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Effect of Phosphate Carriers and Doses on Progressive Changes on the Available Phosphorus Status of Major Soil Groups of South India: Soil Incubation Study

by

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Introduction: A detailed knowledge of the pattern of fixation existing over a period of time will enable one to decide upon the type of phosphate fertilizer to be applied to bring about the minimum waste of fertilizer through fixation. Soils are known to differ considerably with reference to their capacity to fix applied soluble phosphates. Variation in soil reaction, clay minerals, lime and free sesquioxides have been demonstrated to bring about appreciable differences in the capacity of soils in the matter of fixation or availabilisation of phosphates. In Madras State a number of dissimilar groups of soils occur and detailed information regarding phosphate availability changes with time in these soils is not available. The present work was taken up to obtain such detailed information.

Review of Literature: Cho and Caldwell (1959) noted mostly iron and aluminium phosphates in acid soils, calcium phosphate in alkaline soils and an equal representation of all the above three forms in neutral soils. Acidifying the soils having large amounts of calcium phosphate increased phosphorus solubility (Pratt, 1961). Most of the calcium phosphate was found to be converted to aluminium phosphate along with some iron phosphate also. Kurtz *et al.* (1946) working on Illinois soils found not only a gradual increase in the adsorbed phosphate with time, but also a gradual change in the status of the adsorbed phosphate. Aluminium and calcium phosphates gradually changed to the less soluble iron phosphate form according to Chang and Chu (1961), the rate of transformation increasing with the moisture content of the soil. Rajagopal and Idnani (1963) concluded that capacity of Nilgiri soils to fix phosphate was due to the large quantities of free sesquioxides they contained.

Water-soluble forms of phosphate fertilizers were found to be very effective on Texas black soils (Speer 1951). Mattingly (1963) reported from the recent reports of Rothamsted Experiment Station that none of the

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newer fertilizers were significantly and consistently better than superphosphate. Motiramani *et al.* (1964) found maximum availability for superphosphate on black soils and for dicalcium phosphate on alluvial soils.

Materials and Methods: Nine soils from three soil groups, namely red, black and laterite ones were taken for the incubation study. The selection was mainly based on the geographical distribution of the soils. Of each soil, 150 gm. was taken in beakers and the calculated amounts of fertilizers were added and mixed thoroughly. Each of the soils was kept at its respective water holding capacity. The moisture level was kept constant in all the beakers by periodic addition of the calculated quantity of water to compensate for evaporation losses.

Representative samples were drawn at regular fortnightly intervals from each of the beakers and analysed for available phosphorus by Olsen's, and Bray and Kurtz No. 1 reagents. The details of the treatments are furnished in Table 1 and the results were satistically analysed.

TABLE 1. *Details of incubation studies.*

Particulars of soil	
Red :	Salem-Red soil
	Coimbatore - Chemmankuzhiyur Red soil
	Coimbatore - Ondipudur Red soil
Black :	Coimbatore - Black soil
	Dindigul - Black soil
	Koilpatty - Black soil
Laterite :	Nanjanad laterite - High level
	East Coast Laterite - (Neyveli) - Low level
	West Cost Laterite - Kerala (Pattambi) - Low level
* *Treatments* :	
T_1	Control
T_2	Superphosphate - 20 lb. P_2O_5 per acre
T_3	Superphosphate - 40 lb. P_2O_5 per acre
T_4	Dicalcium phosphate - 20 lb. P_2O_5 per acre
T_5	Dicalcium phosphate - 40 lb. P_2O_5 per acre

* Basal dressing of 40 lb. N as Ammonium sulphate and 20 lb. K_2O per acre as potassium chloride.

Started on 25—10—1965 first sample taken on 25—10—1965

Results and Discussion: (a) *Olsen's Method :* Statistical significance was obtained for soil types, treatments, periods and soils *versus* periods.

