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Assessment of the available phosphorus status of the soil during crop growth and factors influencing it*

by

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Synopsis: The influence of superphosphate and farm yard manure on equal phosphorus basis and their combinations, on the available phosphorus status of soil was studied using two strains of *ragi* Co. 1 and Co. 7 and also in fallow plots throughout the growth period. Plots where Co. 7 *ragi* was grown had higher amounts of available phosphorus. Plots receiving combinations of super and farm yard manure had always higher amounts of available P than plots receiving them alone. Combinations comprising low amounts of farm yard manure and higher amounts of superphosphate proved to be best. Superphosphate was better than farm yard manure when applied individually on equal P basis.

It is well known that the phosphorus status of the soil can be changed through manuring. This can be achieved either through organic manures or inorganic fertilizers or through the judicious combination of both. So the present study was undertaken to assess the exact combination by which this could be achieved.

Srivastava *et al* (1955) found significant increase in the availability of phosphorus when superphosphate was applied either alone or in combination with farm yard manure than with farm yard manure alone. Nijhawan (1956) reviewing the work done in Punjab reported that the application of farm yard manure on equal phosphorus basis to superphosphate did not result in economical increased yields in wheat, maize etc. Smirnov and Ploshkov (1955) showed that the uptake was maximum when superphosphate alone was applied. However yields were more when compost and superphosphate were mixed and then applied than when applied individually. The Government Agricultural Chemist and the Paddy Specialist of Madras State (1944) in their review of the manurial trials conducted between 1930–'40, reported significant increase in the yield of *ragi* when superphosphate was applied in combination with cattle manure than when superphosphate alone was applied. Similar results were reported by Sen and Bains (1955), who found that superphosphate alone or in combination with the farm yard manure were better than the farm yard manure alone when applied at the same level of phosphorus.

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Salter and Schollenberger (1939) contended that the availability to plants of phosphorus in the farm yard manure was equal to or in some instances exceeded that applied in chemical fertilizers. McAuliffe and Bradfield (1952) found in a study that the two sources of phosphorus were the same in the first 30 days while the availability of phosphorus in farm yard manure exceeded that of superphosphate afterwards.

From these, it was clear that the combination of superphosphate and farm yard manure was better than the application of phosphorus from the inorganic source as superphosphate or from the organic source as farm yard manure and that conflicting opinions were expressed only about the superiority of each form over the other when applied individually. With the background of the agronomic studies reviewed above, this investigation was undertaken to study the chemical changes that take place in the soil due to the application of phosphorus individually and in combinations from the two sources, viz., from superphosphate and from farm yard manure. In particular the changes that take place in the available phosphorus status of the soil due to the application of these two types of phosphorus was studied.

Materials and Methods: Two strains of *ragi* viz. Co. 1 (Long duration) *ragi*, and Co. 7 (short duration) *ragi* were used for the study. The field experiment was laid out in the Central Farm of the Agricultural College and Research Institute, Coimbatore with the following treatments, supplying P_2O_5 in the organic and inorganic forms as sub-treatments.

Treatment 1	CONTROL—no manure.
Treatments 2 to 5	Farm yard manure to supply 10 lb, 20 lb, 30 lb and 40 lb P_2O_5/acre respectively.
Treatments 6 to 9	Superphosphate to supply 10 lb, 20 lb, 30 lb and 40 lb P_2O_5/acre respectively.
Treatments 10 to 15	Combination of farm yard manure and superphosphate as given below. to supply 20, 30 & 40 lb: of P_2O_5 partly as organic and partly as inorganic P_2O_5.

Treatment No.	Farm yard manure to supply.		Superphosphate to supply.
10	10 lb. P_2O_5/acre	+	10 lb. P_2O_5/acre
11	10 lb. P_2O_5/acre	+	20 lb. P_2O_5/acre
12	10 lb. P_2O_5/acre	+	30 lb. P_2O_5/acre
13	20 lb. P_2O_5/acre	+	10 lb. P_2O_5/acre
14	20 lb. P_2O_5/acre	+	20 lb. P_2O_5/acre
15	30 lb. P_2O_5/acre	+	10 lb. P_2O_5/acre

Plot size: 20′ x 6′ Split plot design

Net plot size: 18′ x 5′ No. of replications: 3

The above levels of phosphorus were chosen with a view to have two levels below and two levels above the State manurial recommendation for the crop, viz. 20 lb. P_2O_5/acre. The crop was sown in the nursery on 10—3—1959 and was transplanted on 1—4—1959 and 2—4—1959 in the field.

