

PHOSPHATE FRACTIONS OF KERALA RICE SOILS IN RELATION TO THEIR OCCURRENCE AND PEDOGENESIS

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There are at least 3 major rice soil types in Kerala based on their location viz lateritic alluvium in the narrow velleys and depressions which might be called the ribbon valleys surrounded by undulating lateritic uplands, the paddy lands of the alluvial plains and terraces and the paddy lands of the low coastal plains which are to some extent situated below sea level. The well-known Kari (Peat), Kayal (Reclaimed lake-bed) and Karapadam (River-borne alluvium) of the Kuttanad area, the Kole soils of Trichur which are similar to the Kari soils of Kuttanad in some respects and the Pokkali and Kaipad soils which are the typical marine-saline soils of the coastal area come under this group. Attempts to study the chemical characteristics of these soils and assign a position to them in the taxonomy of soils was made by Menon (1975), Santhakumari (1975), Hameed (1975), Samikutty (1977) and Hassan (1977). However, no attempt has been made earlier to study the phosphate fractions of these soils particularly in relation to their occurrence and the pedogenic processes by which they are formed. The present work is an attempt in this direction.

Materials and Methods

Surface samples of six different rice soil types (vide table 1) were collected. The physical and chemical characteristics were studied by standard methods described in Jackson (1967). The fractionation of the soil P was carried out by the procedure of Peterson and Corey (1976). Total P was determined by digestion in perchloric acid and measuring the P by the Vanado-molybdate method.

Results and Discussion

Table 1 presents the chemical characteristics of these soils. All the soils have a clay content between 30.0 to 36.0 per cent. The pH of the soils varies between 5.5 to 4.4. The Pokkali soils have a fairly high conductivity of 1.54 mmhos/cm. for the 1 : 2 soil water extract. The Kayal, Karapadam, and Kari soils have medium salinity while the Kole and the lateritic alluvium have very low salinity. The Kari soils have the highest organic matter content as revealed by the percentage of organic carbon. The Kayal, Karapadam, pokkali and Kole soils have an organic C content ranging between 2.0 and 1.7. per cent, while the lateritic alluvium has the lowest values for organic carbon content.

Table 1 Important chemical and physical characteristics of rice soils of Kerala

Soil	Sand %	Silt %	Clay %	PH	Conductivity in m. mhos/cm 1:2 soil water extract	Lime require- ment tons/ha	Orga- nic-C %	Total-N %
Kayal	45.4	15.1	34.5	5.5	0.1-	1.80	1.74	0.059
Kari	54.5	14.3	30.5	5.1	0.27	2.30	5.37	0.033
Pokkali	50.7	16.2	33.1	4.4	1.54	2.60	1.71	0.026
Karapadam	49.5	14.5	36.0	5.2	0.37	2.10	1.86	0.025
Kole	51.7	16.3	32.5	5.0	0.05	2.40	2.07	0.018
Lateritic alluvium	49.9	13.8	33.2	5.2	0.05	2.20	1.01	0.021

Table 2 presents data on the P fractions in the rice soil types of Kerala and their percentage incidence on the total P. The total P content varies between 816 and 917 though these soils represent six rice soil types varying widely in the nature of the parent alluvium, their degree of weathering prior to alluviation and subsequent genesis and soil development. It is seen that the variation in total P content is only to the extent of about 10 to 12 per cent between the highest and the lowest content of total P (coefficient of variation = 4.0). Cholitkul and Tyner (1971) in their study on the rice soils of Thailand included a number of recent alluvial soils and the total P content reported for such soils are closely similar to the total P content observed for the rice soils in the present study. The earlier studies on the rice soils of Kerala (Menon 1975; Santhakumari 1975; Hameed 1975; Samikutty 1977; Hassan 1977) indicate that rice soils of the State are also recent alluvium. It has to be realised that these soils are continuously in a state of being formed by alluviation and developed by pedogenic processes. Such a dynamic situation exists on account of their being situated in the flood plains of rivers, in ribbon-valleys of the midlands, or low lying areas below sea level near the coast or near the backwaters. From the result it is evident that the Fe-P fraction is the most abundant fraction in all the soils accounting for 21.8 to 39.8 per cent of the total P in all the soils and 38 to 50 per cent of the inorganic P. Al-P is the second most abundant fraction of P accounting up to 12.7 to 25.8 per cent of the total P and 16.7 to 30.7 per cent of the inorganic P. The third abundant fraction which varies between 5.9 to 10.3 per cent is the Ca-P fraction. Organic P incidence is highest in the Kari, the Kole and the Pokkali soils which are also richer in organic matter content.

