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Evaluation of Soil Tests for Phosphorus Availability*

by

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Introduction: A number of methods are in use to determine the available phosphorus in soils. Some of these methods have given satisfactory results in certain soils, but none has been found to be applicable under all soil conditions. Hence in this study an attempt is made to compare a number of soil tests for available phosphorus with the phosphorus uptake by *ragi* seedlings in a Neubauer experiment to determine which method is most suitable for each soil type or a group of soil types in the matter of predicting yield or uptake of phosphorus. Simplicity, rapidity and dependability have been taken as the chief considerations in the choice of methods for determination of available phosphorus.

Materials and Methods: Forty soil samples representing the major soil groups of Tamil Nadu, namely, red, black, alluvial and laterite ones were collected from various places and analysed for moisture, pH, and available phosphorus with various extractants.

The ten methods of extraction employed for the estimation of available phosphorus are as follows:

Method	*Extractant employed*
Bingham (water extraction)	Water
Bray and Kurtz No. 1.	0.03 N NH_4 in 0.025 N HCl.
Bray and Kurtz No. 2.	0.03 N NH_4F in 0.1 N HCl.
Truog	0.002 N H_2SO_4 buffered to pH 3.0 with $(NH_4)_2SO_4$.
Frap	0.2 N HNO_3
Morgan	0.52 N acetic acid buffered to pH 4.8 with 0.73 N sodium acetate
William	0.5 N acetic acid with pH 2.8
Dyer	1% Citric acid
Olsen	0.5 M $NaHCO_3$ adjusted to pH 8.5
Das (Volumetric)	1% K_2CO_3

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The Neubauer experiment was conducted with all the 40 samples. One hundred g of air dry original soil mixed with 50 g of acid-washed sand were placed in a petri-dish. One hundred seeds of *ragi* were sown and watered regularly. After 17 days, the seedlings were pulled out, washed with water, dried and weighed. The dried seedlings were analysed for the phosphoric acid content by the Vanadomolybdate method.

Results and Discussion: The relationships between the available phosphorus by various reagents and the phosphorus uptake by *ragi* seedlings were statistically scrutinised and the list of correlations obtained and the corresponding regression equations are furnished in Table.

TABLE. *Correlation and Regression*

Relationship between		Correlation coefficient (r)	Regression equation	Number of pairs of values
X	Y			
Water extractable phosphorus	Phosphorus uptake	0.413*	Y=0.03 X+0.66	33
Bray & Kurtz No. 2 available phosphorus	Phosphorus uptake	0.784***	Y=0.01 X+0.60	37
Morgan's available phosphorus	Phosphorus uptake	0.696***	Y=0.02 X+0.62	35
Dyer's available phosphorus	Phosphorus uptake	0.398*	Y=0.0094 X+0.55	31
Olsen's available phosphorus	Phosphorus uptake	0.700***	Y=0.03 X+0.51	33
Das available phosphorus	Phosphorus content	0.722***	Y=0.008 X+0.08	31

NOTE: *** Significant at 0.1% level * Significant at 5% level

No relationship could be obtained between the dry weight of seedlings in Neubauer test and the available phosphorus values using different reagents presumably because the vegetative growth and the consequent dry weight are dependent on the supply of available nitrogen and not phosphorus.

The phosphorus uptake which is considered to be a good index of phosphorus availability was employed in the correlation study as it takes into account the dry matter also. There was no correlation between available phosphorus by Bray and Kurtz No. 1, Truog, Frap or Das methods and phosphorus uptake by *ragi* seedlings. Das method is not convenient as it is laborious and time consuming. The methods of Truog and Frap gave high values for available phosphorus which were not related to phosphorus uptake by *ragi* seedlings. Presumably because of its very low acid strength, the available phosphorus values by Bray and Kurtz No. 1 reagent did not show any relationship with plant uptake of phosphorus.

Significant correlations were obtained between phosphorus uptake by *ragi* seedlings and the available phosphorus extracted by water, Bray and Kurtz No. 2, Morgan, Dyer and Olsen reagents. The relationships with

available phosphorus extracted by water ($r=0.413^{*}$) and Dyer ($r=0.398^{*}$) were very poor. This is in agreement with the claim of Forsee (1950) that water extraction could be employed only on sandy soils where phosphorus reversion was least. Russell and Russell (1962) pointed out that Dyer's citric acid failed in acid soils as it dissolved iron phosphate of low availability to crops.

The other correlations were very high, thereby indicating the usefulness of Bray and Kurtz No. 2 ($r=0.784^{***}$), Morgan ($r=0.696^{***}$) and Olsen ($r=0.700^{***}$) in evaluating the available phosphorus of soils studied within a pH range of 3.9 to 9.9. Datta and Datta (1963), Jackson *et al.* (1964) and Thomas (1964) showed that Olsen's method generally yielded highest values for correlations with phosphorus uptake by plants and with A-values. Albal *et al.* (1964) and Thomas (1964) observed that phosphorus uptake by plants was significantly correlated with phosphorus extractable in dilute acid–ammonium fluoride mixture.

In general, Bray and Kurtz No. 2 extractant can be recommended for all soil groups of Tamil Nadu for estimation of available phosphorus, because,

(a) this reagent yielded the highest correlation value with phosphorus uptake by *ragi* seedlings ($r=0.784^{***}$)

(b) the available phosphorus obtained by this extractant was closely related to aluminium and calcium phosphate fractions (Balasubramanian, 1966) which were regarded by Taylor *et al.* (1960) and Smith (1965) as good sources of plant available phosphorus in soils, and

(c) the comparatively high acid strength of this extractant makes it useful in acid as well as calcareous and alkaline soils for estimating available phosphorus.

Summary and Conclusions: Ten selected chemical extractants used for the estimation of available phosphorus were compared with the phosphorus uptake by *ragi* seedlings in a Neubauer test, so as to determine the most suitable method for each soil type or a group of soil types in the matter of predicting yield or uptake of phosphorus. It was concluded from the study that the phosphorus uptake by *ragi* seedlings showed no relationship with available phosphorus extracted by Bray and Kurtz No. 1, Truog, Frap and Das methods.

The relationships with available phosphorus values obtained by water extraction and Dyer's method were very poor. Morgan's and Olsen's extractants gave very close correlations with phosphorus uptake by *ragi* seedlings,

Highest correlation was obtained between the phosphorus test value with Bray and Kurtz No. 2 and the plant uptake of phosphorus in the soils studied.

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