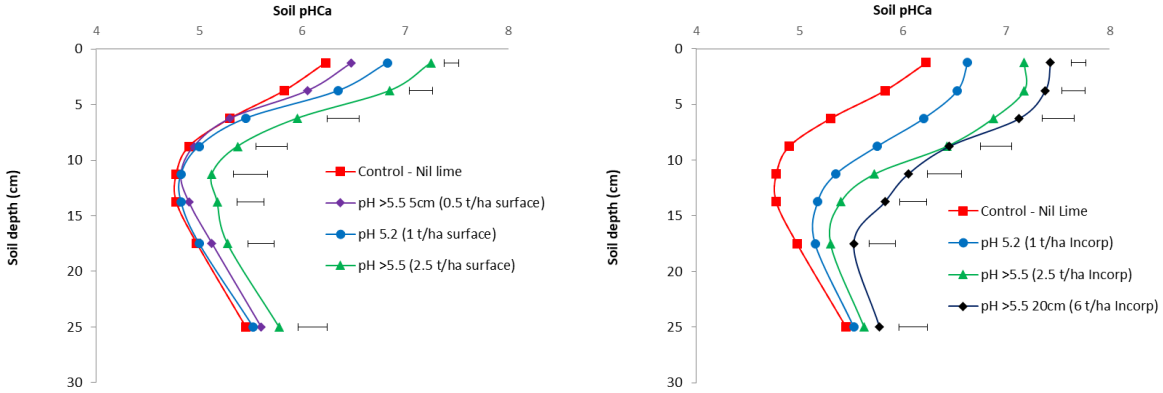
Treatment pH target	**Lime rate (t/ha)**	**Application detail**
control	0	untreated soil
pH 5.2 surface	1	lime applied to the surface at rate of 1t/ha which theoretically would raise the pH of the 0-10 cm to pH 5.2. To be surface re-limed once pH drops to below pH 5.0 in the 0-10 cm layer; representing historic liming practice.
pH 5.2 incorporated	1	as above but incorporated with a scarifier to a depth of 10 cm.
pH >5.5 surface	2.5	lime applied to the surface at a rate of 2.5 t/ha which should raise the soil pH of the 0-10 cm to pH 5.9. To be surface re-limed once pH 0-10 cm drops to pH 5.5.
pH >5.5 incorporated	2.5	as above but incorporated with a scarifier to a depth of 10 cm
pH >5.5 in surface 0-5 cm	0.5	lime applied to the surface at a rate of 0.5 t/ha which should raise only the soil pH of the 0-5 cm to pH 5.9. To be surface re-limed once pH 0-5 cm drops to pH 5.5.
pH >5.5 in 0-20 cm incorporated	6	lime applied to the surface at a rate of 6 t/ha and incorporated with scarifier to 10 cm which should raise the soil pH of the 0-20 cm to pH 5.9. To be surface re-limed once pH 0-10 cm drops to pH 5.5.

Results

The soil pH profiles from 2023 sampling (3 years post-lime application) are shown below.

In the surface applied lime treatments (left graph), the higher lime rate treatment (2.5 t/ha) significantly increased in pH compared to the control, to a depth of 20cm. Whereas, the two lower lime rate treatments (0.5 t/ha and 1 t/ha) significantly increased pH in the top 5cm only.

In the incorporated lime treatments (right graph), there was a significant increase in pH for all treatments compared to the control, to a depth of 20cm (except for the 1 t/ha treatment which significantly increased to a depth of 15cm only). The difference between the two higher lime rates (2.5 t/ha and 6 t/ha) was not statistically significant below the top 2.5cm.



The soil profiles for pH_{Ca} at the Burrumbuttock site, sampled March 2023 (36 months post liming). Horizontal bars represent l.s.d. (P<0.05).

Last year (2022), stunted canola plants with poor root development, lower emergence counts and lower biomass were found in the higher lime rate treatments. Plant tissue analysis identified Molybdenum (Mo) at toxic levels. The trial site paddock has a history of Mo application with the last application in 2018 at 120g/ha. There was, however, no significant effect on canola yield and seed quality.

This year (2023), there was no observed differences in wheat growth between all the treatments. Molybdenum toxicity is not expected in cereals and grasses, only broadleaf crops.

Summary

- Lower rates of surface applied lime have had little effect on subsurface layers in the short-term (3 years post-lime application).
- Incorporated lime has increased pH in the subsurface down to approximately 20cm.
- Molybdenum (Mo) toxicity which occurred in the canola in 2022 has not presented in the wheat this year (as expected).
- Avoid high lime rates in paddocks with a history of Mo application.
- If pH is above 5 then Mo application is not required.