Agropedology 2006, 16 (2), 122-125

Response of rice to applied P in soils of Pahargaon series in Andaman and Nicobar Islands

A. N. GANESHAMURTHY, GANAURI SINGH, A. K. NAIR, R. DINESH AND N. R AVISANKAR

Central Agricultural Research Institute, Port Blair- 744 101, Andaman, India

Abstract: A two-year experiment was conducted on farmers' fields to study the response of rice to applied P in alluvial soils spread over 20 sites representing Pahargaon series. The available P varied from 5.1 to 15.6 mg kg^{-1} soil in different soil samples. There was significant increase in grain and straw yields due to 30 kg P_2O_5 ha^{-1}. It is found that 92 per cent of the grain yield is associated with grain P concentration, whereas 96 per cent of the grain yield with P uptake. A second degree polynomial equation was developed to calculate the amount of P to be applied to get optimum yield depending upon the initial test. Out of six regression models used to relate the response of rice to applied P, quadratic model was the best fit.

Additional key words: *Available P, P uptake, second degree polynomial equation*

Introduction

Pahargaon soil series is one of the major soil series of Andaman and Nicobar Islands and occur on gentle slopes of alluvial and fluvial deposition (Singh *et al.* 1988). The soils are deep, acidic and non-saline with low base saturation. Though rice is extensively grown in these soils, its productivity (2.2 t ha^{-1}) is very low due to poor agro-management (Mongia *et al.*1988). No information is virtually available on the response of rice to applied P in these soils and hence the present study was undertaken.

Materials and Methods

Twenty sites (Farmers' fields) representing Pahargaon series were selected for experiments. Before initiation of field experiments, soil samples were collected from the fields and were analysed for physical and chemical properties. Available P was extracted in Brays-II extractant and P in the filtrate was analysed using the ascorbic acid method of Watanabe and Olsen (1965). Field experiments were laid out at all the 20 sites in a randomized block design with net plot size of 5m x 10m. The treatments consisted of 4 levels of P_2O_5 (0, 30, 60 and 90 kg P_2O_5 ha^{-1}) with three replications. After P was applied as di-ammonium phosphate along with a basal application of 40 kg K_2O and 60 kg N ha^{-1} (taking into account the amount of N added through DAP), 20 days old IR-20 rice seedlings were planted in those plots. Two split applications of 30 kg N ha^{-1} through urea was top-dressed at tillering and flag leaf stage. All other standard agronomic practices were followed. After proper processing, grain and straw samples were digested in tri-acid mixture. The digests were made to volume and P in the filtrate was measured using vanadomolybdate yellow colour method (Piper 1967). The results were statistically analysed using SPSS package.

Results and Discussion

The soil (Typic Dystrochrepts) of the experimental sites were acidic (pH 5.48 to 6.20) and non-saline. In general, the soils were high in organic carbon content (8.3 g kg^{-1}), high in available N (497 kg ha^{-1}) and low in available K (90 kg ha^{-1}). The available P varied from 2.15 to 6.45 with a mean of 4.1mg kg^{-1}. The lowest and the highest P were extracted from sample No.2 and 7 respectively. Grain yield of rice varied from 14 q ha^{-1} to 29.2 q ha^{-1} in control treatment of different sites. The grain and straw yield of rice were increased significantly upto 60 kg P_2O_5 ha^{-1} in 17 out of 20 sites (Table 1). But in other soils, it declined. The response of rice grain yield to applied P can be expressed as:

$Y = 18.9600 + 0.2540$ (fertilizer P) - 0.0017 (fertilizer P)^2 (R^2 = 0.642)

Table 1. Available soil P (mg kg^{-1} soil), rice grain and straw yields (q ha^{-1}) as influenced by P application

