A STUDY OF SOME SOILS OF CHHATRAPUR, MYMENSINGH, EAST PAKISTAN

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The present investigation deals with the study of the soils of Chhatrapur, Mymensingh, East Pakistan. Soils were studied for pH, textural separates and nutrients on 6 in. depth basis from 0 to 18 in. for finding out their distribution pattern.

Introduction

Situated at a distance of 3 miles south of Mymensingh, Chhatrapur is the site of the East Pakistan Agricultural University campus, covering an area of 1100 acres.

A realistic planning of the experimental and commercial farms of the University obviously depends on the availability of the information on the properties of the Chhatrapur soils. No systematic effort was heretofore made to study the soils of the area. It was, therefore, felt necessary to undertake an exploratory study of the soils of Chhatrapur.

The climate of the area is warm humid with a wet summer, and a dry and moderately cold winter. The average annual rainfall, temperature and humidity are respectively 91 in, 77°F and 87.4%. The vegetative association of the area consists of native grass (*Cynodon dactylon* pers.), sporadic palms (*Borassus flabellifer* L.) and agricultural crops such as rice (*Oriza sativa*), jute (Corchorus spp.) etc. The old Brahmaputra river runs along (almost parallel to) the area towards east. The river gets full almost to the bank during the wet season but the level of water in the dry season falls down to almost 25% of the wet season level.

Information on the age and geology of the area is very meagre. It appears from the scanty literature on the post-Miocene geological history of the Indo-Pakistan Subcontinent that the upliftment of the high land which includes Chhatrapur took place as a result of the last orogenic movement in pleistocene (1 million years ago) which caused the upheaval of the ferrugineous argillites to cover, among others, the district of Mymensingh.[4,7]

Field Report

After a reconnaissance survey of the area under the investigation, a number of soil types were encountered which have been tentatively named after their surface texture and locality name as (1) Chhatrapur sandy loam/1 (Chhatrapur sL/1), (2) Chhatrapur silty loam/1 (Chhatrapur sL/1), (3) Chhatrapur loam (Chhatrapur L), (4) Chhatrapur sandy loam/2 (Chhatrapur sL/2), (5) Chhatrapur silty loam/2 (Chhatrapur sL/2) and (6) Chhatrapur silty loam/3 (Chhatrapur sL/3). The description of the soils is as in Table 1.

Sampling and Analyses

Soil sampling was done from undisturbed sites to find their inherent natural properties. Samples were taken on 6 in. depth basis.

Soils were analysed for pH; textural separates; total nitrogen; organic carbon; (NH_4–and NO_3–) nitrogen; available phosphorus, potassium and sulphur; water-soluble magnesium, calcium, potassium and iron at field pH; and exchangeable calcium; magnesium potassium and total exchangeable metal ions. The results of analyses are given in Tables 2 and 3.

The pH values were determined by a glass electrode using 1:5 soil–water suspension, mechanical analysis was done by pipette sampling method and ammoniacal–and nitrate-nitrogen were determined on KCl leachate as outlined by Piper.[5] Available phosphorus (0.002N H_2SO_4 soluble) was estimated by Truog's[6] method, potassium by Dyer's[1] 1% citric acid extraction method and sulphate by Karim and Iajuddin's[2] extraction method. Extraction for magnesium, calcium, potassium and iron at field pH was done with CO_2-saturated water at 1:10 soil–extractant ratio and laboratory analyses were done following the methods outlined by Piper.[5]

Discussion

Textural Separates (*Table 2*)

(a) *The Non-colloid Fraction.*—The figures in Table 2 show that fine sand is rather insignificant in all soils irrespective of depth. In general, the vertical distribution pattern of the fine sand –coarse sand ratio down the depths does not show any uniformity or regularity.

The silt has assumed a significant value in all soils. Except in one or two samples this fraction has assumed values greater than 15% going as high as 60%.

The fine sand–silt ratio in respect of its vertical distribution in all the soils except in Chhatrapur sL/2 seems quite regular and uniform.

(b) *The Colloid Fraction.*—The distribution of clay from surface downwards shows in general a rise with depth. The silt–clay ratio in general presents a reasonably uniform vertical distribution. The silty loam soils have a fairly good clay content (20–29%) but loam and sandy loam soils are poor in clay (around 15%).

Chemical Analyses (*Tables 3-5*)

(a) *Soil Reaction* (pH).—The reaction of the soils is mild acidic to very slightly alkaline, the pH being in the range of 5.8 to 7.4. The pH was determined in wet and dry seasons and under both field and laboratory processed conditions to see whether the pH is reasonably constant. It was found (Table 4) that the pH invariably went up in the wet season. Again the pH under field condition was higher than that under processed and stored condition. It should, therefore, appear that the usual method of determining pH on dried and stored soils does not give a correct picture of the field.

