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RESPONSE OF RICE TO PHOSPHATE MANURING IN A WATERLOGGED LATERIT1C SANDY LOAM OF KERALA

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Studies conducted in India on the phosphate requirements of rice have yielded only conflicting results. The research workers like Singh (1953), Mukerjee (1955), Ghose *et al.* (1956), Mann and Purnapragnachar (1963) Sahu and Lenka (1960) and Rao *et at* (1967) observed positive responses in the yield of rice to phosphate manuring. On the other hand, Sethi *et al* (1952), Basak *et al* (1960), Sahu (1955) and Singh and Singh (1962), found that phosphate did not influence the yield of rice to any significant level. It thus appears that the response of rice to phosphorus depends on the type of soil and as such it is necessary to assess these responses for individual soil types. A series of field experiments were hence undertaken in the waterlogged sandy loam soil of the Central Rice Research Station, Pattambi. Kerala, on the various aspects of of phosphate nutrition of rice, details and results of which are embodied in the present paper.

Properties of the soil

The soil was a sandy loam derived from low level laterite, acid in reaction and moderately low in available plant nutrients. An analysis of the soil revealed the following characteristics :-

Mechanical :-	
Coarse sand	16·42 per cent.
Fine gravel sand	11·07 ,, ,,
Fine sand	18·44 ,, ,,
Silt	7·60 ,, ,,
Fine silt	20·32 ,, ,,
Clay	22·40 ,, ,,
Chemical:-	
Organic carbon	0'92 per cent.
Available P_2O_5 in air dry unmanured soil:	37·00 kg/ha
Available P_2O_5 in air dry soil manured with 80 kg P_2O_5/ha :	55·00 kg/ha
Available P_2O_5 in wet unrnanured soil:	160'00 ,,
Available P_2O_5 in wet soil manured with 80 kg P_2O_5/ha :	253·30 ,,
Available K_2O :	53.1 kg/ha
Total soluble salts :	nil
pH (air dry soil) :	5'4
(wet soil) :	6·3

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The interactional effect of phosphorus with nitrogen was significant only during the second crop season. The results indicated that response to nitrogen was higher at 4 kg P_2O_5 per hectare.

Discussion

The results of all the experiments described above show that applied phosphorus has no effect on the yield of rice under water-logged condition. Soil of Pattambi farm is sandy loam derived from low level laterite. Soils of laterite origin have high phosphate "fixing" capacity because of the predominance of soluble, exchangeable and oxide forms of iron and aluminium in them. The iron and aluminium contents in the Pattambi sandy loam soil comes to 4-8.0 per cent. The presence of such high quantities of iron and aluminium may be making the added phosphorus unavailable to the crop. But submerged conditions appear to favour reduction of iron and aluminium phosphates making the phosphates available rather than helping for their "fixation" (Islam and Elahi 1954, Ponnamperuma 1955). The increase in availability of phosphates under water-logged conditions has been attributed to the hydrolysis of soil phosphates and enhanced solubility of iron and aluminium phosphates (Shapiro 1958, Mitsui 1960). Actually waterlogging has been seen to increase the availability of phosphates in the soil of Pattambi (page 6). Basak and Bhattacharjee (1962) had earlier reported similar results. The absence of effect of applied phosphorus on rice under water-logged conditions thus appears to be due to the increased availability of native and "fixed" phosphates which go to meet the phosphate need of the rice plant.

Summary

The results of six field experiments conducted under water-logged conditions at the Central Rice Research Station, Pattambi, Kerala, over a period of 35 years (1933 to 1968) show that response of rice to phosphate manuring was not significant. Neither the form in which the phosphate was applied nor varying the doses of nitrogen and potash with which phosphate was applied had any effect in influencing rice yields. It is concluded that the phosphate requirement of rice could be met from the native "fixed" phosphates present in the soil.