Soil sample No.	Available P	P_2O_5 (kg ha^{-1})							
		0		30		60		90	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1	2.78	14.65	29.42	22.18	45.26	28.36	55.17	27.64	53.89
2	2.36	14.26	28.67	23.21	46.19	27.98	56.41	27.34	55.76
3	4.90	19.21	40.36	23.42	47.41	28.69	58.30	28.14	27.09
4	6.22	28.67	59.94	27.76	54.08	26.48	53.14	26.32	52.76
5	2.55	14.58	30.19	24.21	49.62	29.67	60.26	29.02	58.87
6	3.05	15.74	31.66	23.21	46.19	28.79	56.94	28.27	55.19
7	6.68	29.16	59.19	28.20	56.06	28.16	55.89	28.25	55.76
8	5.85	24.16	49.22	27.32	53.84	27.61	53.16	27.54	53.87
9	4.95	19.47	40.06	24.12	49.11	29.36	60.31	28.44	56.59
10	4.85	19.55	41.21	24.37	48.76	29.14	59.46	28.37	55.79
11	3.05	15.11	30.21	23.17	47.41	28.62	57.32	28.49	58.26
12	3.40	15.81	30.96	24.26	49.26	29.17	59.19	29.02	59.77
13	2.80	14.49	28.02	23.49	47.19	28.96	57.26	28.63	56.88
14	5.35	23.18	47.19	26.32	53.23	28.94	55.79	28.07	55.07
15	2.98	14.17	29.17	24.17	49.26	29.84	59.76	28.69	58.72
16	2.60	14.02	27.92	22.44	45.11	27.63	55.39	27.11	55.01
17	4.70	19.14	39.21	24.27	49.52	31.63	63.44	30.19	61.28
18	4.95	22.94	44.32	26.14	53.44	29.26	61.36	28.65	55.91
19	6.70	28.21	57.16	27.32	56.29	26.11	53.20	26.11	53.02
20	3.05	15.96	32.11	22.17	45.32	29.66	61.04	28.39	57.88
Mean		20.15	38.66	25.49	49.63	28.40	57.64	28.13	56.37

LSD(P=0.05) P = 0.88, Grain = 1.76, Straw = 2.33

It suggests that optimum rice yield of 28.5 q ha^{-1} can be obtained by applying 67.2 kg P_2O_5 ha^{-1} in these soils.

The P concentration in rice grain in controlled plots ranged from 0.38 to 0.48% (Table 2). The P concentration in grain and straw increased with increase in P levels, which indicated that P in plant is related to the initial available P in soils. The total P uptake in control (Table 3) varied from 6.73 kg ha^{-1} to 17.21 kg ha^{-1}. The total P uptake increased with increase in applied P, but significant response was obtained only upto 60 kg P_2O_5 ha^{-1} in all the soils barring 4, 7, 8 and 19 numbered soils where it remained at par with30 kg P_2O_5 ha^{-1}. The relationship between grain yield and P concentration was worked out as -

$Y = -202.58 + (P\ concentration) - 8875.75\ (P\ concentration)^2$ ($R^2 = 0.919$)

This equation, indicates that optimum grain yield of 26.4 q h^{-1} was obtained with the grain P concentration of 0.459 per cent and only 92 per cent of the grain yield was associated with grain P concentration. Similarly, relationship between grain yield and P uptake was developed as -

$Y = -2.279 + 3.523\ (P\ uptake) - 0.097\ (P\ uptake)^2$ ($R^2 = 0.965$)

It is found that 96 per cent of the grain yield is associated with total P uptake and the optimum yield of 29.2 q ha^{-1} can be obtained with the P uptake of 16.3 kg P ha^{-1}. The relationship between rice grain yield and extractable P

Table 2. Phosphorus concentration (%) in rice grain and straw as influenced by P application

Soil sample No.	P_2O_5 kg (ha^{-1})							
	0		30		60		90	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1	0.39	0.051	0.43	0.055	0.48	0.061	0.51	0.064
2	0.38	0.052	0.44	0.057	0.49	0.065	0.51	0.071
3	0.40	0.054	0.47	0.062	0.50	0.066	0.52	0.075
4	0.48	0.056	0.51	0.064	0.54	0.071	0.57	0.079
5	0.38	0.052	0.44	0.060	0.47	0.067	0.52	0.075
6	0.39	0.053	0.43	0.062	0.48	0.070	0.51	0.081
7	0.48	0.056	0.50	0.061	0.53	0.074	0.55	0.080
8	0.45	0.057	0.49	0.066	0.52	0.075	0.56	0.083
9	0.40	0.054	0.44	0.056	0.47	0.078	0.51	0.086
10	0.41	0.055	0.45	0.065	0.48	0.072	0.52	0.081
11	0.39	0.051	0.44	0.060	0.47	0.069	0.51	0.078
12	0.39	0.052	0.43	0.066	0.57	0.075	0.50	0.082
13	0.38	0.048	0.44	0.058	0.49	0.066	0.52	0.074
14	0.43	0.055	0.47	0.062	0.50	0.068	0.54	0.074
15	0.39	0.050	0.44	0.061	0.47	0.066	0.52	0.075
16	0.38	0.050	0.44	0.064	0.47	0.075	0.53	0.082
17	0.42	0.053	0.46	0.063	0.49	0.071	0.54	0.084
18	0.41	0.054	0.45	0.062	0.48	0.070	0.52	0.081
19	0.47	0.058	0.51	0.068	0.53	0.077	0.56	0.084
20	0.40	0.053	0.44	0.061	0.47	0.070	0.51	0.078
Mean	0.43	0.053	0.43	0.064	0.51	0.070	0.53	0.078
LSD(P=0.05)	Grain = 0.046, Straw = 0.008							

as a function of P fertilization was developed using second degree polynomial as -

$$Y = 15.537 + 0.630\,(\text{Bray P}) + 0.044\,(\text{Bray P})^2 + 0.255\,(\text{P level})^2$$

