Indian J. Hill Farmg. 14 (1) : 136 — 140 2001

PHOSPHORUS FIXATION CAPACITY IN ACID ALFISOLS OF MEGHALAYA

M.S. Venkatesh and B. Majumdar
Division of Soil Science, ICAR Research Complex for NEH Region, Umroi Road, Umiam, Meghalaya 793 103

The recovery of fertilizer phosphorus by the crop amounts to only 10 to 30 percent of quantity added to the soil. Remaining 70 to 90 per cent of P has been assumed to be precipitated by soluble cations in soil solution or sorbed by the soil complex – a process known as "phosphorus fixation". P fixation in soil is influenced by a number of factors such as pH, organic matter, clay content etc. There seems to have been very little attempt to assess the P fixing capacity (PFC) and factors affecting PFC in acid soils of Meghalaya. Studies were therefore undertaken to determine of P fixation capacity and factors affecting PFC in some soil samples collected from various locations of Meghalaya state under different cropping pattern.

A total of 30 surface soil samples (0-20 cm), three each from ten different cropping patterns were collected from different locations of Meghalaya state. Physico-chemical properties of soils viz., pH, organic carbon, textural fractions were determined by following standard methods (Jackson, 1973). Available P was estimated by Bray P-1 method and available K was determined flame photometrically by using neutral N NH_4OAc as an extractant. P fixation capacity was determined by the procedure given by Ghosh *et al* (1983). Two grams of soil was incubated for 96 hours at room temperature by adding 1 ml of solution of different concentrations of P (0, 25, 50, 75, 100, 125, 250, 375 and 500 ppm P as mono-calcium phosphate). Available P was estimated in the soils both initially and after incubation period. P fixation capacity (PFC) was determined by using the formula :

$$PFC = \frac{C - (B - A)}{C} \times 100$$

Where, A = Initial P content in the soil

B = P content in the test samples

C = P added to the soils

Simple correlation and multiple regression analyses were worked out between PFC and some soil physico-chemical properties.

Data on physico-chemical properties are furnished in Table 1. Soils were acidic in reaction with their pH ranging from 4.20 to 4.92 in various locations. Organic carbon content varied from a minium of 0.85% in Mawlai soils to a maximum of 1.98% in low land

soils of Umiam. Clay content ranged from 25.7 to 35.26% with its highest content (35.26%) in low land soils of Umiam.

Results on P fixation capacity of soils as influenced by different locations and by addition of various concentration of P are presented in Table 2. Average P fixing capacity varied from 52.29 to 71.18% in soils of various locations. Highest P fixation capacity (71.18%) was observed in low land soils of Umiam which may be due to the presence of more amount of free iron oxides and clay in these soils. As the concentration of added P increased, there was a gradual decline in per cent P fixing capacity. Highest PFC was noticed when soil was incubated with 25 ppm of added P. This indicates that availability of P is more at higher levels of P application than at lower levels. A decrease in P adsorption in acid soil of West Bengal from 98 to 41% was observed with increase in added P from 25 to 1000 ppm (Basu and Mukherjee, 1969).

P fixation capacity was found to decrease with increase in soil pH. This was further confirmed by the significant and negative correlation (r= - 0.58*) between soil pH and PFC of soils. Significant and positive correlation (r = 0.36*) was noticed between PFC and organic carbon content of soils (Table 3). Higher P fixation capacity in soil with higher organic carbon content has also been reported by earlier researchers (Kanwar and Grewal, 1990). The amount of P fixed at all levels of added P showed significant negative correleation with available P content of soils (Table 3).

Clay minerals are known to adsorb sufficient quantity of phosphates. More the clay content of soils, higher is the P fixation which was evident from the highly positive and significant correlation (r = 0.85**) between PFC and clay content of soils. Nad *et al* (1975) also reported that the clay fractions were the dominant factor responsible for P fixation in major soil groups of India. The rapid fixation of P by the clay minerals is attributed to its reaction with readily available Fe and Al in soils.

Multiple regression analysis (Table 4) indicated that P fixing factors i.e. pH, organic carbon, available P and clay content of soils together accounted for 70 per cent ($R^2 = 0.70$) of the amount of P fixed at different levels of added P. The resultant regression equation for the mean PFC was $Y = -1.65 + (0.52 X_1) + (3.95 X_2) + (0.08 X_3) + (1.82 X_4)$ where X_1, X_2, X_3 and X_4 are pH, organic carbon, available P_2O_5 and clay content of soils respectively. The predicted P fixation values from this equation possessed highly significant positive correlation with the experimental values (r = 0.88**). Similar observations were reported by Das et al (1993) in some acid Alfisols of Orissa.

REFERENCES

Basu, S. N. and Mukherjee, S. K. (1969). J. Indian Soc. Soil Sci, **17**: 391-397.

Das. P. K., Sahu, G.C., Nanda, S.S.K. and Acharya, N. (1993) J. Indian Soc. Soil Sci., **41**: 51-55.

Ghosh, A. B., Bajaj, J.C., Hasan, R. and Singh, D. (1983). Soil and water testing methods. IARI Publication, New Delhi.

