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Effect of Long Term Use of Canal Water on Physical and Chemical Properties of Old Alluvial Soils of Chandan River System (Watershed)

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Abstract

Tal land soils are light gray-dark gray medium to heavy textured soils and old alluvium gray-grayish yellow-heavy textured soils with cracking fall under the watershed of chandan river. The upland physiography of old alluvial soils under immediate influence of the river Chandan are characterized by yellowish brown color, sandy loam to sandy clay loam and clay in texture, presence of low organic carbon, neutral reaction to slightly alkaline (pH 6.4–7.7), very slow to slow hydraulic conductivity, lower CEC, while the soils on upland, under immediate influence of Chandan river are light olive in color, sandy loam to sandy-clay-loam.

Key words : River Chandan, Pore space, Saturated hydraulic conductivity, Soil physico-chemical properties.

Chandan river system occupies major areas of Banka and Bhagalpur districts of South Bihar covering an area of approximately 64 thousand ha. The river originates from the northern part of Deoghar hills and terminates in the river Ganga in the lower regions. Soils of this region are alluvial in nature. The clayey texture of such soils either from the basic nature of parent materials in the mountain regions or from the sedimentation process in wide flood plains. The Chandan river, being the largest hill stream in south Bhagalpur, Thus, this river system has a topographical variability which has contributed greater extent to soil formation in respect to soil depth, textural classes, fertility status, water retaining character and several other physical and chemical characters.

Methods

The experimental sites are situated under Chandan command area which is situated in Bhagalpur and Banka districts in the state of south Bihar. It lies between $24^0 48' - 25^0 16'$ North latitudes and between $86^0 45' - 87^0 4'$ East longitudes and covers an area of 64,000 ha approximately. The climate of the area in sub-tropical and sub-humid with annual precipitation of around 1200 mm covering 63 to 70% of the potential evapotranspiration. The minimum and maximum temperature ranges between 10.2 and 36.5^0C. The rainfall varies from 1135 mm to 1200 mm. The mean annual temperature (MAT) varies from 28.8 to 36.5 C. The control section of the soils may remain moist in some parts for more than 180 cumulative days and dry for 60 consecutive and/or more than 90 cumulative days in a year. Therefore, it qualifies for Ustic moisture regime and Hyperthermic remperature regime. Representative nine pedons (P_1 to P_9) occurring on different land forms were studied. Depth wise soil samples were analyzed by using standard procedures.

Results and Discussion

The particle size distribution indicates to have varied amount of sand and clay particles depending upon the distance of pedon from the river of Chandan (Table 1). The textural classes of upper three pedons varied from sandy loam to sandy clay loam but medium to lower pedons were clay. In general, the top soils (0—15 cm) were having higher sand (64.60%) as compared to the lower layers (14.17%). It might be due to canal irrigation water siltation at the nearest point and also due to sudden decrease in threshold velocity for sand particles. Similarly, the decrease in threshold velocity for silt and clay particles may result in deposition of soil separates. The movement of clay from upper layer may also be resulted in increasing the clay content in lower layers due to every year puddling for rice transplanting.

Table 1. Physical properties of soils.

