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<https://doi.org/10.29321/MAJ.10.A03589>

Soil Fertility Studies in Tamil Nadu Using Radio-tracer Technique-III. Utilisation of Superphosphate Applied to Paddy through a Preceding Green Manure Crop

By

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Introduction : Radio-tracer studies have shown that only 10-20% of the phosphate applied as fertilizer is utilised by crops. With reference to paddy the application of phosphate through a preceding green manure crop has been considered of some value. Sen and Sunder Rao (1952) reported that in Bihar, phosphate manuring of *daincha* for green manuring paddy showed marked increase in yields of both green manure and paddy crop. In Mysore, sunnhemp in conjunction with superphosphate gave marked increases in yields of both green manure and succeeding paddy. Relwani and Ganguli (1959) working on Punjab soils have reported no beneficial effects due to application of phosphate through a green manure for paddy. Work done at Coimbatore during 1954-57 (Anon, 1954-55, 1955-56, 1956-57) did not show any beneficial

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effect of indirect application over direct application of phosphate for improving the paddy yields. The variations in results in these experiments have been attributed to the differences in the phosphorus fertility status of the soils. No evidence is available with reference to the utilisation of the applied phosphate under the direct and indirect methods of application of phosphate. This study, therefore, aims at finding out the efficiency of the superphosphate utilisation by the paddy crop under the direct and indirect methods, using radio-tracer technique.

Materials and Methods : A pot culture experiment was conducted with five treatments, *viz.*, (1) control (no phosphate to green manure and paddy), (2) and (3) 40 and 80 kg P_2O_5 /hectare to green manure respectively (indirect application to paddy). Each treatment was replicated four times. P_2O_5 was applied as P^{32} labelled superphosphate. N at 60 kg / hectare as ammonium sulphate in two split doses (one at planting and the other as top dressing, three weeks after planting) and 30 kg K_2O / hectare as muriate of potash at planting were applied for all treatments. Four paddy soils were used for the study, *viz.*, from Aduthurai (Thanjavur district), Coimbatore, Kallidaikurichi (Tirunelveli district) and Tirurkuppam (Chingleput district). The pH values of the soils were 7.0, 8.5, 7.0 and 8.0 respectively. The available phosphorus (Olsen) values were 4.4, 18.0, 1.2 and 8.8 lb per acre, respectively. Sunnhemp was the green manure and Co. 32 was the paddy strain used. Sunnhemp seeds were sown in all the treatments on 9-8-1966. Moisture was maintained at 75% moisture holding capacity. The sunnhemp crop was harvested at 33 days and the yield recorded. 13.5 g of sunnhemp (equivalent to 500 kg / hectare) was applied as green manure per pot for the succeeding paddy crop and the excess of green matter, after taking uniform quantity (2 g dry matter) for analysis, was dried, ashed and returned to the respective pot. Co. 32 paddy seedlings were transplanted after decomposition of green manure on 17-3-1966. Plant samples of paddy were drawn at 38 days after planting by cutting three out of five plants from each pot. The dry matter yield was recorded and samples were taken for analysis. The final yield of paddy was also recorded at harvest.

Samples of plant materials of sunnhemp and paddy were analysed after triacid digestion for total phosphorus, by the vanadomolybdate method (Koenig and Johnson, 1942) and radio-active phosphorus by the method of McKenzie and Dean (1948). The P^{32} labelled superphosphate was also analysed for total and radioactive P contents. From the specific activities of the phosphorus in the plant and fertilizer, the fraction of phosphorus in the plant derived from the fertiliser was calculated. The percentage utilisation of superphosphate was calculated from the dry matter yield of plant, fertiliser phosphorus fraction and the amount of super applied.

Results: The results for fraction of phosphorus derived from fertilizer and the percentage of utilisation of the applied superphosphate by Co. 32 paddy plants at 38 days after planting are given in Table 1 along with statistical conclusions. The data show that the 'Direct method' of application of P to paddy has utilised more of the fertiliser phosphorus than the 'Indirect method' for all the four soils studied. With reference to doses of P, the fraction of phosphorus in the plant derived from fertiliser is significantly higher at 80 kg P_2O_5 / hectare level than at the 40 kg level. It is also seen that the soil from Kallidaikurichi having the available P status of 1.2 lb per acre, has given the highest fertilizer P in plant while the other soils (testing higher available P) have less fertiliser P in plants. The values for percentage utilisation of super also show more or less the same trend.

