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CHEMICAL PROPERTIES OF THE POONTHALPADAM SOILS OF KERALA*

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The previous two papers on *Poonthalpadam* soils deal with the morphological features and the physical characteristics. In this paper an appraisal of chemical properties is made.

Materials and Methods

Soil samples were collected for the present study from the six sites where profiles were examined namely Perumatty, Chittoor(proper), Chittoor(Thamarachira), Thekkedesam, Valiavallampathy and Kuttippallam. The same soil samples which were prepared for the study of the physical characteristics were utilised for the chemical analysis also. Samples were analysed for the moisture content, loss on ignition, pH and electrical conductivity in 1:2.5. soil:water suspension using a pH meter and an Elico solubridge. Organic carbon, total nitrogen, available phosphorus (Olsen's), carbonates and bicarbonates were determined by adopting standard methods as described by Jackson (1958), cation exchange capacity and exchangeable cations were determined by the methods outlined by Piper (1942). HCl extract was prepared and analysed for total phosphorus,total sesquioxides,aluminium and iron oxide as per methods detailed by Sankaram (1960). Total sodium and potassium were determined using EEL flame photometer from the filtrate obtained after precipitating sesquioxides and calcium was determined from the above filtrate as described in the USDA Hand Book No. 60 (1958).

Results and Discussion

Results are given in Tables 1 to 4. Table 1 shows moisture, loss on ignition, soil reaction, electrical conductivity and bicarbonates. The moisture content varied from 1.22 to 4.64 per cent, and loss on ignition ranged from 6.54 to 14.04 percent. A positive correlation was obtained between loss on ignition and clay. This must be due to the loss of combined water associated with the clay. A positive correlation between organic carbon and loss on ignition was obtained. The pH of the profile samples varied from 6.5 to to 8.5. All the profiles except the profile from Chittoor (proper)showed higher pH values in lower layers which may be due to the presence of carbonates and bicarbonates of sodium and.calcium. The soil profiles in the present investigation had an appreciable amount of calcium and the comparatively higher pH can be attributed to this cation also. The electrical conductivity ranged from 0.18 to 0.66 mmho/cm and bicarbonate content from 0.03 to 0.06 per cent. Colibas *et al.* (1976) found that an exchangeable sodium percentage in the range of 12-15 and a bicarbonate content of about 0.02 per cent

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Table 1

Moisture, loss on ignition, soil reaction, electrical conductivity and bicarbonates

Profile No. Location	Depth (cm)	Moisture %	Loss on ignition %	pH	Electrical conductivity mmho/cm	Bicarbonates %
I	0-30	2.4	6.5	8.0	0.24	0.06
Perumatty	30-60	2.6	7.5	8.3	0.21	0.05
	60-80	3.0	9.6	8.3	0.21	0.05
II	0-30	3.4	8.8	7.7	0.39	0.05
Chittoor	30-60	2.8	8.5	6.8	0.60	0.03
(proper)	60-80	1.2	8.9	6.5	0.30	0.04
III	0-30	1.9	9.5	7.9	0 51	0.06
Chittoor	30-60	1.8	8.8	8.0	0.54	0.04
(Thamarachira)	60-80	1.6	8 9	8.0	0.42	0.04
IV	0-30	3.8	13.0	8.0	0.66	0.05
Thekkedesam	30-60	2.6	13.0	8.4	0.48	0.05
	60-80	3.4	13.1	8.4	0.48	0 04
V	0-30	3.8	13.9	8.2	0.36	0.05
Valiavallampathy	30-60	4.6	14.0	8.4	0.30	0.05
	60-80	2.8	13.2	8.4	0.18	0.05
VI	0-30	3,1	10.7	6.7	0.36	0.04
Kuttippallam	30-60	3.7	10.1	7.1	0.49	0.04
	60-80	3.6	8.0	7.1	0.66	0.05

produced low permeability The bicarbonates present are sufficient to react with sodium to produce poor permeability. $NaHCO_3$ has lower conductivity than other salts at equivalent concentration (Agriculture Hand Book No. 60 USDA). The lower electrical conductivity exhibited inspite of the high pH may be due to the the above reason.

Data corresponding to organic carbon, total and available nitrogen content and C/N ratio are given in Table 2. Organic carbon ranged from 0.76 to 1.56 percent. The maximum organic carbon content was noticed in the surface layers with an average of 1.28 percent. The organic carbon content decreased with depth which is attributable to the poor drainage. The average total nitrogen content in the surface, intermediate and lowest layers was 0.07, 0.06 and 0.50 per cent respectively. All the profiles except the profile from Valiavallampathy had the highest nitrogen content in the surface layers. The impeded drainage which restricts leaching of nitrogen downwards and the denitrification reaction taking place due to the anaerobic condition account for this decrease in

nitrogen down the profile. The wide C/N ratio (average 26.96) encountered in the lowest layer may be due to the low pace of oxidation of the carbonaceous materials and denitrification. (Pearsall, 1950). The average available nitrogen content in the surface, intermediate and the lowest layers was 0.011, 0.010 and 0.008 per cent respectively.

