Mapping soil analysis data in south east Australia

A.J. Brown, K.I. Peverill, G.R. Munro and S.W. Margetts

State Chemistry Laboratory, 5 Macarthur Street, Melbourne VIC 3002
The Phosphate Co-operative Company of Australia, 106 Queen Street, Melbourne VIC 3000

Summary. A series of maps, encompassing mainland south-east Australia are presented for a range of soil chemical parameters The data derive from analysis of advisory soil samples submitted to the State Chemistry Laboratory (Victoria) during 1988-1991. The data were stored and manipulated on computer and mapped by districts derived from Postcode distribution. Strongly acid soils and soils with unfavourable aluminium concentrations were found mainly on the inland side of the Great Dividing Range and in West Gippsland. The occurrence of phosphorus, potassium and sulphur deficiencies were widespread throughout the mapped area and tended to reflect farming enterprises. Soil salinity occurred mainly in south-east South Australia and north-west Victoria.

Introduction

Every year, many farmers' soils throughout Australia are analysed for a variety of chemical and physical parameters. In 1986, approximately 36,000 soils were analysed in NSW, Victoria and South Australia alone (7). Combined with the long-term experience of farmers and agronomists working in a particular district, these data can allow appropriate management strategies to be implemented, both at the farm and district level Detailed mapping of soil data can be useful in determining spatial and temporal changes in land use and management strategies. For example, salinity mapping (chloride and electrical conductivity has been useful in establishing Land Capability and Crop Suitability Classes (4,8) in irrigation districts. However, to date, most detailed mapping has been of small localised areas. Regional, state or national perspectives of soil conditions cannot often be appreciated from local experience or small scale mapping exercises. Large scale mapping of soils has, in general, been confined to soil type and land use characteristics. Except for mapping of soil pH in NSW (2) and north-east Victoria (1), no maps for other regions or other chemical parameters have been published for south-east Australia.

In this study the chemical results for over 10,000 surface soil (0-100 mm) samples of pasture and cropping paddocks analysed by the State Chemistry Laboratory (SCL) for a period of three years from 1 July 1988 to 30 June 1991 (including samples received from Pivot Agricultural Laboratory Services Pty Ltd Trading as AG-PLUS) were mapped on a district by district basis over Victoria, southern New South Wales and south-east South Australia.

Methods

Analytical data and samples details were stored on the SCL computerised sample management system and sorted by Genstat 5 (5) using Postcodes associated with localities of samples. Postcodes tend to increase sequentially along a series of radial arms from the capital cities of each state. Districts were defined along each radial arm to minimise variation due to rainfall, agricultural enterprise and soil/geology. The size of each district was determined in part by consideration of the intensity of farms in that region. Some Postcodes required change to allow the samples to be allocated to their correct district. This was particularly necessary in parts of the NSW Riverina where the same Postcode often applies to towns scattered over a wide area. Also, where the same Postcode applies to a large and diverse area around large centres such as Horsham in Victoria, artificial Postcodes were assigned to split the area into appropriate districts. In all, 148 districts were defined.

Means, ranges, standard deviations and frequencies of data classes were calculated by Genstat 5 (5) for each district. Maps were then prepared by using isolines to enclose data classes. Maps included in this paper are of mean pH (1:5 H_20), percentage of soils deficient in available phosphorus (Olsen 0.5 M $NaHCO_3$ in NSW and Victoria, Colwell 0.5 M NaHCO, in SA), available potassium (Skene 0.05 M HC 1 in NSW and Victoria, Colwell 0.5 M $NaHCO_3$ in SA) or available sulphur (0.01 M CaH_2PO_4 plus charcoal) and percentage of soils with unfavourable exchangeable aluminium (1 M KC1) or electrical conductivity (1:5 soil/water; SCL Methods Manual).

Results and discussion

Soil pH and exchangeable aluminium

A map of mean soil pH is shown as Figure 1. The major pattern of soil pH is that of a band of strongly acid soils (pH 5.5 and less) running rom the central Victorian Highlands through northeast Victoria and into the Southern Tablelands of NSW with a secondary zone in West Gippsland. Isolated districts in Victoria with strongly acid soil means are Coleraine and Balmoral (on the western side of the Grampians), and the Otway ranges. As the soils represented over these districts include various yellow and red duplex soils (Soloths and Podzols) to brown and red friable earths (Krasnozems), it is likely that soil pH is related more closely to factors other than soil type. Other factors may include fertiliser history, rainfall, length of the growing season and the agricultural system employed. These factors have been indicated to affect soil acidification due to nitrate leaching and product removal (2). The remainder of the map shows a pattern of increasing mean pH towards the Mallee and the western Riverina. When compared to previously mapped pH distributions (1,2), this map shows a similar overall pattern although the scales and modes of mapping are different.

