https://doi.org/10.29321/MAJ.10.A03133

Madras agric. J. 65 (11): 725—729, Nov., 1978.

A Study of Phosphorus Soil Tests for Different Rice Soils

C.R. LAKSHMINARASIMHAN[1], K.K. KRISHNAMOORTHY[2] and C.R. VENKATARAMANAN[3]

Cultivation of rice under different moisture levels warrants a revision of present method of soil analysis for phosphorus availability in various soils. In a greenhouse study three different groups of soils were utilised and IR 22 rice was grown under three moisture regimes viz., submergence at 5 cm depth, near field capacity and wetting and drying. Soil samples were collected at the time of tillering, flowering and at harvest and analysed for available-P, using the following extractants (i) Olsen's, (ii) Bray No.1, (iii) 0.01 M $CaCl_2$ and (iv) water. The initial soils were fractionated for various forms of P. Plant uptake of P was estimated after wet digestion and all these were correlated. Bray No. 1 extractant for red and black rice soils, while Olsens/Bray No. 1 for alluvial rice soils may form better indices of P availability.

Rice is grown mainly under submergence and at times under non-submerged conditions as any other upland crops. The availability of phosphorus will definitely be varying under such conditions. Continuous submergence or intermittant flooding bring about important physico-chemical changes in the various systems of the soil. Al Abbas and Barber (1964) and Ponnamperuma (1965) reported that many of the soil test methods commonly adopted for phosphorus generally proved inadequate as indicators of the phosphorus availability of rice soils. Phosphorus is present in the soil in various forms i.e. alluminium-phosphate (Al-P) iron Phosphate (Fe-P) and calcium phosphate (Ca-P). The ability of any extratant depends on the relative solubility of the various forms in it and to make it available to the plant under the soil conditions. The present study was aimed to evaluate the usefulness of the commonly used extractants for predicting the phosphorus availability and also to study the pattern of phosphorus availability to rice under different moisture regimes.

MATERIAL AND METHODS

Three soils each of red, black and alluvial soils of Tamil Nadu were used in the present study under greenhouse conditions. The soils were equilibrated with 100 kg/ha of diammonium phosphate for 30 days and IR 22 rice seedlings were grown in these soils, under three moisture regimes viz., submergence at 5 cm depth, near field capacity and wetting and drying. Soil samples were collected at tillering, flowering and at harvest stages of the crop, air dried and analysed for available phosphorus using the following extractants: (i) Olsen's (Olsen *et al.* 1954), (ii) Bray's No. 1

1 - 3: Department of Soil Science,
Tamil Nadu Agricultural University, Coimbatore - 641 003.

extractant (Chang and Juo. 1962), (iii) 0.01M $CaCl_2$ and (iv) water. The crop was harvested, wet digested and analysed for phosphorus by vanadomolybdate method (Jackson, 1960).

RESULTS AND DISCUSSION

The physico-chemical characteristics of the initial soils are presented in Table I and the different fractions of soil phosphorus in Table II. The soils exhibited marked variations in their physico-chemical properties as well as in the various fractions of soil phosphorus.

Among the methods tried, Bray's No. 1 extractant released more amount of

TABLE I. Analytical data of Intial soil samples

Particulars	Red soil			Black soil			Alluvial soil		
	1	2	3	4	5	6	7	8	9*
1. Mechanical Analysis									
Coarse sand (%)	62.65	39.90	58.91	28.93	39.10	28.65	28.00	13.90	6.73
Fine sand (%)	20.55	11.39	25.57	9.35	14.66	14.23	13.95	33.92	15.44
Silt (%)	0.98	5.21	4.25	5.10	4.75	8.03	9.77	8.55	13.55
Clay (%)	9.27	38.32	4.90	48.65	31.90	33.77	40.90	31.15	44.45
2. Chemical Properties									
Total P_2O_5 (%)	0.24	0.06	0.04	1.22	0.08	0.16	0.07	0.05	0.05
Available P (ppm)	3.50	1.00	1.50	4.00	0.50	2.50	0.50	1.50	0.50
Fe_2O_3 (%)	1.04	2.82	0.80	0.80	1.21	1.28	2.33	1.55	2.10
Al_2O_3 (%)	0.32	0.10	5.36	7.63	0.02	5.27	0.18	0.02	0.37
pH (1:2 suspension)	7.50	7.50	8.10	7.50	7.90	7.80	4.80	6.80	6.30
E.C.	0.20	0.30	0.20	0.20	1.30	0.80	0.40	0.80	0.60
Organic carbon (%)	0.50	1.03	0.59	0.88	0.73	2.22	1.42	1.29	1.65
Total C.E.C. (meq/100 g Soil)	6.70	12.70	21.40	31.60	25.20	29.00	25.50	12.50	8.70

* Nos. 1-9 under soils represent different soils. in order.

