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Correlation of Soil Tests for Phosphorus with Response to Added Phosphorus in Red Soils of Coimbatore

by

K. KHALEEL AHMED [1], S. VENKATACHALAM [2] and P. KRISHNAMURTHY [3]

Introduction: The prime objective of soil testing is to furnish reliable information to the farmer about fertilizer use on his soil. With the view of obtaining an accurate and suitable soil test method that will characterise the nutrient status of the divergent soils of Madras State, under the different climatic conditions and crop growth, to the maximum extent, soil test crop response studies were undertaken on red soils of Coimbatore with *ragi* as the test crop.

Materials and Methods: Ten representative red soils from different localities of Coimbatore were selected for green house experiments. The pH value ranged from 7·3 to 8·6 and the texture varied from sandy loam to sandy clay loam with the cation exchange capacity from 47·01 to 95·2 m. e./100 gm. of clay (Table 1).

A pot culture experiment with *ragi* (K2 variety) as an indicator crop was laid out in the green house with treatments NP_0K, NP_1K, NP_2K and NP_3K and replicated four times, over a basal dressing of nitrogen 60 lb. per acre as ammonium sulphate and potash at 60 lb. per acre as potassium chloride and phosphorus at 0, 40, 80 and 120 lb. P_2O_5 per acre as superphosphate. Earheads and straw weights were recorded separately for all treatments.

The soil samples were tested by the following seven phosphorus testing procedures.

1. Olsen (Olsen, S. R., Cole, C, F., Watnab, F. S., and L. A. Dean, 1954)
2. Bray I (Dickman and Bray, 1940)
3. Bray II (Bray, R. H., and L. T. Kurtz, 1945)
4. Dyer (Dyer, 1894)
5. Truog (Truog, 1930)
6. Saunder (Saunder, D. H., 1956)
7. Carbon-di-oxide water method (McGeorge, 1947)

[1] and [3] Assistants in Chemistry, Agricultural College and Research Institute, Coimbatore - 3.

[2] Soil Chemist (Radio Isotopes), Agricultural College and Research Institute, Coimbatore - 3.

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The per cent yield of grain was calculated as follows:

$$\text{Per cent yield} = \frac{\text{Yield without added (nutrient) P} \times 100}{\text{Maximum yield}}$$

Where the yield without added P refers to yield of control i. e., 0 lb. of P_2O_5 per acre and maximum yield refers to yield either at 0, 40, 80 or 120 lb. per acre, depending on whichever gives the highest yield.

Results and Discussion: The results of analysis for available P by different methods are given in Table 1. The correlation coefficients between soil test values and per cent yield of grain are given in Table 2.

TABLE 1. *Characteristics of soils (red) used for pot culture study in soil test crop response to applied phosphorus*

Sample No.	Texture	pH	Electrical conductivity millimhos/cm	Cation exchange capacity m. e. per 100 gms	
				soil	clay
1.	Sandy loam	8·0	1·1	19·4	72·12
2.	Sandy clay	7·9	1·1	25·2	72·41
3.	Sandy clay loam	7·6	0·2	13·0	47·01
4.	Sandy clay loam	8·1	0·3	16·3	54·43
5.	Sandy clay loam	8·1	0·2	22·1	85·16
6.	Sandy loam	7·3	0·2	11·4	79·45
7.	Sandy loam	7·6	0·2	14·7	76·96
8.	Sandy loam	7·9	0·2	...	...
9.	Sandy clay loam	8·3	0·3	21·1	74·40
10.	Sandy clay loam	8·6	0 25	22·7	95·20

Available phosphorus in P and per acre							
Olsen method	Bray-I method	Bray-II method	Truog method	Dyer method	Saunder method	CO_2 method	Per cent yield of grain
7·6	8·14	133·1	259·0	760	73·9	12·6	72·8
9·2	19·6	125·8	300·0	340	41·5	2·8	70·7
19·2	22·4	92·2	175·0	280	53·0	8·4	84·7
11·6	11·2	64·3	224·0	1000	32·3	5·6	87·5
10·8	25·2	48·9	210·0	420	50·8	72·7	73·3
24·0	25·2	47·2	133·0	1160	62·3	40·5	60·1
17·2	33·6	44·7	112·0	200	43·8	12·6	68·4
11·2	18·2	30·4	203·0	160	36·9	5·6	63·7
27·2	61·5	123·0	280·0	1260	27·7	26·6	30·7
15·2	37·7	68·5	217·0	640	46·1	97·8	73·1

TABLE 2. *Correlation co-efficient of soil test for phosphorus with response of ragi to added 'P'*

'r' values.

S. No.	Method	Soils of CEC 47 to 95·2 m. e. per 100 gm. clay		
		(10 soils)	(8 soils)	(7 soils)
1.	Olsen	+ 0·02	+ 0·07	...
2.	Bray-I	+ 0·06	+ 0·66	+ 0·747
3.	Bray-II	+ 0·44	+ 0·64	...
4.	Truog	+ 0·35	+ 0·65	+ 0·757*
5.	Dyer	+ 0·20	+ 0·36	+ 0·916**
6.	Saunder	— 0·30	— 0·28	...
7.	CO_2-water	— 0·24	— 0·26	...