A parellel experiment with all the above manurial treatments were run in the same field during the same period but without any crop to see the effect of fallowing on availability of phosphorus. Olsen's method (1954) was adopted for the estimation of the available phosphorus in the soil. Soil samples were collected every fortnight from each of the replications and the samples of all the replications in each treatment were pooled and only the composite samples thus obtained, were analysed.

Results: The available phosphorus status in the different plots as estimated are given in Tables I and II.

From the results it will be seen that there is a gradual transition in the available phosphorus status of the soil during the crop growing season. The superphosphate treated plots had high available phosphorus in the early stages while the farm yard manured plots which have low available phosphorus in the beginning, end up with higher available phosphorus compared to the superphosphate treated plots at the end of the season. In regard to the effect of the crop on the availability of phosphorus, it is seen to be more rapidly available in the case of Co.7 short duration *ragi* plots compared to the Co.1 long duration *ragi* plots. This may probably be attributed to the high potentialities of the Co.7 *ragi* strain and also due to its intensive uptake during its short duration.

In all the treatments, the combinations of farm yard manure with superphosphate exhibited an uniform availability throughout the duration of the crop. The available phosphorus was more in the early stages upto 45 days in the treatments where the proportion of farm yard manure was less. This however was made up in the later stages in the treatments which had the greater proportion of farm yard manure. In general the available phosphorus status of the soil was more in the plots with Co.7 short duration *ragi* than in the Co.1 long duration *ragi* plots. The available phosphorus was more in plots where the crop was grown than in fallow plots during the early stages. But during the subsequent period, the fallow plots had higher available phosphorus than the cropped plots possibly due to the uptake of phosphorus by the crop in the cropped plots.

Discussion: The results of the agronomic aspects of the problem in relation to availability of phosphorus alone is presented in this paper. As already pointed out in the introduction, there has been no thorough

study of the phosphorus status of the soil during the complete growth phase of the crop and also in relation to the availability during the growth period depending upon the source of supply of phosphorus. In this study the phosphorus source has been limited to (1) superphosphate and (2) farm yard manure, at the same phosphorus level and the two strains of *ragi* grown vary in their duration as well as their potentialities for drawing upon the fertility source, Co.7 being a high fertility strain to Co.1 *ragi*.

Frustorfer (1955) and Midgley and Danklee (1943) have given the possible effect of the combinations of both the forms of phosphorus application to be due to the mutual protection afforded against the fixation of phosphorus in the soil. In the present experiment also it is seen that the higher available phosphorus is found in combinations of both forms of phosphorus than the individual applications and that the higher available phosphorus status due to the combinations with higher proportion of superphophate with low amounts of phosphorus is compensated later in the crop growth in the combinations with higher amounts of farm yard manure and lower amounts of superphosphate and is in accord with the results of Srivastava, *et al* (1955).

Regarding the availability of phosphorus, in the superphosphate treated plots and farm yard manured plots, it is seen in this study that the superphosphate treated plots had higher available phosphorus in the initial stages than the farm yard manured in the cropped plots and as such is contradictory to the results obtained by McAuliffe and Bradfield (1952). The availability of phosphorus in the later stages of crop growth, was more in the farm yard manure treated plots than superphosphate and is in agreement in this aspect alone, with the results of McAuliffe and Bradfield.

Summary: Availability of phosphorus in the soil as affected by the crop grown and the form of phosphorus applied was studied by growing two strains of *ragi* viz., Co. 1 *ragi* and Co.7 *ragi*, the former being one of long duration and latter one being short duration and high fertility strain and also in fallow plots. Phosphorus was supplied on equal phosphorus basis in the form of farm yard manure and superphosphate individually and in different combinations ranging from 1 : 1 to 1 : 3. It was seen from the results obtained that Co.7 *ragi* plots always had higher amounts of available phosphorus in the soil, while the combinations of both superphosphate and farm yard manure gave higher amounts of available phosphorus compared to the treatments which received superphosphate or farm yard manure individually. It was also seen that the low amounts of farm yard manure in combinations with superphosphate was superior in higher amounts of available phosphorus in the first 45 days though this was compensated later

on by other combinations with higher amounts of farm yard manure with low amounts of superphosphate. It could therefore be concluded from the experiment that the best combinations of the two forms is 10 lb. P_2O_5/acre as farm yard manure and 30 lb. P_2O_5/acre as superphosphate. It was found that superphosphate was preferable to farm yard manure at equal phosphorus level when applied individually.