(b) *Total Nitrogen.*—The distribution pattern of the total nitrogen shows in general a fall with depth. The surface distribution of the total nitrogen in the soil ranges from 0.021 to 0.084%. The total nitrogen content is higher in the silty soils. It varies from 0.041 to 0.084%. Loam and sandy loam soils contain relatively lesser amount (0.021–0.05%).

(c) *Organic Carbon.*—The organic carbon has shown exactly the same vertical distribution pattern as that of the total nitrogen, i.e. a fall with depth, showing thereby a close relationship with nitrogen. The surface distribution of organic carbon varies from 0.006 to 1.096%.

The distribution pattern of the C/N ratio shows in general a fall with depth.

(d) *Available Nutrients.*—Ammoniacal-and nitrate-nitrogen which may together be taken as the available nitrogen shows in general a fall with depth. The surface distribution of the available nitrogen varies from 1.15 to 2.76 mg%. The available nitrogen content is in general higher in the silty loam soils than the loam and sandy loam soils with the exception of Chhatrapur SL/2.

TABLE 1.—MORPHOLOGY OF THE SOILS.

Soil type	Depth (in.)	Morphology
Chhatrapur sL/1	0–6	Light grey sandy loam, granular structure.
	6–12	Light grey sandy loam, loose, granular.
	12–18	Light brown sandy loam, loose when dry, slightly sticky when wet
Chhatrapur sL/1	0.6	Grey silty loam, crumb structure, slightly sticky when wet
	6–12	Light greyish brown silty loam, sticky when wet and slightly compact when dry, nutty structure
	12–18	Brownish grey silty loam with nutty structure
Chhatrapur L	0–6	Greyish light brown loam, crumb structure, loose sticky when wet
	6–12	Light brown silty loam, granular structure
	12–18	Light brown loam, friable
Chhatrapur SL/2	0.6	Light grey sandy loam, granular structure loose when dry and non-sticky when wet
	6–12	Brown grey sandy loam, granular structure, friable.
	12–18	Brown sandy loam, granular structure, loose
Chhatrapur sL/2	0–6	Grey silty loam
	6–12	Light brown silty loam, blocky structure, sticky when wet
	12–18	Yellowish brown silty loam, blocky structure
Chhatrapur sL/3	0–6	Greyish brown silty loam, granular structure
	6–12	Light brown silty loam, nutty structure, sticky when wet
	12–18	Brownish silty loam, granular

Table 2.—Textural Separates of the Soils.

Soil type	Depth (in.)	Mechanical analysis * Coarse sand 2 to 0.2 mm %	Fine sand 0.2 to 0.02 mm %	Silt 0.02 to 0.002 mm %	Clay 0.002 mm %	Fine sand / Coarse sand	Fines and / Silt	Silt / Clay	Loss on acid treatment %	Moistur content † %
Chhatrapur SL/1	0–6	0.436	61.95	22.50	11.50	142.09	2.75	1.95	3.57	0.61
	6–12	0.715	62.31	18.90	12.24	87.14	3.29	1.54	3.97	0.66
	12–18	0.294	44.42	33.34	17.78	151.08	1.33	1.87	4.20	1.00
Chhatrapur sL/1	0–6	0.617	25.87	46.56	20.06	41.92	0.55	2.32	3.80	0.90
	6–12	1.167	14.00	51.86	29.42	83.83	0.26	1.76	4.55	1.15
	12–18	0.219	19.13	51.74	22.10	87.35	0.36	2.34	4.29	1.06
Chhatrapur L	0–6	0.564	60.92	23.30	10.66	108.01	2.50	2.27	3.47	0.58
	6–12	0.762	59.52	24.22	12.28	78.11	2.45	1.97	3.41	0.57
	12–18	1.585	50.00	28.78	14.04	31.54	1.77	2.06	3.68	0.83
Chhatrapur SL/2	0–6	0.624	61.76	15.58	17.28	98.97	3.96	0.90	2.92	0.53
	6–12	0.447	76.19	5.34	13.18	170.44	14.26	4.06	2.67	0.31
	12–18	0.379	71.42	12.64	13.50	188.44	5.65	0.93	2.69	0.47
Chhatrapur sL/2	0-6	2.157	55.30	23.26	15.12	25.63	2.37	1.53	3.18	0.72
	6–12	1.634	48.09	27.20	17.84	29.43	1.76	1.52	3.62	0.72
	12–18	2.526	47.64	24.13	20.06	18.85	1.97	1.20	3.47	0.67
Chhatrapur sL/3	0–6	0.132	14.06	56.20	23.60	106.51	0.25	2.38	4.65	1.00
	6–12	0.098	10.90	58.82	25.24	111.22	0.18	2.33	4.42	1.00
	12-18	0.097	12.45	60.36	19.56	143.10	0.20	3.08	4.29	0.96

*On oven dry basis †Of air dry soil.

