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Studies on Fixation and Availability of Phosphorus in the Alkaline Soils of Tamil Nadu

by

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Introduction : In most cases, the phosphorus level of soils is too low to sustain a good crop. This necessitates a regular practice of phosphorus fertilization. However, this does not solve the problem completely because the phosphorus is rendered unavailable in several ways under different conditions in soils. The present study was taken up with the object to study the important physical and chemical constituents of soils, having a bearing on the fixation and availability of phosphorus in alkaline soils and also to observe the progressive changes in the availability of phosphorus with time following the addition of different doses of fertilizer phosphorus in the soils.

Materials and Methods : Forty representative soil samples consisting of red, black and alluvial soils with alkaline reaction were collected from different regions of Tamil Nadu. The selected soil samples were analysed for their physical and chemical properties with special reference to phosphorus status of soils to assess their influence on fixation and availability of phosphorus.

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A soil incubation study was undertaken to observe the trend in availability of phosphorus from applied phosphorus. For this study, samples consisting of all the three types *viz.*, red, black and alluvial soils were given two treatments namely 30 lb P_2O_5/acre and 60 lb of P_2O_5/acre in the form of super phosphate. These two sets of samples were maintained under identical conditions at room temperature, the moisture level being maintained at field capacity. Samples were analysed for available phosphorus by Olsen's method at fortnightly intervals for a period of three months. The trend in availability of phosphorus from the applied fertilizer was observed.

Results and Discussion: Data on contents of total phosphorus and available phosphorus as well as phosphorus-fixing capacity and values for pH, percentage of clay, organic carbon, free calcium carbonate, aluminium oxide and iron oxide were collected and analysed statistically. Table 1 indicates results of soil incubation study. In Table 2, results of statistical analysis are given.

TABLE 1. *Results of soil incubation study : Available phosphorus estimated (Fortnightly intervals)*

(ppm 'P' on air dry basis)

Treatment I = 30 lb P_2O_5 / acre and Treatment II = 60 lb P_2O_5 / acre

15th day		30th day		45th day		60th day		75th day	
Tr. I	Tr. II	Tr. I	Tr. II	Tr. I	Tr. II	Tr. I	Tr. II	Tr. I	Tr. II
41	53	184	224	16	102	20	23	12	30
53	52	120	218	60	102	26	24	26	55
47	41	88	82	100	128	20	40	14	36
36	41	64	6	52	104	22	40	12	42
36	41	58	90	44	64	26	22	30	33
48	36	68	126	54	60	28	22	20	24
52	60	92	138	58	68	22	26	36	14
30	33	94	134	62	50	24	30	24	36
39	39	56	70	46	54	10	24	24	28
43	39	108	136	82	44	20	38	32	44
33	47	66	140	102	40	20	36	32	48
39	39	94	93	96	64	24	40	24	38

Comparison of Treatments :		I		II		
	Treatments	30 lb P_2O_5/acre	60 lb P_2O_5/acre	S.E.	C.D,
	Mean	48 98	60.87	2.99	8.375
	Conclusion :	00, II, I			

Comparison of Periods :	15th day	30th day	45th day	60th day	75th day	S.E.	C.D.
Mean	42.42	106.25	70.78	26.13	29.75	4.67	13.08

Conclusion : 30th day, 45th day, 15th day, 75th day, 60th day

TABLE 2. *Results of statistical analysis*

Relationship between X	Y	Correlation Coefficient	Regression Equation
Soil reaction (pH)	Phosphorus fixing capacity	−0.5602**	Y=26.889X+632.13
Clay %	-do-	0.7545***	Y=2.9462X+332.58
Aluminium phosphate	-do-	0.7524***	Y=1.686 X+320.10
Sesaquioxides	-do-	0.7247***	Y=13.9125X+344.56
Free Calcium Carbonate	-do-	0.4927***	Y=10.083 X+387.48
Clay %	Available phosphorus	0.9170***	Y=1.586 X=2.28
Total phosphorus	-do-	0.8283***	Y=0.0745 X+4.13
Organic carbon	-do-	0.4383**	Y−23.882 X+21.11

***=Significant at 0.1% level **=Significant at 1.0% level

Phosphorus-fixing capacity: The relationship between soil reaction and the phosphorus fixing capacity was found to be inverse as indicated by a negative correlation (r=−0.560**) obtained between them. The fact that phosphorus fixing capacity decreases with increasing pH has been observed by Kanwar and Grewal (1960).

