Responses to lime by cereals

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In 1981 a field experiment was sown on an acid soil to examine the usefulness of plant aluminium tolerance in the field, and its relationship to lime application.

Methods

The site, 25 km east of Wagga, was a yellow podsolic soil (Dy 3.41; Ref (1)) and in the previous season wheat had leaf yellowing symptoms and yielded poorly. Soil tests at Biological and Chemical Institute Rydalmere showed an acid surface soil (0 to 10 cm, pH 3.9 in $CaCl_2$) with high exchangeable aluminium (35% saturation). The acidity and high exchangeable aluminium were noted to exist between the 10 cm depth and the less acid, non-aluminium toxic subsoil at 30 to 60 cm depth.

The cereal varieties and their reaction to aluminium in solution culture were Egret wheat and Clipper barley, aluminium-sensitive; Olympic wheat moderately tolerant; and Satu and Tyalla triticale, aluminium-tolerant. A fine grade of lime was applied and incorporated (0 to 10 cm approx.) seven weeks before a late June sowing.

Results and Discussion

All cereals responded to lime application with increased dry matter production and grain yield. The aluminium-sensitive varieties (Egret and Clipper) practically failed to produce grain (35 kg ha^{-1}) when lime was not applied and gave low grain yields (520 kg ha^{-1}) with the highest lime rate of 5 tonnes ha^{-1}. The tolerant varieties yielded 445 kg ha^{-1} of grain with no lime and 1220 kg ha^{-1} at the high lime rate.

The advantage that plant tolerance of aluminium conferred when high rates of lime were applied may have been due to incomplete lime reaction by sowing, but was probably the result of high exchangeable aluminium still present in the soil below 10 cm and above the subsoil.

My experience at this site and that of others in New South Wales (A.D. Doyle, Tamworth and C.L. Mullens, Dubbo) would suggest that on soils where aluminium toxicity extends below 10 cm depth (the normal level of lime incorporation in the wheatbelt) aluminium-sensitive varieties and crops may not be able to be grown successfully even with high rates of lime applied. This is contrary to earlier recommendations (2),where liming to reduce exchangeable aluminium to low levels in the surface soil was considered adequate amelioration for the growth of aluminium-sensitive species like barley and lucerne. It is clear that aluminium toxicity down the soil profile would need to be considered. Tolerant varieties have a grain yield advantage in soils with high exchangeable aluminium below 10 cm and respond to lime application.

Research in this project on plant tolerance to aluminium and the role of lime application will continue. Emphasis on tolerance will be on the screening, in solution culture and field, of lines bred by J.A. Fisher (Wagga) in a project aimed at breeding an Egret wheat with aluminium tolerance. Lime use on cereals on a range of acid soils will be investigated, as well as the residual value of lime applications. The effect of lime on a first cereal crop in a cropping phase combined with its residual value to subsequent crops may economically justify the use of lime on acid soils in the wheatbelt.

As the soils studied in this project are low in magnesium, the possibility of magnesium deficiency induced by lime application will be investigated.

1. Northcote, K.H. 1966. Atlas of Australian Soils Sheet 3. CSIRO Melbourne University Press.

2. Cregan, P.D. 1980. Agbulletin 7. New South Wales Department of Agriculture.