https://doi.org/10.29321/MAJ.10.A02658

Madras agric J 70: (9). 590—594 September 1983

PHOSPHORUS UTILIZATION BY RICE (*Oryza sativa* L.) IN ALLUVIAL SOIL OF DELHI*

A. SREENIVASA RAJU[1] M. B. KAMATH[2] and N. N. GOSWAMI[2]

Employing tracer techniques, the effects of split application and dipping of rice seedling roots in phosphate slurry on yield and P uptake parameters of rice were studied under field conditions on an alluvial soil of I.A.R.I. Farm, New Delhi. Though yields were not influenced much, the P uptake parameters were considerably influenced by both the methods. Rice absorbed more P from DAP than from SSP under split application compared to full basal application. Results with alternate tagging technique indicated that the fertilizer P uptake was higher from the basally applied portion than from the top dressed quantity. Though seedling root dipping in DAP slurry resulted in highest P utilization, this method was inferior to soil application of P as the latter resulted in more fertilizer P uptake by rice crop when both methods were tried simultaneously.

Phosphorus nutrition of rice has been extensively studied during the past two to three decades in view of the inherent difficulty associated with phosphate fertilization of crops due to its immediate fixation by soils when applied, either due to chemical precipitation or by the clay and clay minerals in soils. The evolution of methods like split application, seedling root dipping in phosphate slurry etc., designed to improve the efficiency of utilization of applied P are of very recent origin and need to be evaluated. Hence an attempt has been made in the present investigation to findout the efficiencies of these methods when tried on rice grown in alluvial soil of Delhi. Alternate tagging technique has been employed to find out the contributions of phosphate from either individual splits or methods tried in this study.

MATERIAL AND METHODS

Employing tracer techniques, a field experiment was conducted on an alluvial soil (av. P = 22.7 kg/ha with a P fixting capacity of 32%) belonging to Jagat sandy loam series of I.A.R.I. Farm, New Delhi durjng *Kharif*, 1978 using Pusa 2—21 rice as the test crop.

The field experiment was a R.B.D. with 20 treatments each replicated thrice. The treatments details are furnished in table 1. Each plot under individual treatments was divided into two portionsone portion was a micro-plot and the other a main plot having demensions of 0.5 × 1.05 m² and 10.0 × 1.05 m² respectively All the plots received uniform doses of nitrogen (@ 120 kg N/ha) and potash (50 kg K_2O/ha) through urea and muriate of potash respectively. The N content of DAP was taken into account while calculating the N does for the crop. Nitrogen was applied in two equal splits at basal and at the time of top dressing with P. Rice seedlings were transplanted @ 2 seedlings / hill in 7 rows at the recommended spacing of 10 × 15 cm. The micro plots received the ^{32}P tagged fertilizers (sp. activity of 0.3 mci/g P_2O_5) and served for

1. Part of Ph. D thesis submitted to Post Graduate School, Indian Agricultural Research Institute, New Delhi.

2. Present Address : Department of Soil Science & Agrl. Chemistry College of Agriculture, Rajendranagar, Hyderabad-500030, A. P.

collection of samples while the main plot was exclusively meant for recording yields.

Plant samples were collected at flowering and at maturity for determining the P content (Koenig and Johnson, 1942 and for ^{32}P assay (Mackenzie and Dean, 1948). The dry matter yields were recorded after drying the samples at 70°c to a constant weight. An area of 0.5 × 1.05 m^2 was harvested in the main plot at the time of flowering (i.e. middle harvest), the dried weight of which was taken into consideration for computing the P uptake parameters at this stage Counting measurements were done on a G.M. counter (for samples at flowering) and a Tricarb liquid scintillation spectrometer (for samples at maturity). The treatments of the experiment were reduced from 20 to 14 by pooling the information as some treatments were repeated since alternate tagging technique was employed and statistical analysis was done on these 14 treatments only.

RESULTS AND DISCUSSION

The data obtained from the experiment are presented in Tables 1 to 4. The yield responses were ranging from 5 6 to 16.3 per cent at flowering and 10.6 to 19.1 per cent at maturity among the treatments. The yield responses recorded were 21.2 and 12.5 kg grain/kg P_2O_5 for SSP and 24.2 and 12.0 kg grain/kg P_2O_5 for DAP when phosphate was applied as full basal at 30 and 60 kg P_2O_5/ha respectively. Such responses of rice crop to the applied P even when the soils are having medium to high P were not uncommon (Bhumbla and Rana, 1965) and in this context Krishnamoorthy *et al.* (1963) suggested that the upper critical limit of the Olsen's P for rice soils be fixed at 26 to 35 kg P/ha.