Table 3 shows data relating to total P_2O_5, available CaO, MgO, K_2O, total sodium, sesquioxides, Fe_2O_3 and Al_2O_3. The average total P_2O_5 content in the three layers, namely the surface, intermediate and the lowest was 0.14, 0.13 and 0.12 per cent respectively. Though there was no regularity in the distribution of phosphorus in soils, the surface layers had the highest P_2O_5 content except in two profiles and this is in conformity with the findings of Venugopal (1969). Available phosphorus content in profile samples ranged from a trace to 25 ppm with an average of 7.4 ppm of P. Due to the presence of exchangeable calcium in an appreciable amount, the P might have been fixed as Ca–P which would explain the

Table 2

Organic carbon, total nitrogen, available nitrogen and carbon/nitrogen ratio of the samples

Location	Depth (cm)	Organic carbon %	Total nitrogen %	Available nitrogen %	Carbon/ nitrogen ratio
I	0-30	1.01	0.04	0.005	28.4
Perumatty	30-60	0.84	0.02	0.005	35.4
	60-80	0.76	0.01	0.004	59.3
II	0-30	1.12	0.06	0.005	17.7
Chittoor	30-60	1.41	0.05	0.004	26.4
(proper)	60-80	0.89	0.03	0.004	34.1
III	0-30	1.56	0.07	0.010	23.6
Chittoor	30-60	0.85	0.06	0.009	14.6
(Thamarachira)	60-80	0.79	0.04	0.006	22.6
IV	0-30	1 33	0.08	0.010	13.9
Thekkedesam	30-60	1.05	0.04	0.007	17.3
	60-80	1.41	0.06	0.009	26.3
V	0-30	1.40	0.05	0.020	28.0
Valiavallampathy	30-60	1.10	0.09	0.016	12.7
	60-80	0.90	0.07	0.010	12.8
VI	0-30	1.24	0.12	0.020	10.8
Kuttippallam	30-60	1.53	0.11	0.020	135
	60-80	0.82	0.13	0.020	6.8

low levels of available P in the soil. The average CaO content for the three layers was 2.90 percent for the surface, 1.60 per cent for the intermediate and 2.44 per cent for the lowest layers. The average MgO content was 0.82, 0.39 and 0.76 per cent respectively for the three layers, surface, intermediate and the lowest. The mean K_2O content in the three layers, surface, intermediate and the lowest was 0.16, 0.20 and 0.19 per cent respectively. The average value of total sodium content in the surface layer was 0.13 per cent. In the intermediate and the lowest layers total sodium content was 0.13 and 0.12 per cent respectively. The poor physical characteristics exhibited by these soils may be attributed to the presence of sodium.

The average value for the sesquioxide content in the surface, intermediate and the lowest layers was 7.8, 7.82 and 7.2 per cent respectively. Fe_2O_3 content in these layers was 5.8, 5.9 and 6.1 per cent and Al_2O_3 content 2.05, 1.89 and 1.07 per cent respectively. These values are comparatively low when compared to the other soils of Kerala. This may be because the *Poonthalpadam* soils are derived from the black soils while the majority of the Kerala soils are lateritic in origin. High levels of HCO_3 in the rooting medium can bring about iron deficiency and one of the reasons for poor performance of paddy in these soils might be due to the reduced iron availability in the presence of bicarbonates.

Cation exchange capacity, exchangeable cations and exchangeable sodium percentage are given in Table 4. The average cation exchange capacity in the surface, intermediate and the lowest layers was 12.05, 12.0 and 10.86 me/100g of soil respectively. Average exchangeable calcium content for these layers was 7.3, 7.7 and 6.05 me/100 g of soil respectively The average exchangeable magnesium and potassium content in the surface layers were 1.04 and 0.17 me/100 g, 1.19 and 0.15 me/100 g in the intermediate layers and in the lowest layers 1.07 and 0.16 me/100 g. The three layers, surface, intermediate and the lowest were found to have an average exchangeable sodium content of 1.23, 1.16 and 1.00 me/100 g respectively, the average exchangeable sodium percentege in the three layers being 10.91, 9.2 and 9.3 per cent respectively. The value of CEC was higher than that a kaolinitic type of clay but lower than that for 2:1 type of clay mineral and was found to range from 7.17 to 17.3 m3/109 g in the different layers from the to p. Therefore, it may be concluded that these soils contain an admixture of illitic (2:1) and kaolinitic (1:1) types of clay minerals. It was found that in the profile samples as a whole about 67 per cent of the total CEC was satisfied by exchangeable calcium an magnesium (bivalent metals). According to Mahapatra and Prasad (1970) and exchangeable potassium content of 0.2 me/100 g in soils is a satisfactory level for rice. Some of the samples examined contain much lower levels of potassium than this critical lavel which points to the necessity for potash fertilization. The surface layers of the profiles from Perumatty, Chittoor (proper) and Thekkedesam had an exchangeable sodium content of more than 12 per cent and bicarbonate content more

