Subsurface acid throttles and canola growth

John Angus, Tony Swan and John Kirkegaard, CSIRO Plant Industry
Email: John.Angus@csiro.au

Key messages

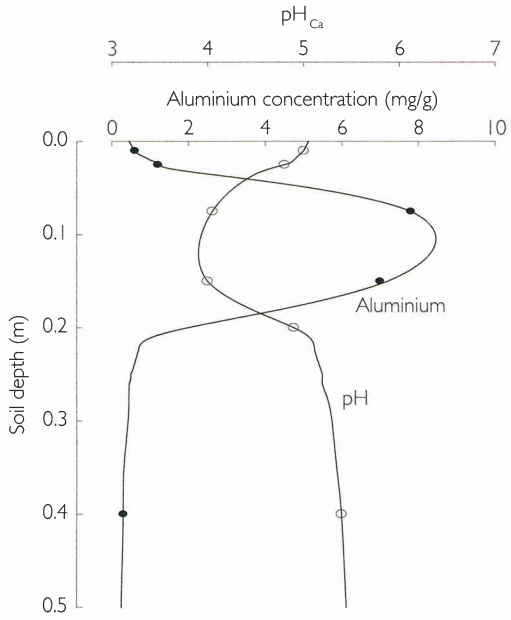
- Many soils in the Harden area have an acid throttle, consisting of a layer of low pH and high aluminium sandwiched between a limed surface and a naturally neutral subsoil.
- A single application of surface-applied lime does not ameliorate an acid throttle and prolonged liming will be needed to overcome the problem.
- Injecting lime into subsurface soil neutralised the acid layer but did not increase canola growth.

Background

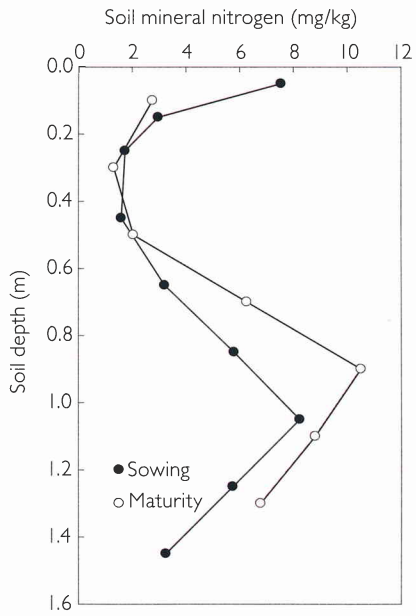
Many light-textured red soils in south-eastern Australia have become very acid and the granite soils of the Harden district are among the most severely affected. The acidification is severe because of their low buffering capacity and the long history of pasture improvement. Lime has been applied to many paddocks in the district since the 1980s and has led to increased growth of crops and pastures. Lime has not affected the pH of the subsurface layers because, at the prevailing application rates, virtually all of the applied lime reacts with the surface acidity and none is left over to neutralise the subsoil. Many Harden soils have an 'acid throttle' at a depth of about 10-20 cm where the pH (in calcium chloride) is 4.0-4.2. Soil deeper than 20 cm typically has pHCa greater than 6.0, which is probably unchanged since the land was cleared for farming. Figure 1 shows an example of an acid throttle in a soil in the Harden district in 1989. Studies on acid subsurface soils in the Harden and surrounding districts have focussed on their possible effects on the environment and on the growth and yield of canola, the most common acid-sensitive crop in the farming system.

Mineral N in acid soils

Figure 2 shows profiles of mineral nitrogen below in a soil with acid throttle during growth of a wheat crop. Soil mineral nitrogen was present as a bulge at a depth of about 1 m and actually accumulated during crop growth rather than decreasing as is normal. In non-acid soils the soil mineral N at maturity is generally less than the amount shown in Figure 2 (124 kg/ha). It is likely that the mineral N accumulated over a period of several years during growth of crops and pastures that were not acid tolerant. Accumulating mineral N is a risk for further acidification and leaching into groundwater.



> Figure 1. Example of the profiles of pH and aluminium concentration in a Harden soil with an acid throttle.



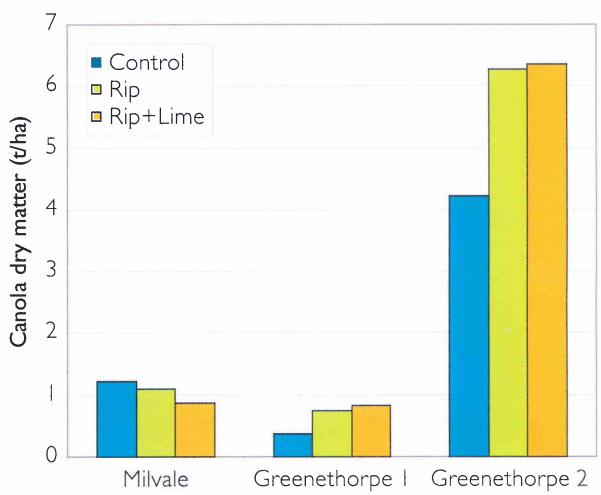
> Figure 2. Profile of mineral N at the times of sowing and maturity.

> Figure 3. Implement that injects dry lime into the subsurface behind ripper tines (courtesy of Farmlink and Yeomans Plow).

Liming the acid subsurface

Since canola is the most acid-sensitive crop in the farming system of the region, we investigated the effect of injecting lime into an acid subsurface soil, using the implement shown in Figure 3. This implement blows dry lime through tubes mounted behind tines that rip the soil to a depth of about 35 cm and significantly increases subsurface pH. Three experiments were conducted in dry seasons when no canola seed was harvested, so the results refer to growth of canola dry matter before the appearance of stress. Figure 4 shows no increase in growth in response to injecting lime into the subsurface.

One explanation is that canola roots were able to push through the acid subsurface and reach the neutral subsoil without damage. An alternative explanation is that manganese, which restricts canola roots more than aluminium, was not present in the subsurface at a sufficient level to reduce canola growth. From these data it appears that canola can tolerate an acid subsurface, provided the surface is limed. This is reassuring for canola production but is a matter of concern for natural resource management. We don't yet know whether other species are as tolerant to acid throttles as canola and we recommend continued surface liming to prevent further development of acid throttles.



> Figure 4. Injecting lime into an acid subsurface did not increase canola growth, but the effect of ripping was significant in two of the three experiments.

Further reading

Angus, J., Swan, A., Kirkegaard, J., Beven, A., Duff, C. and Conyers, M. (2008). Canola and the acid throttle. GRDC Update, Wagga Wagga, February 2008 and on the GRDC website.

Scott, B. J., Fenton, I. G., Fanning, A. G., Schumann, W. G. and Castleman, L. J. C. (2007). Surface soil acidity and fertility in the eastern Riverina and Western Slopes of southern New South Wales. *Australian Journal of Experimental Agriculture* 47, 949-964.