TABLE 1 Utilisation of superphosphate by paddy

Variety : Co. 32. Age of crop: 38 days

Treatments (kg / ha)	Fertiliser P in plant (% of total P)				% utilisation			
	ADT	CBE	KLD	TKM	ADT	CBE	KLD	TEM
40 kg P_2O_5 (Indirect)	10.1 (7.2)	12.2 (11.1)	30.6 (5.4)	14.6 (13.9)	2.6	4.4	5.3	6.9
80 kg P_2O_5 (Indirect)	23.2 (8.5)	21.5 (12.4)	49.3 (9.2)	24.2 (15.0)	3.3	4.5	7.2	6.1
40 kg P_2O_5 (Direct)	23.6 (9.8)	18.2 (12.6)	47.8 (5.7)	23.0 (12.3)	7.7	7.8	9.4	9.6
80 kg P_2O_5 (Direct)	32.7 (10.9)	33.9 (9.8)	68.1 (9.0)	35.6 (13.6)	6.1	5.5	10.4	8.2
(Total P-Control)	(6.4)	(11.3)	(2.9)	(13.8)				

Conclusions for fertiliser P.

Soils : KLD TKM ADT CBE
 Methods : Direct Indirect
 Doses : 80 40

Conclusions for % utilisation of phosphate :

KLD TKM CBE ADT
 Direct Indirect
 Not significant

N.B. Figures in parenthesis refer to Total P in mg

The dry matter yield of the paddy plants at 38 days and the grain yield at harvest are presented in Table 2.

TABLE 2. Yield of paddy

Variety: Co. 32 Paddy

Treatments (kg/ha)	Dry matter yield of paddy plants at 38 days (g per 3 plants)				Paddy grain yield (g per pot)			
	ADT	CBE	KLD	TKM	ADT	CBE	KLD	TKM
Control	3.08	4.18	2.93	4.48	5.1	6.5	6.1	9.7
40 kg P ₂ O ₅ (Indirect)	3.15	4.18	3.35	4.53	6.7	7.1	7.4	9.2
80 kg P ₂ O ₅ (Indirect)	3.35	4.55	4.45	4.95	7.7	8.2	8.4	10.7
40 kg P ₂ O ₅ (Direct)	3.80	4.48	3.45	4.25	7.0	7.9	7.8	9.3
80 kg P ₂ O ₅ (Direct)	3.70	3.78	3.63	4.40	9.3	6.9	7.8	9.1

Conclusion:

i) Soils:	TKM	CBE	KLD	ADT	TKM	KLD	CBE	ADT
ii) Methods:	Not significant				Not significant			
iii) Doses:	-do-				80	40	0	
iv) Methods × Doses:	Indirect:		80	40	Not significant			
a) Comparing Doses:	Direct:		40	80				
b) Comparing of Methods:	40 kg P ₂ O ₅ per hectare		Direct	Indirect				
	80 kg P ₂ O ₅ per hectare		Indirect	Direct				

The results show that (1) the results for comparison of the two methods of phosphate application are not significant, (2) with reference to doses, the results for grain yield alone are significant and there is significant increase in grain yields with increase in doses of P₂O₅, (3) the results for interactions between the methods and doses are significant only for the dry matter yield. It is seen that at 40 kg P₂O₅ level, the 'Direct' and 'Indirect' are on a par and at 80 kg level the 'Indirect' is significantly better than the 'Direct'.

Discussion: The treatments included in the study bring out the effects of: (1) application of phosphate with green manure to paddy over green manure alone and (2) the effect of supplying the phosphate direct to paddy and indirectly through a green manure crop.

The results for grain yield as well as total P uptake show that there is a general response in grain yield and P uptake to phosphate application.

The utilisation of superphosphate by paddy (at 38 days after planting) is significantly superior when applied direct to paddy than when applied through the preceding green manure (sunhemp) crop. In a previous paper,

Venkatachalam *et al* (1966), the utilisation of superphosphate by sunnhemp has been reported. These results along with the utilisation by paddy under 'Direct' and 'Indirect' application are summarised below. It is seen therefrom that the green manure has utilised more of the phosphate than paddy in three of the four soils studied. However, the phosphate in the green manure has not fully passed over to the succeeding paddy crop.