TABLE II. Inorganic fractionation of phosphorus in the original soils (ppm)

Inorganic phosphorus fractions	Red soil			Black soil			Alluvial soil		
	1	2	3	4	5	6	7	8	9
Al-P	15.00	15.00	16.25	20.00	32.50	28.70	6.25	8.75	8.75
Fe-P	8.75	8.75	1.25	9.75	5.00	6.29	15.25	8.00	10.00
Ca-P	17.50	6.25	10.00	20.63	18.75	5.63	5.63	3.13	6.25
Occluded Fe-P	10.00	3.13	3.13	3.13	3.75	7.50	5.63	3.13	3.13
Occluded Al-P	3.13	3.13	2.50	2.50	3.75	3.75	5.00	3.75	3.75

TABLE III. Estimates of available phosphorus in different soils, under various moisture level (ppm)

Soils / Moisture levels	Soil numbers								
	1	2	3	4	5	6	7	8	9
I. Olsen's									
S	21	11	6	13	13	9	9	13	11
Fc	19	5	11	14	6	17	9	11	11
WD	21	6	8	13	10	20	9	13	8
II. Bray's No. 1									
S	33	15	13	24	24	16	9	12	12
Fc	33	11	24	21	21	21	8	8	12
WD	30	15	21	24	17	17	6	8	10
III. 0.01M $CaCl_2$									
S	1	1	<1	<1	<1	1	<1	<1	<1
Fc	2	<1	<1	<1	<1	1	<1	<1	<1
WD	2	<1	<1	<1	<1	1	<1	<1	<1
IV. Water									
S	7	4	2	4	3	6	3	3	2
Fc	8	7	1	4	6	13	6	5	5
WD	5	5	1	5	5	8	3	4	2

(S = Submerged; FC = Field capacity; WD = Wetting and drying)

phosphorus from the soils and it ranged from 6 to 32 ppm. Among the soils, red soils recorded higher available phosphorus (33 ppm) followed by black soils (24 ppm) and alluvial soils (13 ppm). Olsen's extracted more phosphorus in alluvial soils (13 ppm). This extractant is very specific in the selection of particular form of P from the soil that is available to the crop under the given condition. Extractants like 0.01M $CaCl_2$ and water were found to be distinctly inferior in their ability to extract the phosphorus from these soils. Though the extractability was better by Bray's No. 1 followed by Olsen's, still they were not found to be statistically significant in relation to phosphorus availability in these soils ($r = +0.337$). This indicates the complexity of transformation of P under rice culture.

Much work has been carried out in India and elsewhere to evaluate the chemical methods of estimating available phosphorus in soils. Wider variations in the availability of nutrients from region to region and even field to field were found to occur. Submergence to rice was found beneficial in as much as it affords reductions and increases the availability of iron and promotion of P release in solution. This was reflected in better uptake of phosphorus under submerged soils as indicated in the present study.

It is generally believed that A 1-P and Fe-P fractions dominate in acid soils and as the pH increases the quantities of A1-P and Fe-P decreases. But in the present study, the pH of the soils used ranged from 6.3 to 8.1 and still they contained a fair distribution of A1-P and Fe-P. Existence of such soils in India have already been recorded (Datta and Datta, 1963). In general, Fe-P fractions were found to be higher in alluvial soils than red and black soils (Rajakkannu and Ravikumar, 1975).

The Bray's No. 1 extractant with 0.03N NH_4F extracts small portions from more than one fraction of Soil-P and it provides a good measure of A1-P in soils (Mahapatra and Patrick, 1969). Preferential extraction of Fe-P by the Olsen's method over other fractions of soil P was already recorded (Khanna and Mahajan, 1971). The dominance of A1-P and Fe-P in the case of red and black soils and Fe-P in the case of alluvial soils corroborates with the above statements. Further, in this study, a significant negative correlation ($r = -0.682^*$) between Fe P and plant available P was obtained. Similar results were reported by Khanna and Mahajan (1971).

Among the extractants tried none of them had any significant relationship with uptake by rice. When all the soil tests were pooled and correlated with uptake still the correlation co-efficient was not significant. Though these tests have some validity in case of upland crops, under waterlogged conditions they lose the precision and ascertaining the respective P fractions becomes more difficult one.

In the present study red and black rice soils gave higher values with Bray No.1 extractant while alluvial soils indicated similar values for Olsen's/Bray No. 1 extractant which are in line with the findings of Grigg (1965) and Tripathi *et al.* (1970). Further co-ordinated work may be necessary in this line for refinement and wider adoption.

REFERENCES

CHANG, S.C. and S.R. JUO. 1963. Available phosphorus in relation to forms of phosphorus in soils. *Soil Sci.* 95 : 91-96.

DATTA, N.R. and N.P. DATTA. 1963. Response to phosphates in rice and wheat in different soils. *J. Indian Soc. Soil Sci.* 11 : 117-28.

GRIGG, J.L. 1965. Inorganic phosphorus fractions in South Island soils and their solubility in commonly used extracting solutions. New Zealand *J. agric. Res.* 8 : 313-26.

JACKSON, M.L. 1960. Soil Chemical Analysis. Printice Hall of India Pvt. Ltd. New Delhi.

KHANNA, S. S. and K. K. MAHAJAN. 1971. A study of the behaviour of added phosphorus in soils of variable physico-chemical properties. Int. Symp. Soil Fert. Evaluation. New Delhi. I : pp. 725-36.

MAHAPATRA, I. C. and W. H. PATRICK, Jr. 1969. Inorganic phosphate transformation in waterlogged soils. *Soil Sci.* 107 : 231-88.

OLSEN, S.R., C.V. COLE, F.F. WATANABE and L.A. DEAN. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept. Agr. Circ. 939.

PONNAMPERUMA, F. N. 1965. Dynamic aspects of flooded soils and the nutrition of the rice plants. In the Mineral Nutrition of the Rice Plants. IRRI, John Hopkins Press, Baltimore, Md. 295-328.

RAJAKKANNU, K and V. RAVIKUMAR 1975. Fractions of inorganic phosphorus and their relation to availability in soils. *Madras agric. J.* 62 : 435-38.

TRIPATHI, B. P., H. L. S. TANDON and E. H. TYNER. 1970. Native inorganic P-forms and their relation to some chemical indices of phosphate availability for soils of Agra District, India. *Soil Sci.* 109 : 93-101.