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Table 5

Mean grain yield (kg/ha) corresponding to different levels of P_2O_5

Year & Season	Level of P_2O_5 kg/ha			F test
	0	40	80	
1966-67				
I Crop	3301·57	3411·38	3170·99	N. S.
II Crop	4312·08	4380·34	4570·27	N. S.
Mean	3806·83	3895·86	3870·63	

Response of dwarf indica variety I R. 8 to phosphorus in combination with different levels of N and K

Experimental details. The experiment was laid out for two seasons in the year 1967-68 with 3^3 partially confounded factorial design with 3 blocks per replication and 2 plot replicates. The doses of N (as urea) were 60, 120 and 180 kg/ha and those of P_2O_5 (as super phosphate) and K_2O (as muriate of potash) were 0, 45 and 90 kg/ha each. Plot size was 4·0×5·9 metres and spacings 15x20 centimetres. Of the total quantity of nitrogen, 75 per cent was applied at planting along with superphosphate and potash and 25 per cent one month before flowering.

Results. The results are set out in Table 6. During the first crop season the control plot receiving no phosphorus recorded significantly higher yields compared to the other two levels. But in the second crop season phosphate application did not show any effect on grain yield.

Table 6

Mean grain yield in kg/ha under different doses of P_2O_5

Year & Season		Doses of P_2O_5			F test	C. D. (0·05)
		0	45	90		
1967-68	I crop	4652·20	4281·50	4324·20	Significant	136·91
1967-68	II crop	5224·40	5301·27	5283·50	N. S.	—
Mean		4938·30	4731·39	4803·85		

Details and Results of Experiments

Response of paddy to phosphate manuring

Experimental details. This experiment was conducted repeatedly in three first crop seasons during 1933—36 in the same site using a latin square design. The treatments consisted of 5 levels of phosphate to give 0, 22'42, 33·63, 44·84 and 56·05 kg/P_2O_5 per hectare. The gross plot size was $5·18 \times 4·27$ metres. Each plot was given a basal dressing of green leaf at the rate of 4484 kg per hectare. The variety used was Ptb 23 (120 days duration) transplanted at 15×15 cm spacing.

Results. The mean grain yields obtained under the various levels of phosphorus are presented in Table 1. There was no significant effect of phosphate application on the yield of rice.

Table I

Mean grain yield (kg/ha) in treatments receiving different doses of P_2O_5

Year	Levels of P_2O_5 applied (kg/ha)					F test
	0	22·42	33·63	44·84	56·05	
1933-34	1980·03	2001·69	1997 87	1999·57	1954·75	N. S.
1934-35	1803·41	1847·80	1882·94	1838·55	1873·70	N. S.
1935-36	1912·70	1881·28	1951·26	1962·83	1930·05	N. S.
Mean	1898·71	1910·26	1944·02	1933·65	1919·50	

N. S. not significant.

Response of rice to different forms and doses of P_2O_5

Experimental details. This experiment was conducted for 4 consecutive seasons commencing from the first crop season of 1948—49 with the treatments given in Table 2 laid out in randomized block design with 4 replications. The gross plot size was 6·71 x 3'05 metres. The variety used was Ptb 2 (135 days duration) in the first season and Ptb 20 (135 days) in the second crop season and planted at 15×15 cm. spacing. Each plot was given a uniform dose of green leaf as basal manuring at 5605 kg per hectare and nitrogen at 16"82 kg per hectare as urea and K_2O at 22·42 kg per hectare as muriate of potash. At tillering phase 16"82 kg nitrogen (as urea) per hectare was applied as top dressing.

Results. Table 2 gives the results. It shows that none of the phosphatic fertilizers tried gave any significant increase in grain yield. The forms of P_2O_5 also did not show any significant effect on the yield.

Effect of different modes of application of phosphatic fertilizers on rice yield

Experimental details. The effect of application of phosphates before and after final ploughing was determined in this experiment. P_2O_5 was applied at 44'84 kg/ha as superphosphate. Each plot was given a uniform dose of green leaf at the rate of 5605 kg ha and nitrogen at 33 kg/ha as urea and K_2O at 22·42 kg/ha as muriate of potash as basal dressing. The design was randomised block with 8 replications. The varieties used were Ptb 2 (135 days) in the first crop season and Ptb 18 (110 days) in the second crop season. Spacing was 15x15 cm. Plot size was 6·40 x 11·58 metres. The experiment was repeated 4 times during the period 1948-47 to 1950-51.

Results. The results are given in Table 3. The methods of application showed no significant difference in their effect on grain yield.

