Effect of fertiliser and pasture improvement on soil pH on Northern Tablelands NSW soils.

M.R. Duncan and G.J. Crocker

NSW Agriculture, Armidale and Tamworth

Soil pH decline in Mediterranean areas of Southern Australia has been studied by many workers since the late 1950s. Williams and Donald (1957) reported on pH changes as a result of pasture improvement in Southern NSW where superphosphate and subterranean clover were thought to be indirectly involved in increased surface soil acidity. The reasons for pH decline have also been the subject of research projects. Most workers consider increased soil nitrogen and organic matter with subsequent leaching of nitrates below the plant root zone to be largely responsible for increased acidification. The nitrogen cycle involves many complex chemical reactions, but it has been shown (Helyar, 1976) that inadequate utilisation of nitrogen resulting from improved legume growth is a significant factor in pH decline.

The continued use of superphosphate is not considered to be, in itself, a cause of acidification. Research under field conditions has not shown a decline in soil pH to be a direct result of long-term superphosphate applications. Rather, the effect on legume growth, nitrogen accumulation, increased organic matter and an inability of some plants to efficiently use nitrate nitrogen are thought to be the main factors causing soil acidification over time (Helyar, 1976).

This paper reports on two separate studies on soil pH changes as influenced by long term use of superphosphate and discusses the influence of soil type under Northern Tablelands, summer rainfall conditions.

Methods

The first study formed part of a post graduate program (Duncan, 1980). This project involved the sampling of 42 plots located at the CSIRO Research Field Station at "Chiswick" each month for 2 years from 1978-1980. These phalaris and white clover plots had been used for a long term fertiliser research program conducted by E.J. Hilder with treatments commencing in 1948. Soil type at this location is a wiesenboden/ironstone, intermediate between a heavy basalt and lighter trap (podsolic) soil. Monthly sampling to a depth of 7.5cm took place to measure pH, P (Bray No.1) and electrical conductivity to monitor temporal and spatial variability over the two year duration of the project.

The second study conducted by Crocker and Holford (1991) aimed at determining the effects of pasture improvement including long term superphosphate application on soil pH, total N, organic carbon and extractable phosphorus in the major soil types of the Northern Tablelands of NSW. This was achieved by analysing 7.5 cm depth samples from adjacent soils representing improved and unimproved pastures at 67 sites. Improved sites contained at least 1 clover species (mainly white) and had received at least 125 kg/ha of P over periods of 15-45 years (ie 1500 kg/ha superphosphate). Unimproved sites were chosen from stock reserves, church yards, roadsides or natural pastures which had received less than 35 kg/ha of P since the project commenced in 1987.

Results

The Duncan study from the wiesenboden soil type recorded no apparent or significant change in pH resulting from rates of nil to 250 kg/ha/yr of superphosphate applied between 1948 and 1978 (Table 1). Seasonal and spatial fluctuations were

Table 1: Soil pH (1:5 water) measured at CSIRO Research laboratory "Chiswick" from plots treated with various fertiliser applications from 1948-1978 (Duncan 1980).

Sampling Time	Fertiliser rate (kg/ha/yr)					
	0	62	125	125 +125	250	Mean
May 1978	5.8	5.6	5.8	5.6	5.7	5.7
June 1978	5.5	5.6	5.7	5.6	5.7	5.6
October 1978	5.8	5.8	5.9	5.8	5.9	5.8
November 1978	5.7	5.6	5.7	5.7	5.7	5.7
December 1978	5.6	5.5	5.5	5.5	5.5	5.5
February 1979	5.6	5.4	5.9	5.6	5.7	5.6
Mean	5.7	5.6	5.7	5.6	5.7	

Table 2: Soil pH (KCl) measured from unimproved (U) and improved (I) pasture sites (Crocker and Holford, 1991). Values in brackets show range of pH readings.

Soil parent material	pH	
	U	I
Sedimentary rocks	5.1±0.23 (4.4-5.7)	5.0±0.2 (4.5-5.6)
Basalt	5.18±0.23 (4.8-4.5)	5.1±0.27 (4.5-5.8)
Granite	5.13±0.29 (4.7-5.8)	5.09±1.28 (4.9-5.4)

more apparent from those that may be attributed to fertiliser applications.

Crocker and Holford (1991) data also showed no significant ($P<0.05$) effect on pH as a result of fertiliser or length of fertiliser history, although trends were evident within soil groupings. Soils formed from granite showed the largest decline in pH where the greatest amount of superphosphate was applied. By contrast, much smaller changes in pH occurred in the more strongly buffered soils of sedimentary or basalt origin.

Discussion

These two studies provide a contrast with those from many locations in Southern NSW (Helyar, Cregan & Godyn, 1990). The first study reported in this paper (Duncan, 1980) did not find significant or apparent pH change after a long history of superphosphate application to a phalaris/white clover pasture. A parallel study (Duncan, 1980) also conducted at CSIRO Research Station 'Chiswick' but on a lighter soil type (sedimentary, yellow podzolic) similarly failed to identify a significant change in pH. Values fluctuated between 4.8 and 5.8 (1:5 soil: water) over the 2 year period, but were not correlated with fertiliser or soil moisture, rather with soil temperature.

The second study (Crocker and Holford, 1991) compared improved with unimproved pasture sites. The majority of the improved sites recorded a higher level of soil nitrogen, carbon and phosphorus and a lower level of pH than the adjacent unimproved sites. The decreases in pH were not statistically significant and not usually related to amount of superphosphate applications. The partitioning of results according to soil type provides an interesting interpretation and extra information. The largest decline in pH occurred on the granite soils which had received more than 250 kg/ha of P.

The assumption to be concluded from these studies by comparison with many from Southern NSW is that acidification of Northern Tableland pasture soils is significantly less than that from Southern NSW. The soils most at risk are the less well buffered granite soils that have the tendency to leach nitrate below the root zone. Nitrate leaching is well established as one of the acidifying factors contributing to a decline in pH in Southern soils. It is also assumed that legume produced nitrogen is more efficiently used by the predominantly summer growing grasses of the Northern Tablelands. The first study reported in this paper was conducted on a phalaris / white clover pasture. Unlike subterranean clover (winter growing annual), white clover does not senesce in spring with a deposit of nitrogen, but rather continues to grow through summer, provided adequate rainfall occurs. In addition, Northern Tableland pastures contain a high proportion of summer grasses, native and introduced, capable of more efficiently re-cycling soil nitrogen and thereby reducing the tendency of nitrate nitrogen to leach.

These studies should not cause producers or advisors to be complacent about soil acidification. In particular, soils derived from granite are shown to be at risk and an apparent change in weather patterns and rainfall distribution since the early 1980's is likely to accelerate soil acidification rates unless management to arrest pH decline are used.

References

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