** Significant at 1 per cent level }
* Significant at 5 per cent level } Differences are not statistically significant.

The suitability and adoption on a practical basis of methods for evaluating soil P status is dependent in no measure of their ability to predict the response to P in terms of crop yield, under field conditions. It is to be admitted that simple laboratory extraction of readily soluble P lacks the unifying effect of integrating the innumerable interrelated factors that condition the uptake of P, plant growth and yield in the field. Some of these factors are moisture, temperature, aeration, soil physical properties, pH, nutrient status, biological activity, nature of crop, cultural practices and incidence of pests and diseases. Correlation between soil P and the crop performance is subject to suffer in the presence of these varying factors. But in pot experiments such variations are largely minimized if not wholly obliterated.

The amount of phosphorus extracted by different extractants depends upon the different native forms of phosphorus in the soil. In attempting to compare the different soil test methods on various types of soils as distinguished by their reaction, Bingham (1962) recorded that acid soils yield comparable values by number of methods while the milder extractants were suitable for neutral and alkaline soils. Sen Gupta and Cornfield (1963) observed that in calcareous soils none of the methods for assessing availability of P was very precise. Van Diest (1963) reported the quantities of phosphorus extracted in the various laboratory tests were little affected by presence of limestone. Vittal Rao and Krishna Rao (1963) in their studies with three methods *viz.*, Truog, Bray and Olsen with paddy as test crop, found that all the three methods are efficient in extracting available P_2O_5 in soil and significant correlations were obtained both for per cent yield of grain and per cent yield of phosphorus.

While the methods of Saunder's and CO_2 water gave a negative correlation, the remaining methods gave a positive correlation. However, none of the co-efficients were significant when all the ten soils were considered. The co-efficients showed considerable improvement when eight soils having cation exchange capacity of above 72 m. e. per 100 gm. of clay were considered, except in the case of Saunder's and CO_2 water methods. The co-efficients reached a level of significance of one per cent for Dyer's method and five per cent for Truog's when a high testing soil was omitted. Bray I method gave a correlation co-efficient slightly short of five per cent level, when a low testing soil was omitted. As pointed out above, Dyer's method gave the highest correlation co-efficient showing thereby that it was the best suited for soils under study. However, this method cannot be adopted as a quick test. Although this method gave the co-efficient of determination of 85 per cent this was not suitable for the soil testing as a rapid soil test. The next best was Truog's method which gave a co-efficient of determination of 58 per cent which was good enough. Venkatachalam, Subramaniam and Kamalam (1963) observed that for soils having high cation exchange capacity Truog's and Bray's methods were suitable with paddy as the test crop. This study pointed out the suitability of Truog's method and probably Bray's method also with *ragi* as test crop.

In obtaining a significant correlation two soils of cation exchange capacity 47 and 54 m. e. per 100 gm. of clay were omitted. Based on the experience with the paddy soils reported by Venkatachalam *et al* (*loc. cit.*) it was presumed that the soils with cation exchange capacity of 40—45 m. e. per 100 gm. of clay might probably fall in the category of high cation exchange capacity soils. However, in this study the soils with 47 and 54 m. e. per 100 gm. of clay did not fit into the correlation. Only soils with cation exchange capacity 72 m. e. per 100 gm. of clay and above have fitted in the correlation. It seems, therefore probable, that the line demarcating medium and high cation exchange capacity soils will have to be moved higher up in the scale to about 70. This seems to be in line with the theoretical calculations.

Summary and Conclusions: Correlation studies were conducted on red soils of Coimbatore with *ragi* as the test crop to determine the best method of estimating available phosphorus on these soils. Ten soils covering a pH range of 7·3 to 8·6 and texture of sandy loam to sandy clay loam, with cation exchange capacity of 47 to 95 m. e. per 100 gm. of clay were used. Pot culture studies with K2 *ragi* was conducted to determine the response to added phosphorus. Data on grain yield were used to calculate per cent yield as suggested by Bray and was used as the response index. The soils were tested by Olsen, Bray I and II, Truog, Dyer, Saunder and CO_2 water methods. The soil test values by these methods were correlated with the per cent yield values. It was observed that for seven out of ten soils studied, with Cation Exchange Capacity ranging from 72 to 95 m. e. per 100 gm. of clay, Dyer's method gave a correlation co-efficient of 0·916 significant at one per cent level followed by Truog's method

(r = 0·757) significant at five per cent level. Bray I giving an 'r' value of 0·747 which is slightly short of significance at five per cent level can be considered promising.

From the above, it is concluded that for the red soils of Coimbatore having high cation exchange capacity (on clay basis) Truog's method seems to be the best rapid soil test for available P followed by Bray-I method which is also promising.

Dyer's method although not suited as a rapid soil test is superior to both Truog and Bray-I methods.

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