Pedons	Soil depth (cm)	Particle size distribution (%)				Bulk density (Mg/m^3)	Saturated hydraulic conductivity (cm/h)
		Sand	Silt	Clay	Soil Texture		
	0-10	64.60	21.15	14.25	Sandy loam	1.49	0.195
	10-21	63.10	20.43	16.47	Sandy loam	1.52	0.270
P_1	21-48	57.90	22.10	20.00	Sandy-clay-loam	1.65	0.300
	48-66	52.20	26.30	21.50	Sandy-clay-loam	1.64	0.280
	66-101	50.15	27.60	22.25	Sandy-clay-loam	1.64	0.240
	0-10	60.15	20.55	19.30	Sandy loam	1.50	0.203
	10-24	56.30	21.15	22.55	Sandy-clay-loam	1.54	0.168
P_2	24-36	54.10	19.40	26.50	Sandy-clay-loam	1.60	0.152
	36-52	60.45	12.40	27.15	Sandy-clay-loam	1.64	0.145
	52-75	60.10	20.40	19.50	Sandy loam	1.52	0.298
	0-16	60.15	20.35	19.50	Sandy-clay-loam	1.32	0.165
	16-32	57.10	22.15	20.75	Sandy-clay-loam	1.48	0.145
P_3	32-64	53.15	24.30	22.55	Sandy-clay-loam	1.45	0.142
	64-85	49.15	27.30	23.55	Sandy-clay-loam	1.43	0.131
	85-130	45.10	27.40	27.50	Sandy-clay-loam	1.45	0.152
	0-20	22.32	24.60	53.08	Clay	1.49	0.090
	20-45	21.25	23.40	55.35	Clay	1.51	0.081
P_4	45-100	21.10	20.25	58.65	Clay	1.53	0.080
	100 +	22.10	20.55	57.25	Clay	1.45	0.080
	0-20	23.50	25.70	50.80	Clay	1.30	0.131
	20-55	23.50	24.10	52.40	Clay	1.41	0.086
P_5	55-95	23.00	23.80	53.20	Clay	1.42	0.072
	95-120	23.35	24.80	51.85	Clay	1.53	0.062
	120-150	22.20	23.70	54.10	Clay	1.54	0.052
	0-15	25.40	22.85	51.75	Clay	1.45	0.088
	15-34	27.10	22.40	50.50	Clay	1.45	0.072
P_6	34-80	4.60	29.40	30.00	Clay loam	1.44	0.085
	80-115	42.40	28.50	29.10	Clay loam	1.41	0.080
	115-150 +	33.30	24.40	42.30	Clay	1.52	0.062
	0-30	17.84	31.06	51.10	Clay	1.31	0.044
	30-65	16.69	28.65	54.66	Clay	1.33	0.041
P_7	65-90	16.10	28.30	55.60	Clay	1.34	0.039
	90-132	15.90	27.82	56.28	Clay	1.40	0.035
	132-172	15.15	27.05	57.80	Clay	1.42	0.030
	0-20	15.32	30.06	54.62	Clay	1.30	0.031
	20-40	15.22	29.19	55.59	Clay	1.31	0.041
P_8	40-85	15.15	27.52	57.33	Clay	1.31	0.045
	85-125	14.97	25.93	59.10	Clay	1.32	0.030
	125-165	14.71	25.69	59.60	Clay	1.30	0.035
	0-20	16.75	30.50	51.75	Clay	1.31	0.042
P_9	20-54	16.45	29.14	54.41	Clay	1.34	0.034
	54-100	16.10	28.60	55.30	Clay	1.40	0.031
	100 +	15.60	27.20	57.20	Clay	1.42	0.024

There was increase in bulk density in lower layers as compared to top soil (Table 1). The highest bulk density in lower layers may also be due to contribution of higher pH and development of sodicity in lower layers of some of the profiles. Similar result was observed by Pandey and Pathak (1). The values of saturated hydraulic conductivity (Table 1) were in the range of very slow to slow hydraulic conductivity. It seems to be due to high bulk density, low organic matter, high pH and high clay content in lower layers. Similar result was observed by Nayer and Shukla (2—4).

Table 2. Effect of long term use of canal water on soil aggregates and pore space under Chandan river area.

Pedons	Soil depth (cm)	Macro-aggregates (>0.25 mm) (%)	Micro-aggregates (<0.25 mm) (%)	Total aggregates (%)	Total pore space (%)
	0-10	24.72	18.92	43.64	43.12
	10-21	23.98	24.78	48.76	42.20
P_1	21-48	25.22	29.48	54.70	37.26
	48-66	27.92	27.68	55.60	37.16
	66-101	30.65	27.34	57.99	36.92
	0-10	34.10	21.10	55.20	42.30
	10-24	34.24	19.32	53.56	40.99
P_2	24-36	38.58	19.38	57.96	38.69
	36-52	32.84	19.44	52.28	37.64
	52-75	30.86	21.26	52.12	42.20
	0-16	21.18	16.08	37.26	50.18
	16-32	22.80	19.44	42.24	44.36
P_3	32-64	26.85	21.25	48.10	45.48
	64-85	28.90	22.30	51.20	46.44
	85-130	30.30	26.35	56.65	45.69
	0-20	35.20	32.20	67.40	43.77
	20-45	32.34	27.52	59.86	43.23
P_4	45-100	32.92	27.26	60.18	42.48
	100 +	30.42	21.04	51.46	45.48
	0-20	33.58	19.32	52.90	50.94
	20-55	36.28	16.84	53.12	46.79
P_5	55-95	27.36	30.12	57.48	46.82
	95-120	25.34	33.52	58.86	41.82
	120-150	28.25	31.94	60.19	41.44
	0-15	32.38	27.60	59.98	44.86
	15-34	30.20	21.16	51.36	45.07
P_6	34-80	24.88	27.22	52.10	45.45
	80-115	26.62	25.04	51.66	46.79
	115-150 +	30.60	29.50	60.10	42.20
	0-30	39.70	26.81	66.51	50.56
	30-65	36.20	20.68	56.88	50.00
P_7	65-90	40.15	20.66	60.81	49.62
	90-132	33.90	27.16	61.06	47.56
	132-172	43.80	24.16	67.96	46.81
	0-20	38.90	31.00	69.90	50.94
	20-40	41.03	38.28	79.31	50.75
P_8	40-85	40.75	28.13	68.88	50.75
	85-125	42.97	25.30	68.27	50.56
	125-165	42.78	26.72	69.50	51.31
	0-20	40.49	26.21	66.70	50.56
P_9	20-54	43.77	24.45	68.22	49.62
	54-100	45.44	25.33	70.77	47.56
	100 +	44.13	35.96	80.09	46.81

Table 3. Some chemical and physio-chemical properties of soils.