Table 3

Total P_2O_5, available P, CaO, MgO, K_2O, total sodium, total sesquioxides, Fe_2O_3 and Al_2O_3 of the samples

Location	Depth (cm)	P_2O_5 %	Available P (ppm)	CaO %	MgO %	K_2O %	Total sodium %	Total R_2O_3	Fe_2O_3 %	Al_2O_3 %
I	0-30	0.13	3	1.54	0.51	0.17	0.18	8.65	5.9	2.75
Perumatty	30-60	0.14	6	1.34	0.59	0.13	0.16	8.50	5.3	3.20
	60-80	0.15	10	1.23	0.92	0.12	0.11	6.60	5.5	1.10
II	0-30	0.12	1	1.16	0.13	0.13	0.12	9.15	6.3	2.85
Chittoor	30-60	0.11	6	0.62	0.18	0.19	0.10	9.75	7.5	2.60
(proper)	60-80	0.11	Trace	0.46	0.13	0.13	0.11	8.20	5.6	2.60
III	0-30	0.15	17	1.57	1.00	0.07	0.11	5.50	4.5	1.00
Chittoor	30-60	0.16	13	0.70	0.14	0.14	0.15	6.85	5.2	1.65
(Thamarachira)	60-80	0.07	3	0.70	1.08	0.13	0.17	7.40	6.7	0.70
IV	0-30	0.18	3	4.99	094	0.12	014	6.65	5.4	1.25
Thekkedesam	30-60	0.17	7	4.62	1.05	0.19	0.10	6.40	5.1	1.30
	60-80	0.17	1	4.99	1.15	0.14	0.10	6.30	5.8	0.50
V	0-30	0.13	25	5.39	1.50	0.24	0·14	8.00	6.3	1.7
Valiavallampathy	30-60	0.11	2.5	1.47	0.27	0.28	0.14	7.75	5.7	2.05
	60-80	0.12	14	5.92	0.95	0.33	0.15	8.15	7.2	0.95
VI	0-30	0.16	2.5	2.77	0.88	0.24	0.10	8.90	6.1	2.80
Kuttippallam	30-60	0.11	7	0.92	0.11	0.28	0.13	7.70	6.8	0.90
	60-80	0.12	13.5	1.39	0.33	0.33	0.08	6.60	6.0	0.60

Table 4

Cation exchange capacity, exchangeable cations and exchangeable sodium percentage of the samples

Location	Depth (cm)	Exchangeable cations, me/100g soil				CEC me/100 g soil	Exchangeable sodium percentage
		Calcium	Magnesium	Potassium	Sodium		
Perumatty	0-30	3.20	0.45	0.23	1.09	7.70	14.15
	30-60	4 00	0.75	0.10	070	7.80	8.90
	60-80	3.10	0.75	0.08	0.76	7.17	10.50
Chittoor (proper)	0-30	4.80	0.60	0.10	1.83	9.70	18.80
	30-60	4 00	0.50	0.12	1.13.	8.30	9.70
	60-80	4.50	070	0.11	1.02	9.40	11.01
Chittoor	0-30	6.00	0.80	0.08	073	10 50	6.90
(Thekkedesam)	30-60	5.50	0.70	0.13	1.83	12.50	14.64
	60-80	5.60	0.70	0.15	1.13	1250	9.04
Thekkedesam	0-30	9.21	2.00	0.20	1.74	13.60	12.79
	30-60	11.00	1.96	0.18	1.04	14.30	7.27
	60-80	6.05	0.80	0.28	1.02	11.50	8.80
	0-30	11.60	0.80	0.24	1.00	13.65	7.32
Valiavallampathy	30-60	12.90	1.50	0.19	1.28	16.00	7.57
	60-80	12.10	2.30	0.19	1.26	15.50	8.12
	0-30	9.40	1.60	0.19	0.96	17.30	5.50
Kuttippallam	30-60	9.25	1.70	0.17	0.96	13.25	7.20
	60-80	4.98	1.20	0.20	0.78	9.10	8.57

than 0.05 per cent. An exchangeable sodium percentage in the range of 12-15 and a bicarbonate content of about 0.02 per cent decreased permeability (Colibas *et al*. 1976). These values fall with in this range and so the slow permeability of these soils can be due to the above two factors. The values for the exchangeable cations generally decreased in the order Ca, Mg, Na and K. However, in quite a good number of samples the proportion of Na was even more than that of Mg thus indicating that sodium may be responsible for the highly dispersed nature of these soils.