Table 3

Mean grain yield (kg/ha) under different modes of application of P_2O_5

Year & Season	Preploughing application	Post ploughing application	Control No P_2O_5	F. Test
1948-49 2nd crop	2578·30	2645·56	2555·88	NS
1949-50 1st crop	2477·41	2301·41	2379·88	NS
1949-50 2nd crop	2543·55	2634·35	2604·08	NS
1950-51 1st crop	2610·81	2531·22	2531·22	NS
Mean	2552·52	2527·86	2517·77	

Response of rice to phosphate manuring in combination with different levels of N and K

Experimental details. The experiment was conducted for 2 seasons in the year 1961–62. The treatments consisted of all the possible combinations of three levels each of N, P_2O_5 and K_2O viz. 16·82, 33·64 and 50·46 kg/ha. The experimental design was 3^3 factorial in randomised block with 4 replications. Plot size was 7·60 × 4·57 metres. The rice varieties tried were Ptb 2 and Ptb 20 in the first and second crop seasons respectively. Planting was done at a spacing of 15x25 centimetres. Each plot received a dose of 5605 kg green leaf per hectare as basal manure. Fifty per cent of the nitrogen

Table 2

Mean yields of rice grain (kg/ha) in plots receiving different forms and levels of P_2O_5

Forms of P_2O_5	Rh[illegible] hyper phosphate			Hyper phosphate		Super phosphate		Bone meal		F test
Levels of P_2O_5 (kg/ha)	0	33·63	50·45	33·63	50·45	33·63	50·45	33·63	50·45	
Seasons										
1948-49 Ist Crop	2954·96	2996·43	2914·04	3107·41	2941·50	2872·00	3204·04	3154·49	307[illegible]·30	NS
1948-49 IInd Crop	3829·37	[illegible]	349[illegible]·40	3338·84	3394·30	3320·40	3394·30	3356·20	3412·32	NS
1949-50 Ist Crop	3194·85	3133·20	2900·88	2976·72	3200·4[illegible]	3031·18	2989·26	3102·03	3081·63	NS
IInd Crop	106[illegible]·99	183[illegible]·56	1853·0[illegible]	1928·12	1839·56	1766·70	1889·56	1868·71	2030·13	NS
Mean	2785·97	2838·65	2813·43	2787·65	2843·98	2747·57	2844·54	2870·60	2900·87	

and potash and the whole quantity of phosphorus were applied as basal dressing and the rest were applied as top dressing at panicle initiation. N, P and K were given in the form of urea, superphosphate and muriate of potash respectively.

Results. Table 4 which gives the results show that the three different levels of P_2O_5 did not differ significantly in their influence on grain yield. The interaction of P with N and K was not significant during the first crop season. It was, however, significant during the second crop season wherein the higher level of phosphorus (especially the 33·64 kg level) enhanced the effect of nitrogen and potash on grain yield.

Table 4

Mean grain yield corresponding to different levels of P_2O_5 (kg/ha)

Year & Season		Level of P_2O_5 kg ha			F test
		16'82	33·64	50·46	
1961-62	I Crop	2695'22	2720·78	2732·33	N. S.
1961-62	II Crop	3178·48	3227·58	3229·60	N. S.
Mean		2936·85	2974·18	2980·96	

Response of Tainan 3 to phosphorus in combination with different doses of N and K

Experimental details. The treatments comprised of the factorial combinations of three levels each of N (as urea), P_2O_5 (as superphosphate) and K_2O (as muriate of potash) viz. 40, 80 and 120 kg/ha for N and 0, 40 and 80 kg'ha each for P_2O_5 and K_2O. There were 2 replications with 3 blocks per replication. Nitrogen was applied half at planting and the rest at panicle initiation. Phosphorus and potash were applied as basal dressing. Plot size was 8·1 X 2'8 metres and spacing 20 × 15 cm. This trial was conducted for 2 seasons in the year 1966-67.

Results. The results are presented in Table 5. Application of phosphorus had no significant effect on grain yield. During the first crop season the interaction of nitrogen with phosphorus was found significant. Phosphate manuring was observed to influence the effect of nitrogen upto 80 kg N per hectare. In the second crop season none of the interactions was found significant.