Root growth in soils rendered acid by improved pastures

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Gradual acidification under improved pastures has been estimated to reduce soil pH by one unit after 30 to 100 years, and may extend to a depth of 60 cm (1). The effects of the Al and Mn toxicities associated with the acidity may limit crop yields, though their effects are less obvious on established pastures. Even when the surface acidity has been corrected by liming, the underlying horizons can remain toxic (2). Root growth of several crops, and the effects of lime, were examined in reconstituted profiles from three sites of differing histories formed on granites near Crookwell, N.S.W.

Materials and Treatments

Table 1. Histories and pH 5 (1:5 water) of soil profiles

Depth (cm)	5	15	25	35	45	55
Unimproved soil (A)	5.9	6.0	6.2	6.5	6.7	6.7
27 year-old improved pasture (B)	5.7	5.6	5.8	5.9	6.2	6.4
55 year-old improved pasture (C)	4.9	4.9	5.0	5.1	5.4	5.7

Treatments of the profiles were (1) unlimed (2) top 10 cm limed to pH 6.5, remainder unlimed (3) top 10 cm limed to pH 6.5, remainder limed to pH 6. Profiles were sown to Triticum aestivum, cv. Songlen or cv. Condor, Brassica napus cv. Wesway, Medicago sativa cv. Siriver, or Phalaris aquatica cv. Seedmaster. Root lengths and shoot weights were determined on 10 cm depth sections after 11, 12, 14, 17 and 18 weeks respectively.

Results and Discussion

Liming Soil A had no effect, and in Soil B effects were small except on lucerne. However, in Soil C effects on root penetration of wheat and lucerne were soon obvious. After 5 weeks, Condor roots had reached c 35cm depth without subsoil lime, but had reached 60 cm in fully-limed profiles. Root penetration of Songlen was not so severely retarded. At harvest, shoot weight increases of 50% for Condor and 30% for Songlen followed addition of lime throughout the profile. Effects on root length were greater, but disappeared below 40 cm. The effects of lime on Phalaris were smaller, but effects on lucerne larger, than those on wheat. For lucerne in Soil C there was a 3-fold increase in shoot weight with surface lime, and a 5-fold increase with lime throughout the profile. The effects on root length increased with depth to 10-fold at 55 cm depth. Shoot weight of rape, and root length below 20 cm, were diminished by lime in Soil B, but increased in Soil C.

The effects observed require elucidation before cropping these soils. Chemical analyses of plants and soils indicate that toxicities of both Al and Mn are involved, and that the complex effects on root growth at any soil depth depend on the sensitivity of each species to the two elements individually or in combination. Thus, the wheat cultivars were susceptible to Al, but lucerne and rape were affected by both elements, while Phalaris was largely unaffected by either. The addition of lime reduced Al and Mn uptake from Soil C. Phalaris tolerated concentrations of Mn affecting rape and lucerne. The deleterious effects of Al and Mn are likely to become obvious on resowing or cropping old pastures. The immediate effects on root penetration indicate that wheat would be susceptible to a dry period during establishment. The poor root growth of lucerne in Soils B and C indicates that not only would it be susceptible to drought, but that satisfactory yields could only be achieved when surface-applied lime had, after many years, raised the pH of the lower layers of the profile.

1. Williams, C.H. 1980. Aust. J. Exp. Agric. Anim. Husb. 20: 561-567.

2. Simpson, J.R., Pinkerton, A., and Lazdovskis, J. 1979. Aust. *J.* Agric. Res. 30: 609-19.