Table 2 P fractions and available-P in the Rice Soils of Kerala before waterlogging

Soils	Saloid-P ppm	Fe-P ppm	Al-P ppm	Reduc- tant-P ppm	Clu- sive-P ppm	Ca-P ppm	Available-P ppm	Total-P ppm	Orga- nic-P ppm	Orga- nic-P %	Inorga- nic-P ppm	Organo- solic-P ppm	
Kayal	1.24	385.0	152.1	85.0	22.8	84.0	80.0	42.0	9.8	124.2	1.7	791.8	14.0
Percentage to total-P	0.13	39.8	16.5	8.1	2.4	0.3	0.8	—	—	—	—	—	—
Kari	1.20	93.9	73.0	41.7	27.0	81.4	74.8	30.0	9.0	2.7	5.3	477.3	12.1
Percentage to total-P	0.13	11.8	9.2	4.6	3.0	8.9	8.3	—	—	—	—	—	—
Kakkal	1.00	38.0	104.0	55.0	22.0	62.0	67.1	32.0	8.6	184.0	1.7	631.1	9.0
Percentage to total-P	0.13	3.9	12.7	6.7	2.7	7.6	8.2	—	—	—	—	—	—
Moochoor	1.15	25.1	22.0	55.1	23.6	7.4	75.3	35.0	887	14.1	1.9	745.7	13.0
Percentage to total-P	0.12	2.0	2.8	6.2	2.6	8.1	8.5	—	—	—	—	—	—
Kole	1.17	31.7	151.0	40.0	22.3	68.9	70.7	40.0	0.4	24.1	2.7	672.2	11.0
Percentage to total-P	0.12	3.1	16.6	4.3	2.4	7.5	7.7	—	—	—	—	—	—
Indoorkonam	1.12	31.2	21.2	71.9	20.8	54.5	66.4	30.0	9.7	166.1	1.0	750.9	9.0
Percentage to total-P	0.12	3.5	2.8	7.8	2.3	5.0	7.2	—	—	—	—	—	—

Coefficient of variation = 4.0

Highly weathered soils, according to Chang and Jackson (1958) always contain appreciable amounts of occluded-P and reductant-P. The fact that these soils contain only 6.0 to 9.5 per cent reductant-P and 2.7 to 5.6 per cent occluded-P confirms that these soils are developed on recent alluvial deposits. Presence of high amounts of Fe-P and Al-P has to be attributed to the fairly high percentage of iron and aluminium oxides, which have been brought into play by the alluviation process and their combination with P, accentuated by the waterlogged *milieu*. High proportions of Fe-P in alluvial soils of South India have been reported by Jose (1973).

Further, it has to be realised that keeping aside the lateritic alluvium of the ribbon-valleys of the midlands all the other soils have varying degrees of marine influence. Such marine influence is maximum in the Pokkali, Kayal and Kari soils and is to a lesser extent in the Kole and Karapadam soils. This may be one of the reasons why the lateritic alluvium is having a Ca-P incidence of only 7.2 per cent while the other soils which are having varying degrees of marine influence have a Ca-P incidence of 9.8 to 12.0 per cent. The continuing alluviation by periodical floods coupled with the marine influence appears to maintain the juvenility of these soils. The higher amounts of Ca-P found in the soils subjected to periodical inundation with salt water is to be attributed to the reactions of soluble Ca in the sea water with reduced Fe-P compounds and the formation of more Ca-P compounds.

Summary

Studies on the P fractions of the major rice soil types of Kerala in relation to their pedogenesis was conducted. The total P content varies between 816 and 917 ppm. The Fe-P fraction is the most dominant fraction in all the soils accounting for 21.8 to 39.3 per cent of the total P in the soils. Al-P is the second most abundant P fraction, accounting up to 12.7 to 25.8 per cent of the total P. The Ca-P fraction varies between 5.9 and 10.3 per cent. These soils contain only 6.0 to 9.5 per cent and 2.7 to 5.6 per cent respectively of reductant-P and occluded-P. The higher Ca-P incidence in the soils under marine influence has been attributed to the reaction of soluble Ca in the sea water with reduced Fe-P compounds and the formation of more insoluble Ca-P compounds. The results indicate that continuous alluviation by periodical floods in the formation of all the soils under study coupled with the marine influence in all the soils except the lateritic alluvium of the ribbon valleys of the midlands appear to maintain their juvenility.

സംഗ്രഹം

കേരളത്തിലെ പ്രധാന നെൽവയൽ മണ്ണുകളിലെ ഫോസ്ഫറസ് അംശങ്ങളെ സംബന്ധിച്ച പഠനം rossJnnlaaxm'IraJ ഫോസ്ഫറസ് അംശം ദശലക്ഷത്തിന് 816 നും 916 നും

ഇടയാണെന്നു കണ്ടു. ഈ മണ്ണുകളിലെ ഫോസ്ഫറസിന്റെ ഘടനാശങ്ങളുടെ വിശദപഠനം നടത്തി. കൂടാതെ സമുദ്രജലസമ്പർക്കം ലയരൂപത്തിലുള്ള കാത്സിയവും ഇരുമ്പും—ഫോസ്ഫറസും സംയുക്തങ്ങളുമായി പ്രതിപ്രവർത്തിക്കുന്നതുമൂലം അലേയ കാത്സിയം ഫോസ്ഫറസും സംയുക്തങ്ങൾ ഉണ്ടാകുന്നതിനടിയായി. കാലാകാലങ്ങളിൽ തുടരെ അടിയറയ്ക്കുന്ന എക്കൽ മണ്ണും സമുദ്ര ജലസമ്പർക്കവും സമതലപ്രദേശങ്ങളിലെ ചെങ്കൽച്ചുവയുള്ള അലൂവിയൽ മണ്ണുകളൊഴികെയുള്ള മണ്ണുകളുടെ രൂപീകരണ സവിശേഷതകളിലേയ്ക്ക് വിദഗ്ദ്ധർ ചൂണ്ടുന്നു.

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