The percentage of soils with an exchangeable aluminium sensitive plant species such as lucerne, phalaris, barley and wheat is mapped in Figure 2. Districts with more than 50% of samples in this category are similar to those with strongly acid mean pH. Districts which have a predominance of Krasnozems, such as Daylesford, the Dandenong Ranges and Warragul in Victoria, show a higher proportion of soils with unfavourable exchangeable aluminium levels may be better described if determined as a percentage of the cation exchange capacity.

Available phosphorus, potassium and sulphur

Critical levels of deficiency for available phosphorus, potassium and sulphur have been arbitrarily set to represent extensive grazing and cropping systems. It is recognised that higher critical levels are required for high intensity systems, such *as* dairying and irrigated cropping.

Figure 3 maps the percentage of soils with a deficient concentration of available phosphorus (8 mg/kg Olsen or less, or 20 mg/kg Colwell or less). The highest occurrence of phosphorus deficiency is in the Mallee, central Riverina and central NSW , Bathurst and Wimmera and far west Victoria. Lowest occurrence of phosphorus deficiency, at least in Victoria, coincides with the dairying areas of the western district, Gippsland and the northern irrigation districts.

Figure 4 maps the percentage of soils with a deficient concentration of available potassium (125 mg/kg Skene and Colwell or less). Potassium deficiency is common throughout South Australia, southern and north-east Victoria, south-east NSW and Southern Tablelands of NSW with the major exceptions of the Monaro Plateau, the western Victorian volcanic plain and the dairying areas of western Victoria, Gippsland and coastal NSW. These latter exceptions relate to soil type or high fertiliser usage. The highest occurrence of deficiency appears for the western and eastern sections of south-east South Australia, far-west Victoria, far-east Gippsland and the Goulburn and Crookwell districts of NSW. Many of the soils in the South Australian and western Victorian districts are light in texture and suffer from nutrient leaching (3).

Unlike the other nutrients, available sulphur is not determined as a routine test, hence the number of samples for mapping were only approximately 2000. Mapping for many NSW districts was not possible as no sulphur analytical data were available. Figure 5 maps the percentage of soils with a deficient concentration of available sulphur (4 ug/g or less). Sulphur deficiency is particular prevalent in the Mallee and western Wimmera, parts of north-east Victoria, east Gippsland and the Southern Tablelands of NSW. Sulphur deficiency in the Mallee is mainly of concern for shallow rooted plant species only, such as medics and field peas. Deep rooted species are thought to obtain their sulphur requirements from subsurface sources (6). Sulphur deficiency does not appear to be *as* widespread as phosphorus deficiency at the present time, but with the increased use of high analysis-low sulphur fertilisers, this is likely to change in the future.

Salinity

Salinity is defined here as an electrical conductivity measurement (greater than 25 mS/m) which is potentially harmful for the establishment and growth of many pasture and crop plant species. Figure 6 is a map of the percentage of saline soils. Highest occurrence of salinity in dryland districts occurs for central and coastal south-east South Australia, central Wimmera, parts of coastal Gippsland and the Temora district of NSW. More than 20% of samples from the northern Victorian irrigation districts were saline (except for Shepparton and Num urkah), while less than 10% of samples from other irrigation districts were saline. However, in some districts, these latter results may be biased by a high proportion of samples from non-saline dryland situations.

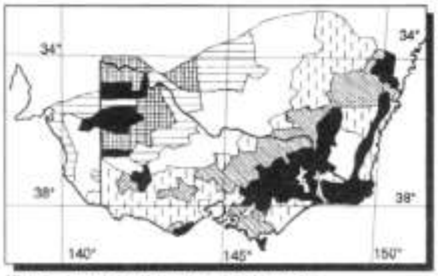

Figure 1: Map of mean soil pH(water).