Jackson, M. L. (1973)., Soil Chemical Analysis, Prentice Hall Pvt. Ltd., New Delhi.

Kanwar, J. S. and Grewal, J. S. 1990. P Fixation in Indian Soils, ICAR, New Delhi

Nad, B. K., Goswamy, N. N. and Leelavathi, C.R. (1975) J. Indian Soc. Soil Sci., **23**: 319-327.

Table 1. Physico-chemical properties of soils

Location	Cropping Pattern	pH	Organic carbon	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Clay content (%)
UMIAM	Lowland Paddy-Fallow	4.20*	1.98	4.48	115.58	35.26
UMIAM	Groundnut - Mustard	4.26	1.77	8.40	271.04	28.50
UMIAM	Maize - Fallow	4.53	1.88	4.48	115.00	30.05
UMIAM	Turmeric - Fallow	4.86	1.60	7.46	108.17	26.25
UMIAM	Ginger- Sweet potato	4.40	1.57	9.68	105.73	27.20
UMIAM	Citrus	4.38	1.90	11.67	186.80	25.75
GARO HILLS	Tea	4.49	1.79	9.86	172.80	30.50
MAWLAI	Tea	4.92	0.85	5.68	137.50	29.50
UMROI PLAIN	Spices - Paddy	4.53	1.77	2.80	109.20	28.20
UMROI HILLS	Spices	4.64	1.79	4.86	112.05	29.20

* Figures indicated are the mean of 3 samples

Table 2. Phosphorus fixation capacity of soil

Location	Cropping Pattern	Phosphours Fixation capacity (%) Concentration of P added (mg/kg)								
		25	50	75	100	125	250	375	500	Average
UMIAM	Low land Paddy – Fallow	96.0*	88.84	83.6	74.3	65.0	59.0	53.0	49.7	71.18
UMIAM	Groundnut-Mustard	92.2	80.0	55.6	58.3	53.4	46.7	44.5	33.3	58.00
UMIAM	Maize-Fallow	86.7	76.6	72.3	63.4	60.0	53.2	48.9	38.3	62.43
UMIAM	Turmeric Fallow	80.0	76.6	72.1	65.8	56.0	41.3	36.5	34.0	57.79
UMIAM	Ginger-sweet Potato	83.6	78.0	73.3	68.4	56.7	43.4	35.6	31.7	58.84
UMIAM	Citrus	73.6	66.8	55.6	59.2	49.3	44.6	36.0	33.2	52.29
GARO HILLS	Tea	84.0	78.5	68.5	65.0	70.3	69.0	58.8	51.0	68.13
MAWLAI	Tea	78.3	69.59	62.0	55.8	52.3	48.26	47.0	42.1	56.91
UMROI Plain	Spices-Paddy	80.5	72.2	65.4	60.5	55.3	50.8	43.9	35.7	58.02
UMROI Hills	Spices	82.7	76.3	67.2	65.2	68.1	65.0	57.8	45.1	65.93
Average		83.75	76.33	67.56	63.6	58.6	52.1	46.20	39.41	

* Figures indicated are the mean of 3 samples.

Table 3. Correlation coefficients between soil characteristics and P fixation capacity at different levels of added P.

P added (mg/kg)	pH (1:2.5)	Organic Carbon (%)	Available P_2O_5 (kg/ha)	Clay (%)
25	-0.84**	0.38*	-0.31	0.75**
50	-0.78**	0.41*	-0.21	0.73**
75	0.35	0.22	-0.39*	0.62**
100	-0.51*	0.48*	-0.12	0.53**
125	-0.43*	0.36*	-0.22	0.61**
250	-0.36*	0.31	-0.24	0.63**
375	-0.33	0.16	-0.39*	0.71**
500	-0.25	0.08	-0.27	0.80**
Mean PFC	-0.58**	0.36*	-0.36*	0.85**

*Significant at 5 % level

** Significant at 1 % level

Table 4. Combined effect of soil characteristics of P fixation capacity at different levels of added P.

P added (mg/kg)	Multiple regression co-efficient					R^2	"'r" pE
		pH	Organic Carbon	Available P_2O_5	Clay		
	a	b1	b2	b3	b4		
25	154.77	-19.11	-1.62	-0.29	0.71	0.79**	0.91**
50	104.02	-12.67	-0.62	-0.25	0.98	0.66**	0.85**
75	-2.45	2.74	4.53	-0.38	1.81	0.26	0.64**
100	21.11	-0.04	6.43	0.21	1.04	0.45*	0.67**
125	-19.21	3.39	6.72	0.17	1.72	0.30	0.67**
250	-83.89	9.14	8.76	0.32	2.66	0.32	0.68**
375	-62.95	6.70	3.27	-0.06	2.53	0.40*	0.73**
500	-123.01	13.75	2.64	0.66	3.13	0.69**	0.87**
Mean PFC	-1.65	0.52	3.95	0.08	1.82	0.70**	0.88**

r PE = 'r' between predicted and experimental P fixation values

Note : Y = a + (b1 x pH) + (b2 x organic carbon) + (b3 x av. P_2O_5) + (b4 x clay)