Summary

An investigation on the chemical properties of *Poonthalpadam* soils of Kerala shows that these soils have a pH range of 6.5—8.4. The total nitrogen content is low in most of the profiles studied. While the level of total P_2O_5 is found to be satisfactory, the available phosphorus content is low probably due to the fact that the P is present in combination with calcium and clay in rather unavailable forms. Tne level of available potassium also is unsatisfactory which warrants potash fertilization. Cation exchange studies reveal that calcium is the predominant cation and 67 percent of the CEC is satisfied by the divalent cations, calcium and magnesium. Sodium is also found to be present in the exchangeable form and in some cases its content exceeded that of magnesium. The poor physical characteristics can be attributed to the presence of sodium, which causes dispersion of clay, and also to the high water table. Organic matter is found to be higher in the surface layers because of the illdrained condition and the wide C/N ratio noticed in some profile samples is possibly due to loss of nitrogen by denitrification and persistence of organic matter due to anaerobic condition.

Improvement of the drainage and ameliorative measures for alkalinity are necessary for the reclamation of these soils.

സംഗ്രഹം

പൂന്തൽപ്പാടം മണ്ണിന്റെ രാസസ്വഭാവത്തെപ്പറ്റി നടത്തിയ പഠനത്തിൽനിന്നും ഈ മണ്ണിന്റെ pH 6.4 തൊട്ട് 8.4 വരെ ആണെന്ന് തെളിഞ്ഞു. മണ്ണിലുള്ള പാക്യജനകത്തിന്റെ അളവ് കുറവായി കാണപ്പെട്ടു. മൊത്തം ഭാവഹം തൃപ്തികരമായി കണപ്പോൾ, ചെടിക്ക് ലഭ്യമാകുന്ന ഭാവഹത്തിന്റെ പങ്ക് വളരെ കുറവാണെന്ന് കണ്ടു. ചെടിക്ക് ലഭ്യമാകുന്ന ക്ഷാരത്തിന്റെ അളവും കുറവായി കാണപ്പെട്ടു. ആകയാൽ ഈ മണ്ണിൽ പൊട്ടാഷ് വളത്തിന്റെ ഉപയോഗം അനിവാര്യമാകുന്നു. മണ്ണിന്റെ ധനായണവിനിമയ പഠനങ്ങളിൽ നിന്നും പ്രധാനമായ അയോൺ കാൽസ്യം rarajsismrm" തെളിഞ്ഞു മണ്ണിന്റെ വിനിമയ വിധേയമാകുന്ന ധനായണുക്കളിൽ 67% കാൽസ്യവും മഗ്നീഷ്യവും ആണെന്നു തെളിഞ്ഞു. ഈ മണ്ണിൽ സോഡിയം ഉള്ളതായി കണ്ടു. ചില സ്ഥലങ്ങളിൽ മഗ്നീഷ്യത്തിന്റെ അളവിനേക്കാൾകൂടുതൽസോഡിയംഉള്ളതായിCTrOlgTSTOTO) 1.ffISmTfflCIftOമോശമായ ഭൗതികഘടനയ്ക്ക് കാരണം സോഡിയത്തിന്റെ അളവും ഉയർന്ന ഭൂഗർഭജലനിരപ്പും ആയിരിക്കാം. മണ്ണിന് നല്ല നീർവാർച്ച ഇല്ലാത്ത സ്വഭാവമാകയാൽ ജൈവാംശത്തിന്റെ അളവ് ഉപരിതലത്തിൽ കൂടുത

ലായി കാണപ്പെട്ടു. കാർബൺ/നൈട്രജൻ അനുപാതം വളരെ കൂടുതലായി കാണപ്പെട്ടതിന്റെ കാരണം നീർവാർച്ച മോശമായതിൽ നിന്നുണ്ടാകുന്ന വായുലഭ്യമല്ലാത്ത അവസ്ഥ മൂലം ജൈവാംശത്തിന്റെ ഓക്സീകരണം fflcracocTsiToanejOcaiidSjQa' ൧ ൧ roitaicrumaD൦ വിനൈട്രീകരണം മൂലം പാക്യജനകം നഷ്ടപ്പെട്ടതുകൊണ്ടും ആകാൻ സാദ്ധ്യതയുണ്ട്.

മണ്ണിന്റെ നീർവാർച്ച മെച്ചപ്പെടുത്തുകയും ക്ഷാരസ്ഥിതി പരിഹരിക്കുകയും ചെയ്താൽ മണ്ണിന്റെ ഉല്പാദനക്ഷമത മെച്ചപ്പെടുത്താവുന്നതാണ്.

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