Utilisation of superphosphate (percentage) by sunnhemp and paddy in different soils :

Crop	Soils			
	Aduthurai	Coimbatore	Kallidaikurichy	Tirurkuppam
Sunnhemp	9.0	5.4	11.6	10.4
Paddy (CO. 32) Indirect application)	3.0	4.4	6.3	6.5
Paddy (CO. 32) Direct application	6.9	6.7	9.9	8.9

Thus it is the lower release of phosphate by green manure in the indirect application that has been responsible for the lower utilisation of phosphate by the paddy crop than in case of direct application. It may also be noted that the percentage of release of phosphate from the green manure to paddy for the different soils varies, being the highest for Coimbatore (81.5 %) and lowest for Aduthurai soil (33.3%). Soundararajan (1965) has observed that between the two methods of application of phosphorus to paddy soil, indirect method of application through green manure resulted in greater available P in soils having higher amounts of native available phosphorus while direct application was better in soils with lower amounts of available P. In the present study the Coimbatore soil which is having the maximum available P (18.0 lb per acre) has released the maximum P to the succeeding paddy crop.

Another point of interest is to know whether the indirect application will result in the greater utilisation of the soil phosphorus by the paddy. The results summarised below show the total P uptake, along with percentage of soil P to total P in paddy.

Total P uptake (mg) and Soil P/Total P (as percentage) in paddy plants at 38 days after planting :

(Figures in parenthesis refer to Soil P / Total P as %)

Treatments	Soils			
	Aduthurai	Coimbatore	Tirurkuppam	Kallidaikurichy
Control (no phosphate-green manure alone)	6.4 (100)	11.3 (100)	13.8 (100)	2.9 (100)
Indirect application of phosphate to paddy	7.9 (83.2)	11.8 (83.4)	14.5 (80.6)	7.3 (60.0)
Direct application of phosphate to paddy	10.4 (74.0)	11.2 (71.9)	13.0 (71.0)	7.5 (42.0)

It is seen from the above table that in the 'Indirect method', greater proportion of the phosphorus comes from the soils as compared to that in the 'Direct method'. This difference is particularly marked in the Kallidaikurichy soil which is the lowest in available P (1.2 lb per acre). It is also seen that green manure with phosphate has resulted in greater uptake of total P in Kallidaikurichy and Aduthurai soils which are testing low in available P.

Irrespective of the differences in the utilisation of the soil and fertiliser phosphorus by paddy in the two methods of application, the paddy grain yield does not show marked differences. In this connection two points are worth mentioning *viz.*, (i) the radio-tracer study has aimed at only finding the utilisation of the soil and fertiliser phosphorus and how far the yield data as collected under pot culture conditions is to be taken as real criterion; (ii) the production of green manure when phosphate is applied was significantly more than without phosphate in all soils except Coimbatore and this is a point in favour of indirect application.

Summary: A pot culture study to compare the relative merits of application of phosphate to paddy directly and through a preceding green manure crop (indirect application) was conducted on four paddy soils of the State, *viz.*, from Aduthurai, Coimbatore, Kallidaikurichy and Tirurkuppam with CO. 32 paddy as the test crop and sunnhemp as green manure crop, using P³² labelled superphosphate. Paddy plant samples drawn at 38 days after planting were analysed for total and radio-active phosphorus contents. The yield of dry matter of the plants at this stage was recorded and the total P uptake, fertilizer P fraction in plant and the percentage of utilisation of superphosphate were calculated. The final yield data were also recorded. From the results, the following conclusions were drawn:

1. The percentage of utilisation of applied superphosphate was higher for the 'Direct' than the 'Indirect' method of phosphate application.
2. The application of phosphate with green manure to paddy (both 'Direct' and 'Indirect' methods) resulted in better grain yield as compared to green manure alone.
3. The total phosphorus uptake by paddy plants was higher for the treatments receiving phosphate in Aduthurai and Kallidaikurichy soils while there was no marked response in the other two soils. The difference between the methods was not significant except in the Aduthurai soil where the 'Direct' was superior to 'Indirect'.
4. The Indirect method of application of phosphate showed greater soil P uptake (expressed as percentage of total P uptake) than the 'Direct' method in all the four soils.

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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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