The available phosphorus in general shows a vertical rise with depth. The distribution of the available phosphorus at the surface is in the range of 1.50 to 4.13 mg%. Of the soils, the loam soil, however, appears to contain the highest value for the available phosphorus (4.13 mg%).

The vertical distribution pattern of the available potassium in the soils seems rather uniform. The available potassium content in the soils ranges from 3.50 to 6.25 mg% at the surface.

The vertical distribution pattern of the available sulphur has not followed any particular trend. The surface distribution of the available sulphur ranges from 6.62 to 16.54 mg%.

The mutual ratio amongst the avialable nitrogen, phosphorus and potassium appears to be variable and widens with depth (Table 5). It has, however, been found that the mutual ratio of the available nitrogen, phosphorus and potassium in the Chhatrapur sL/2 is a close approximation of the best mutual ratio (1:2:2) obtained by Karim and Idris[3] for growth and yield of rice plant.

(e) *Water-soluble Materials at Field pH.*—The distribution of magnesia in general shows a fall with depth in the soils. Magnesia appears to occupy prominent position in silty loam soils. The surface distribution of magnesia varies from 3.77 to 12.27 mg%.

The lime content, however, unlike magnesia in general shows a progressive rise with depth. It ranges from 2.18 to 11.29 mg% at the surface.

The vertical distribution pattern of potassium varies from 0.92 to 2.44 mg%.

Iron also shows uniformity in its vertical distribution pattern. The surface distribution of iron varies from 1.74 to 3.51 mg%. The silty loam soils in general have shown accumulation of a fair amount of iron.

It seems interesting that the water extract at field pH should contain that much of lime, magnesia, potash and iron at the surface and sub-soil. This seems to be a telling information.

(f) *Exchangeable Cations.*—Of the individual cations Ca^{++} is found to occupy a prominent

TABLE 3.—RESULTS OF THE CHEMICAL ANALYSES OF THE SOILS.

Soil type	Depth in.	Available nutrients (mg%)				Water soluble materials at field pH (mg%)				Exchangeable cations (m-equiv. %)				Total nitrogen %	Organic carbon %	C/N ratio
		N	P_2O_5	K_2O	SO_4	MgO	CaO	K_2O	F	Ca	Mg	K	Total			
Chhatrapur SL/1																
	0–6	1.35	3.90	5.61	6.62	3.77	3.33	2.40	1.74	2.86	1.87	0.01	4.88	0.02	2.51	11.9
	6–12	0.85	5.22	6.86	5.79	3.13	5.75	3.14	2.72	3.25	2.20	0.01	5.49	0.014	0.13	9.28
	12–18	0.75	4.37	6.89	8.31	2.62	8.50	4.38	2.59	4.30	3.80	0.09	8.22	0.144	0.09	6.43
Chhatrapur sL/1																
	0–6	1.71	1.50	3.50	9.96	4.38	4.68	2.44	2.15	3.51	2.75	0.08	6.93	0.06	0.59	9.83
	6–12	1.10	3.20	5.03	13.29	4.03	6.21	2.21	2.61	6.39	4.65	11.94	0.05	0.44	0.44	0.80
	12–18	0.79	4.31	4.38	14.47	3.62	7.80	2.24	2.31	6.14	4.75	0.21	11.27	0.04	0.25	5·62
Chhatrapur L																
	0–6	1.15	4.13	4.98	14.90	5.97	11.29	2.80	2.63	3.84	3.57	0.14	7.65	0.05	0.61	12.20
	6–12	0.66	5.40	4.89	16.55	4.11	12.31	1.81	2.73	4.33	2.96	0.16	7.74	0.03	0.32	10.66
	12–18	0.65	5.79	6.25	11.61	3.58	12.76	1.66	3.07	6.12	4.38	0.18	10.96	0.024	0.17	7.08
Chhatrapur SL/2																
	0–6	2.76	2.92	5.60	16.54	9.82	2.18	0.94	2.96	3.66	2.99	0.87	6.87	0.03	0.27	0.90
	6–12	2.13	4.01	5.59	19.81	10.82	2.70	2.09	3.85	2.60	3.06	5.60	0.02	0.02	0.15	7.50
	12–18	1.20	5.01	5.60	16.55	10.33	2.81	1.13	3.67	2.94	2.77	0.07	5.95	0.01	0.06	6.00
Chhatrapur sL/2																
	0–6	2.33	3.76	3.99	8.29	8.19	3.66	1.47	3.51	4.35	3.97	0.18	8.78	0.08	0.86	10.75
	6–12	2.01	5.49	4.62	13.26	9.71	3.89	1.34	4.08	4.44	0.19	9.34	0.06	0.06	0.52	8.67
	12–18	1.74	5.51	5.20	16.57	9.21	3.18	1.33	5.41	3.77	4.13	0.22	8.31	0.04	0.31	7.75
Chhatrapur sL/3																
	0–6	2.16	2.48	6.52	9.97	12.27	2.49	0.92	2.93	6.69	5.55	0.10	12.75	0.08	1.09	13.62
	6–12	1.59	3.21	6.53	13.29	9.62	3.04	0.78	5.16	6.20	5.87	0.18	12.61	0.05	0.50	10.00
	12–18	1.20	4.49	7.15	9.97	6.36	3.63	0.72	5.07	5.33	5.43	0.21	12.09	0.04	0.31	7.75

