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Characterization of Soils of Two Village of Maniyar Block, Ballia District, Uttar Pradesh

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Abstract: Two pedons exposed each in Badagaon and Rampur villages of Maniyar bock, Ballia district to study the layer-wise distribution of some physical and chemical properties. The sand, silt and clay pedon^{-1} were varied from 25 to 55 %, 30 to 60 %, clay 8 to 16 % while it was 40 to 65 %, 25 to 45 % and clay 10 to 17 % respectively in pedon 2. Bulk density increased with depth upto 90 cm, water holding capacity decreased with increasing depth in both the pedon, and it ranged from 43.35% to 34.02% through depth. The pH ranged from 6.2 to 7.4 in both the pedons but its distribution with depth different in these pedons. The electrical conductivity of soils in both the soils was above to 1ds^{-1}. The organic carbon content was high in upper layer of depth in soils. Calcium carbonate ranged from 2.5 to 0.4% and 3.9 to 0.4 with depth in soils. Available N, P and S were higher in surface layer and decreased with depths but their values were in higher side in pedon 2 barring few exceptions with soil depth amount of available P content in surface and sub-surface soil. However, it was slightly medium in soils of pedon 2. The medium available K content was found in surface layer (0-15 cm) and decreased with depth in both the pedons. The S content in surface soil was found to be higher than sub-surface soil. The amount of available S was found in surface horizons (0-15 cm) 13.5 mg kg^{-1} in pedon 1, and 14.2 mg kg^{-1} in pedon 2. The surface layer of pedon 1 had 13.4 cmol (p^+) kg^{-1} exchangeable Ca while it was 6.4 cmol (p^+) kg^{-1} in P2. The exchangeable magnesium in pedon 1 was 8.2 cmol (p^+) kg^{-1} at 0-15 cm and 3.2 at 135-150 cm while in pedon 2 had exchangeable magnesium 7.3 cmol (p^+) kg^{-1} at 0-15 cm and 3.0 at 135-150 cm soil depth.

Keywords: *Physical properties, chemical properties and available nutrients*

Introduction

It is well established that soil is the most vital and precious natural resource that nourish all kind of life on the earth. The indigenous ability of soils to supply sufficient amount of essential nutrients has decreased with higher plant productivity levels associated with increased human demand for food. Therefore, one of the greatest challenge today for every stakeholder of agriculture is to develop and implement such soil, crop and nutrients management technologies that could enhances the plant productivity and also improve the quality of soil, water and air. The understanding of the processes through profile study helps of basis their characterization. The information on characteristics of different layer of soils in block is lacking and hence present study was carried out.

Material and Methods

Maniyar block (25º87'98.96" N;84˚21'69.55" E) of Ballia district occurs at an elevation of 62 meters above the sea level and represents north east alluvial plains. The average maximum (47.5˚C) and minimum (2.5˚C)

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temperature have been recorded in the months of June and January respectively. The relative humidity is generally high during the south west monsoon, being 70%. The profiles were exported upto 150 cm depth and layer-wise soil samples (≈2 kg) were collected processed (≈ 500g) and analysed for different parameters. Bulk density, pH and electrical conductivity were determined by methods described by Kanwar and Chopra (1998). Sand, silt and clay were analysed by International Pipette Method (Kanwar and Chopra 1998) and organic carbon while by the procedure outlined by Walkley and Black (1934). Calcium carbonate was estimated by rapid titration method (Puri 1930). Water holding capacity (WHC) was determine by gravimetric method (Kanwar and Chopra 1998), The available nitrogen (N) was determined by alkaline potassium permanganate method (Subbiah and Asija 1956), available P was estimated by Olsen's *et al.* (1954) method, available K was estimated by Ammonium acetate method as described by Muhr *et al.* (1965). Sulphur content of soil was determined by Williams and Steinberg (1969) rapid extraction method.

Results and Discussion

Physical properties

The percentage of sand, silt and clay varied from 25 to 55%, 30 to 60% and 11 to 22% respectively in pedon 1, while in pedon 2 these varied from 20 to 65%, 20 to 44% and 11 to 18%, respectively. Irrespective of the land use, soil texture was relatively finer in lower horizons than in the surface horizons owing to translocation of finer particles, clay accumulation and migration of sand and silt particles.

Bulk density varied from 1.57 to 1.42 Mg m^{-3} in pedon 1 whereas it ranged between 1.52 to 1.42 Mg m^{-3} in pedon 2 and in general increased with depth due to translocation of clay and other minerals and develop the compaction (Mandal and Sharma 2011).