(i) *Comparison of soil means* (Phosphorus ppm) :

a	b	c	d	e	f	g	h	i	S.E.	C.D.
1.86	1.79	2.95	2.13	1.78	2.03	5.46	2.28	2.98	0.16	0.32

Conclusion : g i c h d f a b e

(ii) *Comparison of treatments :*

T_1	T_2	T_3	T_4	T_5	S.E.	C.D.
2.42	2.60	2.86	2.66	2.92	0.11	0.22

Conclusion : T_5 T_3 T_4 T_2 T_1

(iii) *Comparison of periods :*

I	II	III	IV	S.E.	C.D.
3.07	1.99	2.63	3.10	0.10	0.20

Conclusion : IV I III II

Nanjanad laterite soil contained maximum available P extracted by Olsen's reagent. The minimum availability was recorded in Dindigul black soil. Not much difference in available P status was observed in East Coast laterite, Coimbatore black and Kovilpatti black soils, when the whole period of incubation was considered. Similar observations were made by Speer *et al.* (1951) on Texas black soils. These authors found that in soils of prevailing low pH all the fertilizers were utilized two to three times more efficiently than on alkaline soils.

Maximum availability was seen during the initial and fourth periods. The second period recorded the minimum availability. Chang and Chu (1961) found that when soluble phosphate fertilizers were added to soils between pH 5.3 and 7.5, phosphates were mainly fixed in three days as aluminium phosphate followed by iron phosphate and calcium phosphate. After 100 days the amount of iron phosphate increased and aluminium and calcium phosphates decreased. The same trend was noticed here also. During the initial period all the soils recorded higher test values for phosphorus. In the next period (after a fortnight) there was complete fixation in black soils and a reduction in availability in red and laterite soils. Thereafter there was a gradual increase, reaching the maximum availability

during the fourth period. This may be explained by the fact that during initial period all the treatments including control contained phosphorus in the form of calcium phosphate in red and black soils and as adsorbed phosphate of iron and aluminia in the case of laterite soils. Both these forms are extracted by Olsen's reagent. In the next period most of the phosphates might have been fixed as aluminium, iron and calcium phosphates and hence a reduction in availability can be expected with passage of time.

(a) *Bray and Kurtz No. 1 Extraction Method:* Here also the maximum test value was obtained from Nanjanad laterite soil.

Comparison of soil means (Phosphorus ppm):

a	b	c	d	e	f	g	h	i	S.E.	C.D.
2.72	2.55	3.62	1.10	1.64	2.22	6.12	3.25	4.33	0.13	0.26

Conclusion: g i c h a b f e d

Comparison of treatments:

T_1	T_2	T_3	T_4	T_5	S.E.	C.D.
2.73	3.07	3.19	2.97	3.41	0.09	0.18

Conclusion: T_5 T_3 T_2 T_4 T_1

The test value for phosphorus was minimum from Coimbatore black soil. This may be explained by the fact that Bray and Kurtz No. 1 solution extracts more of iron and aluminium phosphates by anion exchange reactions. In black soil, the observed low test value for phosphorus may be explained by the fact that most of the phosphorus will be present as calcium phosphates which cannot be extracted fully by Bray and Kurtz No. 1 reagent.

Dicalcium phosphate showed the maximum availability. The superiority of decalcium phosphate may be explained as being due to the acidic nature of the laterite soil which whill fix water-soluble forms of fertilizers while the citrate soluble form will be gradually released for plant use. This is in line with the work of Mattingly (1963). The trend of availability was similar to that of the Olsen's method. Initial and final periods recorded the maximum availability and the second period the least. These findings partly confirm the view of Motiramani *et al.* (1964), who observed increasing availability of phosphorus with time and increasing amounts of added fertilizer.

Summary and conclusion: An attempt was made to study fluctuations in phosphate availability with time in different South Indian soils employing various extractants.

Nine representative soils from the three major South Indian soil groups, namely, red, black and laterite ones, were taken in beakers and calculated amounts of superphosphate and dicalcium phosphate at two doses of 20 and 40 lb. P_2O_5 per acre were added. The soil samples were incubated at water-holding capacity under laboratory conditions. Samples were taken periodically and analysed for available phosphorus using Olsen's and Kurtz No. 1 reagents. The results were statistically analysed to bring out any significant differences.

Maximum available phosphorus was noticed in Nanjanad laterite soil in the case of both the extraction methods. Initial and 42nd day samples yielded the comparatively high available phosphorus. Fourteenth day sample contained the minimum.

Regarding the fertilizers, dicalcium phosphate showed the maximum availability with Bray and Kurtz No. 1 extraction.

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