Table 4.—Seasonal Variation of pH under Field and Laboratory Processed Conditions.

Soil type	Depth (in.)	Field condition pH in wet season	Field condition pH in dry season	Laboratory processed fine earth pH in wet season	Laboratory processed fine earth pH in dry season
Chhatrapur SL/1	0–6	6.6	6.1	6.2	5.8
	6–12	7.0	6.5	6.6	6.2
	12–18	7.0	6.8	6.4	6.3
Chhatrapur sL/1	0–6	7.0	6.9	6.6	6.4
	6–12	7.2	7.1	6.8	6.5
	12–18	7.4	7.2	7.1	6.7
Chhatrapur L	0–6	7.2	7.0	7.2	6.8
	6–12	7.2	7.0	7.1	6.8
	12–18	7.4	7.2	7.2	6.9
Chhatrapur SL/2	0–6	7.2	6.3	6.9	6.0
	6–12	7.4	6.7	7.1	6.4
	12–18	7.4	7.1	7.1	6.5
Chhatrapur sL/2	0–6	6.9	6.2	6.6	5.8
	6–12	6.9	6.3	6.6	5.8
	12–18	7.0	6.4	6.6	6.2
Chhatrapur sL/3	0–6	7.4	7.0	7.1	6.9
	6–12	7.4	7.0	7.2	6.9
	12–18	7.4	7.1	7.2	6.8

Table 5.—The Available Nitrogen–Phosphorus–Potassium Ratio in the Soils.

Soil type	Depth (in.)	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O_5)
Chhatrapur SL/1 ..	0–6	1.00	2.89	4.17
	6–12	1.00	6.14	8.07
	12–18	1.00	5.82	9.16
Chhatrapur sL/1 ..	0–6	1.00	0.88	2.05
	6–12	1.00	2.92	4.58
	12–18	1.00	5.43	5.52
Chhatrapur L ..	0–6	1.00	3.59	4.34
	6–12	1.00	8.11	7.35
	12–18	1.0	8.96	9.67
Chhatrapur SL/2 ..	0–6	1.00	1.05	2.02
	6–12	1.00	1.87	2.60
	12–18	1.00	4.16	4.65
Chhatrapur sL/2 ..	0–6	1.00	1.60	1.70
	6–12	1.00	2.73	2.33
	12–18	1.00	3.16	2.98
Chhatrapur sL/2 ..	0–6	1.00	1.14	3.01
	6–12	1.00	2.04	4.08
	12–18	1.00	3.72	5.92

position especially in Chhatrapur sL/1 and sL/3. The distribution of Ca^{++} in general shows uniformity with depth. The surface distribution, however, ranges from 2.86 to 6.69 m-equiv.%.

The surface distribution of Mg^{++} varies from 1.87 to 5.55 m-equiv.%. The vertical distribution pattern of Mg^{++} in general shows uniformity.

The exchangeable K^{+} is very low in comparison to other Cations. The values of K^{+} ranges from 0.01 to 0.18%.

The surface distribution of the total exchangeable metal cations varies from 4.88 to 12.75 m-equiv.%. The total exchangeable metal cations has, however, shown a direct correlation with the sum of the individual exchangeable Ca, Mg and K ions.

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