The minimum water holding capacity (34.02%) was recorded in 135-150 cm layer and while maximum (43.35%) was observed in surface soil of pedon 1 (Table 1). Pedon 2 had 45.75% water holding capacity in 0-15 cm layer but maximum (34.78%) was associated in lowest layer. The water holding capacity of different layers of soils seems to be dependent on clay and organic carbon content of the respective layers.

Table 1. Sand, silt, clay, bulk density and water holding capacity of soils

Depth (cm)	Baragaon (Pedon 1)					Rampur (Pedon 2)				
	Sand (%)	Silt (%)	Clay (%)	BD (Mgm^{-3})	W.H.C (%)	Sand (%)	Silt (%)	Clay (%)	BD ($Mg\ m^{-3}$)	W.H.C (%)
0-15	35	50	15	1.47	43.35	50	30	20	1.49	45.75
15-30	55	31	14	1.54	42.22	54	25	22	1.52	44.55
30-45	36	53	14	1.51	41.09	55	30	15	1.57	42.45
45-60	28	60	12	1.56	40.08	65	22	13	1.48	41.39
60-75	46	45	9	1.57	40.05	48	34	18	1.51	39.41
75-90	52	32	16	1.55	39.32	52	35	13	1.52	38.31
90-105	35	52	13	1.46	38.15	40	45	15	1.46	37.23
105-120	40	48	12	1.42	36.85	50	36	14	1.54	36.65
120-135	40	35	15	1.44	35.65	52	35	13	1.48	36.32
135-150	42	38	20	1.45	34.02	45	44	11	1.42	34.78

Chemical Properties

The pH of different layers of soils in pedon of Baragaon and Rampur villages, ranged from 6.2 (75-90 cm) to 7.4 (30-45 cm). Soil pH is influenced by many soil chemical parameters and may change seasonally depending on external inputs used (Chauhan *et al.* 2016*)* and pedogenic process. The perusal of data on soil EC (Table 2) revealed that the EC of soil samples of Baragaon and Rampur villages ranged from 1.001 to 1.025 dSm^{-1}. In pedon 1 relatively lower EC 1.001 dSm^{-1}.

Data indicated that surface layers of both the pedons had different depth of soil profile was decreasing with highest amount of organic carbon to the tune of 0.88% and 0.62% respectively and decreased with depth. Singh *et al.* (2015) also reported similar pattern of organic carbon distributed in the soils of eastern Uttar Pradesh. The data on $CaCO_3$ revealed that its content in soils of pedon 1 ranged from 2.55 to 0.40% whereas it varied from 3.95% to 0.47% in pedon 2 through depth.

Table 2. Status of soil pH, EC, organic carbon and $CaCO_3$ of soils

Depth (cm)	Baragaon (Pedon 1)				Rampur (Pedon 2)			
	pH (1:2.5)	EC (dSm^{-1})	O.C. (%)	$CaCO_3$ (%)	pH (1:2.5)	EC (dSm^{-1})	O.C. (%)	$CaCO_3$ (%)
0-15	6.5	1.013	0.88	2.55	7.1	1.016	0.62	3.95
15-30	6.4	1.015	0.83	1.42	7.1	1.011	0.56	1.15
30-45	7.4	1.020	0.72	0.95	7.4	1.010	0.49	1.05
45-60	6.5	1.005	0.69	1.25	7.2	1.020	0.45	1.42
60-75	6.4	1.002	0.63	1.05	6.6	1.025	0.38	1.0
75-90	6.2	1.005	0.58	0.75	6.2	1.009	0.36	1.30
90-105	6.3	1.001	0.55	0.82	7.0	1.003	0.32	0.75
105-120	6.6	1.008	0.49	0.55	6.5	1.032	0.27	0.92
120-135	6.3	1.006	0.42	0.95	6.7	1.014	0.30	0.47
135-150	6.6	1.007	0.32	0.40	6.9	1.009	0.25	0.57

Available nutrients in soils

Available N content in pedon 1 was found to be maximum (188.6 kg ha^{-1}) in surface layer while it was minimum (138.6 kg ha^{-1}) in lowest horizon (135-150 cm). It seems that available N is in close association with the distribution of organic carbon in soils. Rani *et al*. (1992) reported similar findings. In pedon 2, available nitrogen ranged from 257.2 to 145.8 kg ha^{-1} through depth. This might be due to the accumulation of natural vegetation, residues and organic materials at upper layer of soil and more microbial transformation due to moisture content.