At flowering, split application of SSP was found inferior to DAP at 60 kg P_2O_5/ha with respect to P content. While full basal application of SSP was superior to that of DAP, split application of DAP was better than SSP at the same level of P with respect to P uptake (Table-1). Such increases in P uptake with split application were observed at maturity also.

The per cent P derived from fertilizer (% Pdff) increased with increase in levels at both stages of the crop growth and so also was the fertilizer P uptake These values decreased with split application of phosphate at flowering. However, at maturity split application of P increased both these parameters significantly. The per cent P utilization was significantly higher when DAP was applied in splits The lower values of per cent P utilization under split application treatments at flowering suggest that the crop favoured presence of maximum phosphate in its root zone during early stages of growth. Ishizuka (1960) reported that phosphorus was absobred by rice from the beginning to the earing stage beyond which the absorption was slight or absent. However, the results presented in Tables-1 and 2 show that the P uptake continued even beyond flowering which could be confirmed by alternate tagging of the split doses. When phosphate was applied in splits, at flowering the P uptake from fertilizer was higher from the basally applied portion than from the top dressed quantity. The same trend was observed at maturity also (Table -2). However, the % Pdff and fertilizer P uptake data of the grain and straw indicated that quite a good amount of basally applied P was retained in the straw perhaps to take part in the body building process of the plant, while very little amount of the top dressed was observed in the straw. This shows that the P applied through the top dressing is directly translocated to the grain not influenceing the production of dry matter or yield. Patnaik *et al.* (1965) reported that late application of phosphate was found to increase the uptake but was not effective in increasing the yields. The results of this investigation are in confirmation with such findings. Besides the data also supports the fact that P absorption continues beyond flowering. However the role of such directly translocated P influencing the quality of the grain merits further study.

The per cent utilization of phosphate at flowering was highest in case of seedling root dipping at 20 kg P_2O_5/ha. Soil application of 20 kg P_2O_5/ha as DAP resulted in significantly higher soil P uptake than seedling root dipping at the same level, at maturity. The fertilizer P uptake values due to seedling root dipping in case of combined treatments increased with increase in level of soil application of P. Both seedling root dipping and soil application of phosphate contributed to fertilizer P uptake by grain and straw. However the seedling root dipping in phosphate solution alone will not support the plant during the rest of the crop growth and it needs to be supplemented through soil application. Not only this, the data on available P after crop suggested that the residual P left in the soil is very little in case of seedling root dipping treatments when compared to the soil application suggesting the need for more and more amounts of P application during subsequent years under such treatments.

The authors are thankful to Dr. T D. Biswas former Head, Division of Soil Science and Agricultural Chemistry, I.A.R.I. for providing necessary facilities and showing keen interest in the investigation.

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TABLE : 1 Effect of treatments on yield and P uptake parameters in rice

