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THE LABORATORY ESTIMATION OF THE PHOSPHORUS STATUS OF SOIL. 1. CHOICE OF EXTRACTION METHOD

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SUMMARY

The empirical extractants for "available" soil phosphorus, 0·01N H_2SO_4 (B.S.E.S. Method) and 0·1N HCl/0·03N NH_4F (Bray and Kurtz method), have been shown to give, for some North Queensland soils, results which are approximately linearly related.

The B.S.E.S. method results were related to the uptake of P by plants and it was concluded that this method would be suitable for routine estimation of soil available phosphorus.

There are many reports of the phosphorus extracted from acid soils by dilute solutions of mineral acids being correlated with crop response to phosphate fertilizer. This enables such empirical extraction methods to be used as a measure of plant-available phosphorus and so become the basis of a fertilizer prediction scheme.

In Queensland, the extractant 0·01N H_2SO_4, as developed by Kerr and von Stieglitz (1938), is used by the Bureau of Sugar Experiment Stations (B.S.E.S.) and the Department of Primary Industries (D.P.I.). Kerr and von Stieglitz have correlated the method with the growth of sugar-cane on a wide variety of Queensland soils and a level of at least 40 p.p.m. P_2O_5 has been suggested as necessary for best growth of cane. von Stieglitz (1956) has also related this method to the response to superphosphate of a range of crops on a variety of soils.

Comparison of this B.S.E.S. method with the response of tropical pasture species to superphosphate has not been reported.

The method of Bray and Kurtz (1945) was developed for the Corn Belt soils of the U.S.A. but has been used successfully in Australia and other countries as well. In Australia, Spencer and Barrow (1963) and McLachlan (1963) have used this method to predict the fertilizer requirements of pastures in New South Wales.

In the present investigation it was decided to compare the Bray and Kurtz method with the B.S.E.S. method to find which gave the better correlation with uptake of phosphorus by tropical pasture species.

Methods

B.S.E.S. method.—2·5 g soil are shaken overnight (16 hr) with 500 ml of 0·01N H_2SO_4, filtered, and 50 ml taken for colour development.

Bray and Kurtz method.—2·85 g soil are shaken for 40 sec with 20 ml of extractant (0·03N NH_4F in 0·1N HCl), filtered, and 2 ml taken for colour development.

In each case the chlorostannous-reduced molybdenum blue colour method was used. The sulphuric acid system was used for the B.S.E.S. method and the hydrochloric acid system for the Bray and Kurtz method.

Results

Comparison of methods.—Figure 1 shows a comparison of the results of analyses of a number of surface soil (0-6 in.) samples by the two methods. The results of the two methods appear to be approximately linearly related. The samples have been divided broadly into four parent material groups, and the relation holds for all groups.

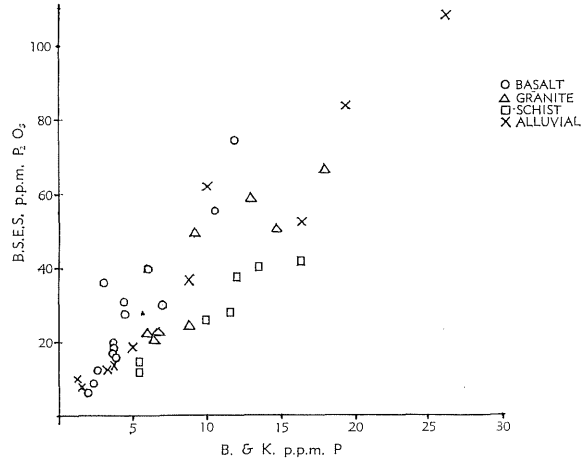

Fig. 1—Comparison of two extraction methods.

Pot experiment I.—Figure 2 shows a plot of phosphorus uptake by legumes (average of three species) against acid-extractable phosphorus at harvest. Fertilized and unfertilized pots are included. The experiment involved three red basalt soils with three rates of applied sodium orthophosphate.

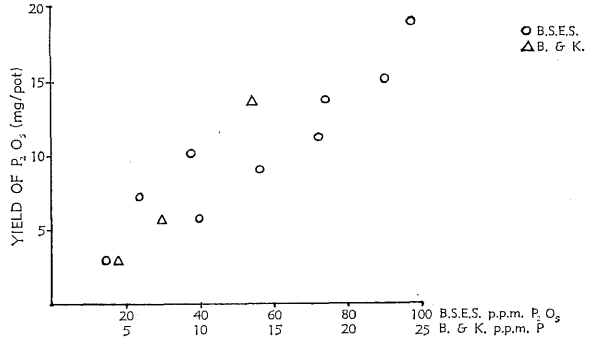

Fig. 2.—Plot of phosphorus uptake of legumes against acid-extractable phosphorus at harvest.

