Assessment of soil tests for aluminium toxicity in sub. clover

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Soil acidification under legume based pastures in Australia is recognised as a widespread problem. Adding lime to raise the pH is expensive and adding too much or too little could reduce already slim profit margins. Where Mn toxicity is absent, some measure of toxic Al may predict lime requirements more accurately than pH measurements alone. Because Al can form soluble nonphytotoxic complexes (1) such a test must distinguish these from toxic forms of Al, especially in topsoils where complexing ligands are more prevalent than in subsoils.

Methods

In a glasshouse pot trial Trifolium subterraneum cv. "Mt Barker" was grown with rhizobium inoculant or NH4NO3 in three poorly buffered top-soils with 8 pH treatments ranging from approximately pH 4 to pH 7 (1:5 0.01M $CaCl_2$). The soils had an unamended pH of between 4.4 and 4.7 and differed in P-responsiveness and organic matter content. P rates were selected to produce 90% maximum growth in order to miniminse the ameliorating effects of P on any Al toxicity. Toxic aluminium was estimated by the 15 s 8-hydroxyquinoline (8-HQ) Method (2) in centrifuged soil solutions (3) and 1:5 extracts in 0.01M $CaCl_2$ and in centrifuged soil solutions with a cation exchange resin (4).

Results and discussion

In all soils acidification reduced top dry weights with each N-source and early nodulation in the inoculated treatments. With the addition of lime plant growth increased most in the P-responsive soils whereas nodulation increased independently of P status up to pH 4.6. The concentration of total and 8-HQ Al in both types of extract increased exponentially as the pH decreased in all soils but the proportion of 8-HQ Al was greatest in the soil with the lowest organic matter content.

8-HQ Al in both types of extract was a better predictor of plant growth than total and resin exchanged Al or pH, but there was less difference between the soil tests for predicting early nodulation. Prediction of yield improved when each soil was considered separately and over all soils when the concentration of 8-HQ Al in the soil solution was multiplied by the phosphorus retention index (PRI) of each soil. However, although the concentration of P in the plant tops from the P responsive soils decreased as the pH decreased, it did not fall below the critical concentration of 0.15% w/w (5). It appears that the 8-HQ Method can distinguish phytotoxic forms of aluminium in the presence of organic matter but is less affected by differences in P concentration. Prediction models for Al toxicity may therefore need to account for the availablity of factors known to modify Al toxicity and which do not directly affect the test for phytotoxic Al.

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