Spatial and temporal variability of soil test p values under permanent pasture

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Variations in estimates of soil nutrient availability include components attributable to spatial variability of soil in the field, temporal (seasonal) variability in the size of the available P pool as well as analytical variation. While the effect of time of sampling on soil test values may be significant (e.g. Jessop et al. 1977), a sizeable portion of observed time-to-time fluctuations may in fact be due to sampling error.

In a study to assess fluctuations in P availability under pasture, two ten-core composite soil samples (7.5 cm depth) were taken at monthly intervals from adjacent 10m x 10m squares within plots of a permanent pasture trial which has received 0, 62, 125, 250 and 250 (split application) kg/ha/yr of single superphosphate since 1948. A portion of the data, shown in Table 1, illustrates the differences that can be obtained despite intensive sampling.

Table 1: Soil test P by Colwell's method in composite samples (ppm)

Superphosphate, kg/ha/yr		0				125			
Months after applic.		1	6	11	Annual range	1	6	11	Annual range
Rep. 1	Sub. 1	15	17	19	22–34	51	38	56	
1	2	25	20	18	22–34	43	36	36	34–60
2	1	22	26	19		29	32	37	
2	2	18	17	22		47	29	32	
$\bar{x}$		20	20	20	15–24	43	34	40	26–88

Although analysis of variance of data from twelve sampling dates indicates a significant effect of time on soil test P values, when the components of variance of the mean (Equation 1) are calculated, one finds that components due to spatial variability are of similar magnitude to that of temporal variation.

$$\text{var}(\bar{\bar{x}}) = \frac{\sigma^2 (\text{temporal})}{12} + \frac{\sigma^2 (\text{P x temporal})}{48} + \frac{\sigma^2 (\text{exp.err.})}{120} + \frac{\sigma^2 (\text{samp.err.})}{240} \quad (1)$$

$$\text{spatial}$$

$$= 1.278 \quad + 0.500 \quad + 0.118 \quad + 0.694$$

Closer scrutiny of the data suggest that much of the temporal variance is due to the increase and subsequent decline in soil test values immediately after superphosphate application. Since temporal and spatial components of variance are of similar magnitude little improvement in precision can be obtained by sampling at a particular time of year.

Sampling programs are continuing in an effort to relate soil test fluctuations to climatic parameters as well as to find means of reducing sampling errors in large paddocks.

Jessop, R.S., et al. (1977). Aust. J. Soil Res. 15: 167-70.