Tr. No	Treatment (Kg P_2O_5/ha)	Yield (q/ha)	Dry mark (q/ha)	P content (mg/g) Flg.	P content (mg/g) raty.	P uptake (Kg/ha) Flg.	P uptake (Kg/ha) raty.	P dff (%) Flg.	P dff (%) raty.	Fertilizer P uptake (Kg/ha) Flg.	Fertilizer P uptake (Kg/ha) raty.	P utilization (%) Flg.	P utilization (%) raty.	P uptake from soil (Kg/ha) Flg.	P uptake from soil (Kg/ha) raty.
T_1	Control	107	54.6	2.34	1.26	12.8	13.6	—	—	—	—	—	—	12.8	13.6
T_2	30 SSP (FB)	124	62.8	2.74	1.38	17 2	17.0	15.2	11.7	2.69	1.98	20.6	15.1	14.5	15.1
T_3	60 SSP (FB)	125	63.3	2.76	1.38	17.6	17.3	25.9	12.7	4.50	2.20	17.2	8.3	13.0	15.1
T_4	60 SSP (Split)	126	613	2 58	1.43	15.8	18.2	15.6	14.3	2.47	2.63	9.4	9.9	13.4	15.6
T_5	60 DAP (FB)	123	62.8	2.55	1 35	18.0	16 7	25.3	15.6	4.04	2.61	15.4	9.9	12.0	14.1
T_6	60 DAP (Split)	128	63.0	2.79	1.41	17.5	18.1	16 6	17.9	2.92	3.24	11.1	12.4	14.7	14.9
T_7	20DAP (SD)	123	59.6	2.58	1.32	15.4	16.3	12.4	9 1	1.91	1.49	21.5	17.0	13.5	14.8
T_8	10 DAP (SA)	118	57.7	2.53	1.33	14.6	15.8	6.1	5.6	0.88	0.89	20.2	20.3	13.7	14.9
T_9	20 DAP (SA)	123	58.9	2.56	1.42	15.1	17.5	11.3	8.5	1.70	1.49	19.5	17.0	13.3	16.0
T_{10}	30 DAP (SA)	125	62.2	2.57	1.38	16.9	17.4	14.4	10.1	2 29	1.76	17.5	013.4	13.7	15.7
T_{11}	40 DAP (SA)	124	63.0	2.65	1.48	16.7	18.4	17.2	11.8	2.89	2.15	16.5	12.3	13.8	16.3
T_{12}	20(SD)+10(SA*)	126	59.3	2.54	1.40	15 1	17 8	16.1	13.5	2.43	2.40	18.5	18.3	12.6	15 4
T_{13}	20(SD)+20(SA)	128	61.9	2.57	1.39	15.8	17.5	21.5	16.2	3.41	2.84	19.5	16.2	12.4	14.7
T_{14}	20(SD)+30(SA)	123	61.1	2.69	1.53	16.4	18.8	23.9	17.8	3.91	3.34	17.9	15.3	12.5	15.6
	CD (5%)	7.99		0.21	0 11	1.1	1.2	4.5	2.2	0.74	0.43	4.6	2.9	1.3	1.1

*Half as basal and baef as top. FB : Full basal ; SA : Soil application . SD : Seeding roof dipping : P dff (%) —Percent P : derived from fertilizer SSP : Single super phosphate ; DAP ; Diammonium phosphate.

TABLE-2: Fertilizer P uptake from basally applied and topdressed phosphate by rice (using alternate tagging technique)

Particulars	Pdff (%)		Fert. P uptake (Kg/ha)	
	SSP	DAP	SSD	DAP
At flowering :				
Basal	9.57	9 27	1.48	1.75
Top dressing	5.76	7.11	0.98	1.17
At maturity (Grain + Straw)				
Basal	8.43	9 23	1.57	1.74
Top dressing	5.62	8.58	1.05	1.50
Grain				
Basal	7.49	9.25	1.07	1.38
Top dressing	5 60	8.91	0.87	1.23
Straw				
Basal	11 42	9.17	0 50	0.35
Top dressing	5.76	7.34	0.18	0.28

(Both the doses were at 30kg P_2O_5/ha)

TABLE-3 : Fertilizer P uptake from combined application of seedling root dipping and soil application by rice (using alternate tagging technique)

Particulars	Pdff (%)		Fert. P uptake (kg/ha)	
	S D.	S.A.	S.D.	S.A.
20 S.D. + 10 S.A.	9.62	6.47	1.44	0.98
20 S.D. + 20 S A.	8 89	12.68	1.41	2.00
20 S.D. + 30 S.A.	9.86	14.35	1.62	2.29
At maturity (*Grain + straw*)				
20 S.D. + 10 S.A.	7.66	5.81	1.37	1.03
20 S.D. + 20 S.A.	8.30	7.92	1.41	1.43
20 S D. + 30 S.A.	8 39	10.10	1.68	1.76
Grain				
20 S.D. + 10 S.A.	7.66	5.34	1.07	0.78
20 S D. + 20 S.A.	8 44	7.89	1.17	1.18
20 S D. + 30 S A.	8 39	9.75	1.23	1.34
Straw				
20 S.D. + 10 S.A.	7.66	7.58	0.31	0.28
20 S.D. + 20 S.A.	7.67	8.01	0.24	0.27
20 S.D + 30 S.A.	8.40	11.66	0.35	0.42

(Source of P was DAP)

P dff = derived from from fertilizer.