Pot experiment II.—Figure 3 shows a plot of uptake of phosphorus by centro (*Centrosema pubescens*) against the soil phosphorus measurement. The pots were sampled at harvest time. At the high rate of applied superphosphate, the dry-matter yield curve levelled out, causing the phosphorus yield to do likewise.

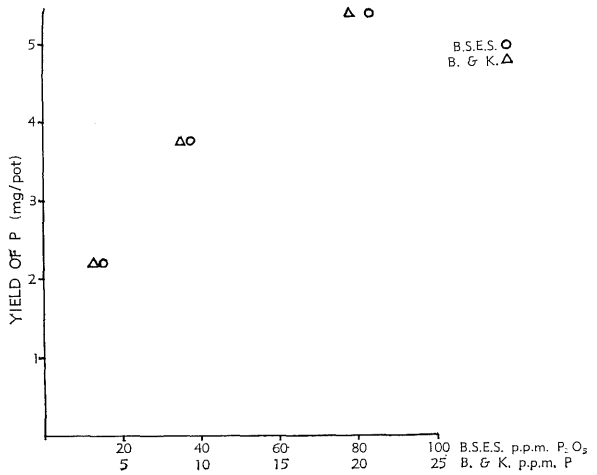

Fig. 3.—Plot of uptake of phosphorus by centro against soil phosphorus.

Field experiment.—In this experiment a stand of stylo (*Stylosanthes gracilis*) was top-dressed with superphosphate. The P_2O_5 yields from two cuts in 6 months and the soil P_2O_5 level at the second harvest are given in Figure 4.

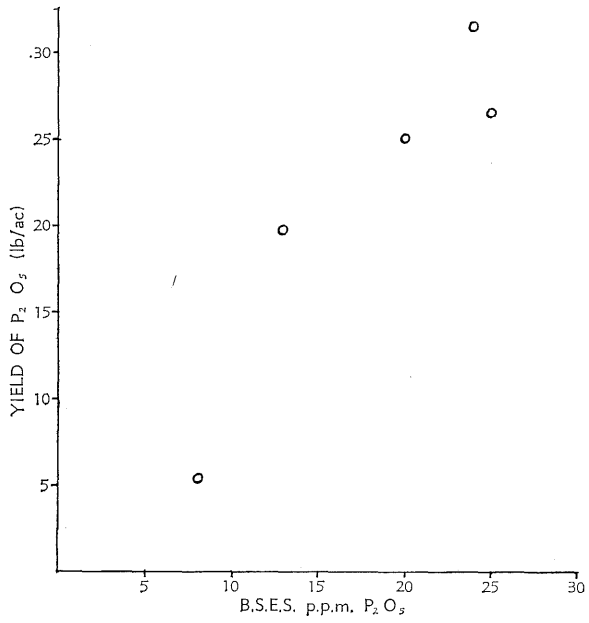

Fig. 4.—Plot of P_2O_5 yield of stylo against soil P_2O_5

Discussion

Figures 1-3 show that results of both B.S.E.S. and Bray and Kurtz methods give similar correlations with plant data, and in Figure 1 appear to be linearly related.

If this is the case, choice of a method would depend on convenience. Although the B.S.E.S. method includes a 16-hr shaking period as opposed to Bray and Kurtz 40-sec shaking, the number of man-hours required for a batch of 12 samples is little different. The B.S.E.S. method uses larger volumes and allows the use of measuring cylinders instead of pipettes. The B.S.E.S. method is probably better suited for use as a routine chemical analysis of reasonable accuracy and reproducibility.

One inconsistency has shown up between the two methods. This concerns samples taken at depth in the red soils. Where B.S.E.S. method shows an increase in available phosphorus with depth, the Bray and Kurtz procedure shows either no increase or very little. This is shown below:

Site	Depth (in.)	B.S.E.S. (p.p.m. P_2O_5)	B. and K. (p.p.m. P)
1	0–6	30	6·8
	6–12	45	3·9
	18–24	78	4·5
	30–36	93	6·8
2	0–6	17	3·4
	12–24	34	2·0
	24–36	34	2·0
3	0–6	9	2·1
	12–24	18	4·5
	24–36	25	4·5

The existence of an increase in available phosphorus with depth would explain observed plant growth better.

All factors considered, there is no case for changing from the B.S.E.S. method to the Bray and Kurtz method.

The results of the two pot experiments and the one field experiment quoted above show that the uptake of phosphorus by the legumes is related to the soil analysis value and so suggest that the B.S.E.S. method would be suitable for more precise correlation with plant response data.

The current summer programme at the Tropical Agriculture Research Station includes 15 rate-of-superphosphate experiments on the wet tropical coast between Ingham and Innisfail. It is proposed to use these experiments to relate plant response to soil analyses and also to plant analyses.

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