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TABLE I.

Variation in available phosphorus status of Soil (Cropped plots) (in lb. per acre).

Sl. No.	Amount of Farm yard manure	P_2O_5 supplied as Super-Phosphate	Co. 1. Ragi						Co. 7. Ragi					
			20-4-59	5-5-59	20-5-59	5-6-59	20-6-59	12-7-59	20-4-59	5-5-59	20-5-59	5-6-59	20-6-59	12-7-59
1.	CONTROL		17·2	18·8	14·4	24·2	11·2	15·2	22·0	24·0	19·2	19·0	16·0	16·8
2.	10 lb.	...	34·8	30·8	26·0	24·6	21·2	23·2	26·4	33·6	20·8	22·3	16·0	20·4
3.	20 lb.	...	44·0	35·2	31·8	28·8	22·0	24·0	34·4	49·2	28·0	31·5	31·2	24·8
4.	30 lb.	...	54·0	35·6	29·6	28·5	22·0	21·8	49·2	56·0	40·8	42·4	34·4	28·4
5.	40 lb.	...	48·0	44·0	25·2	22·5	30·4	22·8	40·0	56·4	42·4	45·8	28·0	19·6
6.	...	10 lb.	30·0	31·2	27·6	26·0	18·0	16·4	31·2	30·0	20·8	20·7	18·0	20·0
7.	...	20 lb.	42·0	44·0	36·0	26·5	17·2	18·0	43·2	32·8	22·8	24·4	30·0	20·8
8.	...	30 lb.	42·8	46·4	40·0	30·1	17·6	24·0	47·6	49·2	24·8	26·8	30·4	28·0
9.	...	40 lb.	50·0	45·2	34·0	25·3	23·2	18·0	43·2	54·6	31·2	33·8	20·0	20·6
10.	10 lb. +	10 lb.	45·6	45·0	32·8	26·2	31·2	18·4	48·0	43·2	32·0	27·6	31·0	17·6
11.	10 lb. +	20 lb.	54·0	46·8	44·0	29·9	31·6	18·8	52·0	50·0	34·0	40·3	40·0	17·6
12.	10 lb. +	30 lb.	55·2	54·8	47·2	34·6	32·0	18·4	49·6	55·2	36·0	45·1	36·0	19·2
13.	20 lb. +	10 lb.	51·2	50·4	38·4	37·9	23·6	16·2	45·2	55·2	36·4	40·0	31·6	20·0
14.	20 lb. +	20 lb.	56·8	48·0	30·8	37·5	22·4	18·8	46·8	57·6	40·4	44·4	37·2	29·6
15.	30 lb. +	10 lb.	46·4	48·0	32·8	30·1	32·6	20·4	42·4	57·2	41·6	47·8	42·0	34·3

TABLE II.

Variation in available phosphorus status of Soil (Fallow plots) in lb. per acre.

S. No.	Amount of Farm yard manure		P_2O_5 supplied as Super-phosphate	20—4—1959	5—5—1959	20—5—1959	5—6—1959	20—6—1959	12—7—1959
1.	CONTROL			16·8	16·0	17·2	17·5	17·6	12·8
2.	10 lb.		...	18·0	20·0	22·8	20·2	17·6	15·2
3.	20 lb.		....	28·4	28·8	23·2	31·5	17·2	16·6
4.	30 lb.		...	30·0	42·8	39·2	35·1	25·2	18·0
5.	40 lb.		...	38·0	52·0	39·6	36·9	29·6	16·4
6.	...		10 lb.	18·7	20·8	26·4	22·3	19·2	18·0
7.	...		20 lb.	33·6	41·6	30·4	35·3	20·8	15·6
8.	...		30 lb.	34·0	46·8	37·6	42·0	33·6	14·4
9.	...		40 lb.	36·4	56·4	38·4	44·2	33·2	13·2
10.	10 lb.	+	10 lb.	32·8	36·8	38·8	36·9	24·8	12·0
11.	10 lb.	+	20 lb.	36·8	44·0	38·4	40·5	30·8	17·6
12.	10 lb.	+	30 lb.	46·4	52·0	42·8	44·4	37·6	22·0
13.	20 lb.	+	10 lb.	32·0	43·4	41·4	41·4	25·2	19·6
14.	20 lb.	+	20 lb.	38·6	48·7	41·4	43·6	32·8	21·6
15.	30 lb.	+	10 lb.	32·0	55·6	40·8	41·3	32·8	23·6