($R^2 = 0.738$)

This equation helps to calculate the quantity of fertilizer P to be added to the soil of known soil test P to obtain the target yield.

Six regression models were used to relate the response of rice to applied P (at 60 kg P2O5 ha^{-1}) and available P extracted by Bray's extractant using six-regression models *viz.*, linear, quadratic, reciprocal, logarithmic, linear square root and quadratic square root models. The relationship between the amount of soil P extracted and response of rice to 60 kg P2O5 ha^{-1} showed that quadratic model (Table 4) was better fit (R2=0.977) than the other models in these soils.

Thus, it can be concluded that rice grain yield in these soils could be significantly increased with an application of 60 kg $P_2O_5 ha^{-1}$. However, the amount of P to be applied to get optimum yield depends upon the initial soil test P and can be calculated from the second degree polynomial equation developed from this study.

Table 3. Phosphorus uptake (kg ha^{-1}) by rice grain and straw as influenced by P application

Soil sample No.	P_2O_5 (kg ha^{-1})							
	0		30		60		90	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1	5.71	1.50	9.54	2.49	13.61	3.37	14.96	3.45
2	5.42	1.49	10.21	2.63	13.71	3.67	13.94	3.96
3	7.68	2.18	11.00	2.94	14.35	3.85	14.63	4.28
4	13.76	3.34	13.90	3.46	14.30	3.77	15.00	4.17
5	5.54	1.57	10.67	2.98	13.94	4.04	15.09	4.42
6	6.14	1.68	9.98	2.86	13.82	3.99	14.42	4.47
7	13.90	3.31	14.10	3.42	14.42	4.14	15.68	4.46
8	10.87	2.81	13.88	3.55	14.36	4.00	15.42	4.47
9	7.79	2.16	10.61	2.75	13.80	4.70	14.05	4.87
10	8.02	2.27	10.96	3.17	14.00	4.28	14.75	4.52
11	5.89	1.54	10.19	2.84	13.45	3.96	14.63	4.54
12	6.17	1.61	10.43	3.25	13.71	4.44	14.51	4.90
13	5.51	1.34	10.34	2.74	14.19	3.78	14.88	4.21
14	9.97	2.60	12.37	3.30	14.47	3.79	15.57	4.08
15	5.53	1.46	10.63	3.00	14.02	3.94	14.92	4.40
16	5.33	1.40	9.87	2.89	12.99	4.15	14.37	4.51
17	8.04	2.08	11.16	3.12	15.50	4.50	16.30	5.11
18	9.41	2.34	11.76	3.31	14.04	4.30	14.90	4.53
19	13.26	3.32	13.95	3.83	13.83	4.10	14.62	4.45
20	6.38	1.70	9.75	2.76	13.94	4.27	14.48	4.51
Mean	8.02	2.09	11.23	3.06	15.96	4.05	15.49	4.41

LSD(P=0.05) Grain = 0.49, Straw = 0.21

Table 4. Coefficient of determination between absolute response of rice to 60 kg P_2O_5 ha^{-1} and soil test P

Model	Bray P
Linear	0.867
Quadratic	0.977
Reciprocal	0.671
Logarithmic	0.778
Square root	0.826
Quadratic square root	0.971

References

Mongia, A.D., Ganeshamurthy, A.N. and Singh, N.T. (1988). Chemical changes and reponse of rice to rock phosphate and super phosphate in acid soil. *Journal of Andaman Science Association* **4:** 13-17.

Piper, C.S. (1967). Soil and Plant Analysis, (Hans Publishers: Bombay, India).

Singh, N.T., Mongia, A.D. and Ganeshamurthy, A.N. (1988). Characteristics and classification of the soils of Andaman and Nicobar Islands. *Journal of Andaman Science Association* **4:** 1-12.

Watanabe, F.A. and Olsen, S.R. (1965). Test of an ascorbic acid method for determining phosphorous in water and NaHCO3 extracts from soil. *Soil Science Society of America Proceedings* **29:** 677-878.

Received July, 2000; Accepted August, 2006