Pedons	Soil Depth (cm)	pH	EC (dS/m)	Organic carbon (g/kg)	Free $CaCO_3$ (%)
	0-10	6.6	0.16	0.55	0.80
	10-21	7.4	0.13	0.29	0.78
P_1	21-48	7.2	0.17	0.37	0.78
	48-66	6.8	0.13	0.31	0.77
	66-101	7.2	0.11	0.25	0.77
	0-10	7.4	0.15	0.64	0.74
	10-24	7.0	0.13	0.56	0.74
P_2	24-36	7.2	0.11	0.32	0.73
	36-52	7.6	0.09	0.23	0.72
	52-75	7.7	0.09	0.59	0.71
	0-16	7.4	0.12	0.55	0.75
	16-32	7.4	0.13	0.41	0.73
P_3	32-64	7.5	0.15	0.42	0.73
	64-85	7.6	0.14	0.35	0.72
	85-130	7.7	0.16	0.40	0.72
	0-20	6.6	0.13	0.63	1.60
	20-45	7.0	0.11	0.51	1.59
P_4	45-100	7.2	0.09	0.34	1.59
	100 +	7.2	0.07	0.41	1.58
	0-20	7.4	0.10	0.60	1.60
	20-55	7.6	0.09	0.39	1.58
P_8	55-95	7.5	0.09	0.42	1.56
	95-120	7.5	0.11	0.39	1.55
	120-150	7.6	0.12	0.37	1.52
	0-15	7.4	0.10	0.56	1.60
	15-34	7.6	0.10	0.36	1.60
P_6	34-80	7.7	0.12	0.20	1.58
	80-115	7.5	0.14	0.17	1.56
	115-150+	7.6	0.15	0.15	1.54
	0-30	7.0	0.05	0.68	3.10
	30-65	7.1	0.05	0.42	2.68
P_7	65-90	7.1	0.05	0.41	2.74
	90-132	7.1	0.04	0.41	2.58
	132-172	7.3	0.03	0.40	2.57
	0-20	7.5	0.13	0.70	6.82
	20-40	7.5	0.13	0.45	5.76
P_8	40-85	7.5	0.11	0.44	5.72
	85-125	7.6	0.11	0.44	4.64
	125-165	7.6	0.11	0.38	4.68
	0-20	7.3	0.11	0.58	3.10
P_9	20-54	7.3	0.11	0.46	2.59
	54-100	7.4	0.09	0.43	2.58
	100 +	7.4	0.07	0.41	2.58

Table 2 reveals that there was an increase of total aggregates with depth (Table 2). The depth wise variation of micro and macro aggregates was differential. The micro aggregate generally decreased whereas macro aggregates increased with soil depth. This might be accentuated that an extra pressure generated due to fracture along with the wetting front in the lower layers of the pedons was conductive to the generation of macro-aggregate at fastest rate. The depth wise increasing of macro-aggregate was also reported by Kauraw et al. (5) and Diwakar and Singh (6). Taking all the nine pedons into consideration, it seemed that clay mineral played an important role in the aggregation. As there was a positive and highly

significant correlation of clay with total aggregate and macro-aggregate. This also confirms the findings of Krishnamurti and Singh (7).

It is evident that total porosity of top layer i.e. 0—15 cm in all profiles were having higher values (50.94%) as compared to lower layer (36.92%) of the profiles (Table 2). This might be due to the contribution of higher amount of organic carbon and organic matter content in the top layer as compared to lower layers. With the increase in depth of soil, the porosity will decrease because of compactness in the sub-soil. This may also be due to higher organic matter content of the surface soil which might have resulted in the higher rooting density, their decay in rice-wheat cropping system in surface soil. The higher amount of per cent pore space in lower layer may be due to higher clay content of soil in lower layers. The lowest values of per cent of pore space in lower soil layers might be due to lower organic carbon content and higher clay content. Similar results were obtained by Baver (8).

The chemical and physico-chemical properties of the soils (Table 3) reveal that the electrical conductivity varying between 0.03 to 0.17 dS/m indicated non-hazardous concentration of soluble soils in all the profiles (Table 3). The soils have free $CaCO_3$ varying between 0.71 and 6.8%. The medium to low organic carbon of these soils (0.64 to 0.15%) may be attributed to the oxidation loss of organic matter due to tropical climate condition (9). The soils are slightly acidic to neutral (pH 6.4 to 7.7) in reaction may be due to loss of bases under well drained conditions and upland physiography and the higher pH may be attributed to the accumulation of soluble salts and sodium in saucer-shaped physiography under the influence of compact and hard layers formed due to high clay content. The pH has significant and negative correlation with the organic carbon content of these soils.

Conclusion

These above mentioned soil characters were due to influence of Chandan river system which has modified basic soil characters by influencing water raising and vegetation of these areas. Influence of topography gad definitely played a major role in modified the soil characters of this system.

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