< 5.6 5.6- 5.9 6.0- 6.9 7.0- 7.9 > 7.9

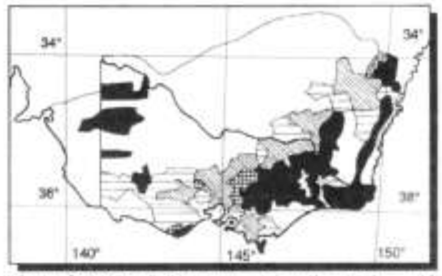

Figure 2: Map of percentage of soil samples with unfavourable exchangeable aluminium (20 mg/kg or more).

< 25 25 - 49 50 - 75 > 75

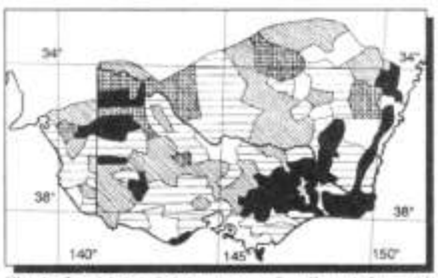

Figure 3: Map of percentage of soil samples with deficient available phosphorus (8 mg/kg or less)

< 25 25 - 49 50 - 75 > 75

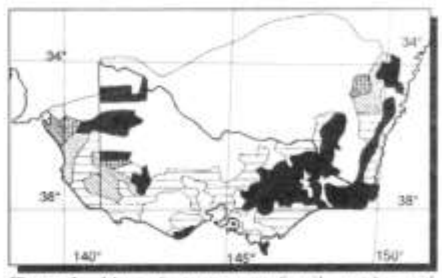

Figure 4: Map of percentage of soil samples with deficient available potassium (125 mk/kg or less).

< 25 25 - 49 50 - 75 > 75

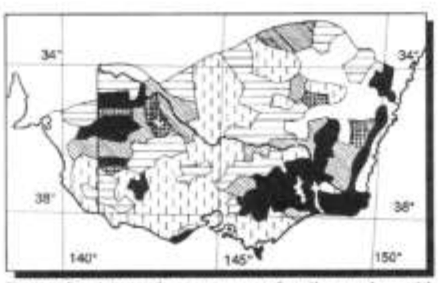

Figure 5: Map of percentage of soil samples with deficient available sulphur (4 mg/kg or less).

No data < 25 25 - 49 50 - 75 > 75

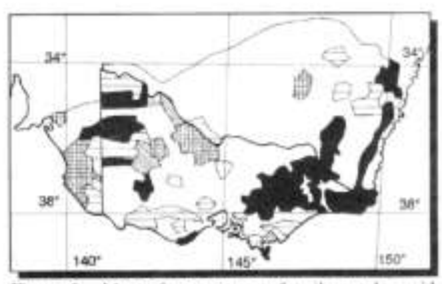

Figure 6: Map of percentage of soil samples with unfavourable electrical conductivity (25 mS/m or more).

< 10 10 - 20 20 - 30 > 30

Non-Agricultural Land

References

2. Coventry, D.R. and Maden, J.J.L. 1989. In: Proc. 5th Aust. Agron. Conf., Perth. p. 595.

3. Helyar, K.R., Cregan, P.D. and Godyn, D.L. 1990. Aust. J. Soil Res., 28, 523-537.

4. Hodge, T.J.V.and Lewis, D.C. 1989. Aust. J. Soil Res., 27, 149-159.

5. Maher, J.M. and Martin, J.J. 1979. Soil and Land Survey of the State Research Farm Werribee, Division of Agricultural Chemistry, Project Series No. 42, Government of Victoria.

6. Payne, R.W., Lane, P.W., Ainsley, A.E., Bicknell, K.E., Digby, P.G.N., Harding, S.A., Leech, P.K., Simpson, H.R., Todd, A.D., Verrier, J.P. and White, R.P. 1989. Genstat Reference Manual. (Clarendon Press).

7. Quigley, P.E. and Ferguson, M.W. 1982. In: Proc. 2nd Aust. Agron. Conf., Wagga Wagga. p. 281.

8. Reuter, D.J. and Hannam, R.J. 1987. In: Proc. 4th Aust. Agron. Conf., Melbourne. pp. 34-46.

9. Sargeant, U., Newell, J.W. and Walbran, W.I. 1979. Soil and Land Use in the Torrumbarry Irrigation District Victoria, Division of Agricultural Chemistry, Project Series No. 49, Government of Victoria.