Finer fractions of the soil exert very great influence on the phosphorus fixing capacity of the soil. The present study shows a high correlation coefficient of the order of 0.756 between the clay content and phosphorus fixing capacity. This is in line with the observation made by Coleman (1944) and Chatterjee and Datta (1951) who stated that clays retain considerable amount of phosphorus because of their high specific surface area.

In acid soils, sesquioxides are mainly responsible for the fixation of phosphorus. In soils with alkaline reaction also, the phosphate fixing capacity has been found to have a direct relationship with sesquioxide content of soil. Hence the role of sesquioxide in phosphate fixation in alkaline soils cannot be ruled out. In the alkaline calcareous soils of the Punjab, Kanwar and Grewal (1960) showed that 29.6% of phosphorus fixed was due to free sesquioxides.

Data indicate that the phosphate fixing capacity increases with increasing amounts of free calcium carbonate. Similar to clay, calcium carbonate particles with high specific surface area serve as sites of phosphate fixation. The depressing effect of free calcium carbonate on phosphorus solubility was observed by Bioschot *et al* (1950) and Talibudeen (1957). Degree of solubility of the inorganic phosphorus fractions at a particular pH determines the phosphate fixing capacity of the soil. Among different fractions of inorganic phosphorus, aluminium phosphate exhibited close correlation (r=0.752) with the phosphate fixing capacity. Similar relationship has been observed by Raychaudhuri and Mukerjee (1941) and Coleman *et al* (1960).

Available phosphorus: Availability of phosphorus depends mainly on the solubility of various forms of phosphorus, easily soluble forms being more readily available than difficultly soluble ones. Solubility of phosphorus fractions seems to be controlled by pH of the soil. However, in the present study, no direct relationship could be obtained between the soil pH and available phosphorus. Rajagopal (1961) stated that pH alone could not be considered to be a major factor in the fixation and availability of soil phosphorus. Metha and Patel (1963) also showed that phosphorus availability was not correlated with soil reaction, and suggested that the phosphorus availability was influenced by the interaction of all soil factors like pH, clay content and soil organic matter. Available phosphorus exhibited a close relationship ($r=0.9100$) with clay %, indicating the availability increases with increase of clay content.

Besides being a source of phosphorus, organic matter is credited with its capacity to increase the availability of phosphorus. In the present investigation, a general relationship between organic carbon and available phosphorus has been established. Suppressing effects of humates on phosphorus fixation and consequent increase in available phosphorus have been indicated by Hannapal *et al* (1964).

Incubation study: The soil incubation study indicated a definite trend for the availability of phosphorus from the applied fertilizer. The amount of available phosphorus increased regularly with the increasing dose of fertilizer. There was no variation in the trend in availability in all the three types of soils and for the two different doses of fertilizer applied. Availability increased upto 30th day. Afterwards, it declined upto 60th day. As time proceeded further, the trend was towards attaining an equilibrium stage at which there was no significant difference among the periods in the release of phosphorus from applied super phosphate.

The decreasing trend in the availability of phosphorus after a stage of maximum availability might be due to the progressive reversion of applied phosphorus. Rapidity of reversion of applied phosphorus depends upon the conditions existing in the soils. In the lateritic soils of the Nilgiris, Mathan (1964) reported that maximum availability was on the 3rd day and a decline was noticed afterwards. Vijayachandran (1966) indicated that the declining trend started from 15th day in some laterite soils of South India. But in the present study with soils having alkaline reaction, the decline in availability was observed from 30th day. This means that reversion of phosphate starts much later in alkaline soils. Collings (1955) stated that reversion of water-soluble phosphate is not as rapid in neutral or alkaline soils as in acid soils.

A significant difference was observed in the availability of phosphorus from the two different doses of fertilizer studied. Availability increases with increasing amounts of applied phosphate.

Summary: Forty representative soils of alkaline reaction, collected from different regions of Tamil Nadu were analysed for their physical and chemical properties with special reference to the phosphorus status. The phosphorus fixing capacity of the soils were found to have direct relationship with the clay content, sesquioxides, free calcium carbonate and amount of aluminium phosphate in the soils. The availability of phosphorus seemed to increase with increasing amounts of clay and organic matter. The soil incubation study indicated that the availability of phosphorus from applied fertilizer increases upto 30th day, followed by a decline upto 60th day heading towards an equilibrium stage.

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