Pedon 2 had 13.4 kg ha^{-1}available P in 0-15 cm layer which got decreased to 7.8 kg ha^{-1} in available phosphorus in surface soil of pedon 1 was found to be 12.8 kg ha^{-1} and it decreased to 6.8 kg ha^{-1}in last layer. Similarly higher content of available phosphorus in the surface horizons might be due to supplementation of the depleted phosphorus through external sources and land use system (Thangaswamy *et al.* 2005)

The last layer of pedon 2 was associated with 210.4 kg potassium ha^{-1} while it was 286.4 kg potassium ha^{-1} in surface horizon. Pedon 1 had 115.4 kg available potassium ha^{-1} in 135-150 cm while it was 201.6 kg ha^{-1} in surface horizon (Table 3). The distribution of available K with depth could be attributed to more intensive weathering and release of exchangeable K from organic residues, application of potassium fertilizer and upward translocation of K from lower depth along capillary rise of ground water (Gupta *et al.* 2019).

Table 3. Available N, P and K in of soils

Depth (cm)	Baragaon (Pedon 1)			Rampur (Pedon 2)		
	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
0-15	188.6	12.8	201.6	257.2	13.4	286.4
15-30	186.6	11.7	186.8	245.5	11.7	279.2
30-45	180.2	11.3	163.4	236.6	11.2	256.8
54-60	172.8	10.4	155.6	228.2	10.7	245.6
60-75	168.7	10.2	149.2	198.4	10.7	279.2
75-90	163.8	9.9	147.3	186.8	9.8	268.0
90-105	158.5	10.0	138.4	183.4	8.9	145.6
105-120	152.4	8.3	130.6	175.2	8.4	236.8
120-135	145.6	7.6	120.2	160.6	8.0	225.6
135-150	138.6	6.8	115.4	145.8	7.8	210.4

The available S in surface soil of pedon 1 was 13.5 mg kg^{-1} (Table 4) whereas it was 8.9 mg kg^{-1} in lowest layer. The available S in pedon 2 varied from 9.0 mg kg^{-1} (surface layer) to 14.2 mg kg^{-1} (135-150 cm). The higher amount of available sulphur in surface soil than sub surface soil resulted from its recycling over the years by plant and subsequent organic matter accumulation (Bhatnagar *et al.* 2003).

Exchangeable calcium content in surface soil and in sub-soil (135-150 cm) of pedon 2 was 15.0 and 9.2 [cmol (p^+) kg^{-1}], respectively. The exchangeable calcium in pedon 1 varied from 13.4 to 6.4 [cmol (p^+) kg^{-1}] in surface and sub-soil, respectively.

Table 4. Available sulphur and exchangeable Ca and Mg content in soils

Depth (cm)	Baragaon (Pedon 1)			Rampur (Pedon 2)		
	S (mg kg^{-1})	Ca [cmol (p^+)kg^{-1}]	Mg [cmol (p^+)kg^{-1}]	S (mg kg^{-1})	Ca [cmol (p^+)kg^{-1}]	Mg [cmol (p^+)kg^{-1}]
0-15	13.5	13.4	8.2	14.2	15.0	7.3
15-30	13.2	11.8	8.0	14.0	14.8	7.0
30-45	12.5	10.2	7.5	13.6	14.2	6.7
45-60	11.9	9.7	7.2	13.2	13.6	5.8
60-75	11.0	8.6	6.4	11.8	12.6	5.2
75-90	10.5	8.4	5.8	11.2	11.4	6.5
90-105	10.2	7.0	6.4	10.5	11.2	4.6
105-120	9.8	7.5	4.9	10.3	10.5	4.2
120-135	9.4	6.9	4.5	9.6	9.8	3.8
135-150	8.9	6.8	3.2	9.0	9.2	3.0

Baragaon soils had maximum exchangeable magnesium *i.e.* 7.3 [cmol (P^+) kg^{-1})] at 0-15 cm depth whereas minimum *i.e* 3.0 [cmol (P^+) kg^{-1}] was recorded at 135-150 depth in pedon 2. The pedon 1 had 8.2 [cmol (P^+) kg^{-1}] exchangeable Mg at 0-15 cm depth while it was 3.2 [cmol (P^+) kg^{-1}] in last horizon. Trivedi *et al.* (1998) also reported similar findings.

Conclusion

The higher pH was found at upper layer of both the pedons. Water holding capacity decreased with depth in both the pedons. The organic carbon content was higher in surface soil than sub-soil irrespective of pedons. The calcium carbonate ranged from 2.5 to 0.4 and 3.9 to 0.4 in pedon 1 and pedon 2, respectively. The percentage of sand, silt and clay in pedons varied from 25 to 55 %, 30 to 60 % and 9 to 20 % in pedon 1 and 40 to 65 %, 25 to 45 % and 10 to 14 % in pedon 2 respectively. In general available N, P, K, S, Exchangeable Ca and Mg were higher in surface layer than the underlying layers. The pH, EC, bulk density, water holding capacity, soil organic carbon, available N, P, K and S, exchangeable Ca^{++} and Mg^{++} were found in suitable range for cultivation.

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