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Research Article

ASSESSMENT OF VERTICAL DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF SOILS OF CHILKAHAR BLOCK OF BALLIA DISTRICT UTTAR PRADESH

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Abstract: The depth wise soil sampling was carried out for physico-chemical and chemical characterization of soils of Chilkahar block of Ballia district. Depth wise soil samples were collected from two villages namely Kureji (P1) and Palta (P2) were collected from different depths. Standard analytical methods and procedures were followed for analysis of physico-chemical and chemical parameters of soils. The results revealed that soil texture was found loamy sand nature, pH of soil was found to moderately acidic to moderate alkaline where EC in considerable range. Bulk density of soil was found with ranges of 1.52 -1.66 Mgm^{-3} and water holding capacity contained 37.18–48.86 %. Organic carbon content was lower range and Calcium carbonate was moderately calcareous. The Available N, P, K, and S content in soil varied from lower to high and very high range respectively.

Keywords: *Soil physical, Physico-chemical, Chemical properties, Soil organic carbon, Available nutrients, Soil texture and pedon*

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Introduction

Soils provided food, fodder, fiber and fuel for meeting the basic needs of humans and animals. Day by day increasing population growth of human and animals, demanding foods and related substances. Moreover, the maximum carrying capacity of the soils is finite and limits the production process. It is influenced by intrinsic characteristics of soils, agro-ecological setting, land use and management. This demands systematic appraisal of our soil resources with respect to their extent, distribution, characteristic, behavior and use-potential which is very crucial for developing an effective land use system for augmenting agricultural production on sustainable basis.

The sustainable development of a region needs not only protection and reclamation of natural resources particularly soil and land, but also a scientific basis for the management in harmony with environment [1]. Soil characterization provides the information for understanding of the physical, chemical, mineralogical and microbiological properties of the soils which are highly essential to grow crops, sustain forest and grasslands as well as to support homes and society structures.

The vertical distribution of all soil properties in downwards into the ground with various layers of soil horizons can be reservoir of raw materials for growth and development of organisms on the soil. This cross-sectional view is made up of layers, running parallel to the surface and may be slightly or very much different from the other layer existing above or below it. Therefore, the systematic study of morphology and taxonomy of soils provides information on nature and type of soils, their constraints, potentials, capabilities and their suitability for various uses such as land use planning.

There is no information regarding the vertical distribution of Chilkahar block of Ballia district soil for different land use planning under Inceptisols of Indo-Gangetic plains. Hence, the present experiment was initiated in July, 2019 and the results are presented in this paper in a condensed form.

Materials and methods

Ballia district is situated in central portion of the Gangas and Ghaghara Basin at the eastern part of the state of Uttar Pradesh. Chilkahar block is located 30 km towards West from distrct head quarter Ballia. The geographical position of Ballia district lies between the parallel of 25°23" and 26°11" North latitude and 83° 38" and 84°39" East longitude and 59 m to 64 m above the sea level. The mean annual rainfall ranges from 950–1150 mm. Study area Chilkahar (Kureji and Palta village) block lies at 83°59'45" to 84°15'05" E longitude and 25°51'57" to 25°45'48" N latitude with an altitude of 72 m, above the sea level and Chilkahar Block 25°49'33" N and 83°57'43" E with longitude of 68 m above the sea level. For study of vertical distribution of physical and chemical properties of soil, two pedon was open in each village in the last week of June, 2020 when field was open, no crop and no rain with 48 hours.

Soil samples were collected from rainfed area of Chilkahar block soils from the field of well cultivated area of two village as Kureji and Palta. Sampling sites were carefully chosen taking in into consideration the ground cover, micro relief, degree of erosion, surface drainage, proximity to tress and all other factors likely to affect the soil in comparison with the normal type. Soil samples were collected from villages namely; Kureji (P1) and Palta (P2). Soil samples were collected on suitable spot (pedon) dug in the two villages – (Kureji, and Palta) to collect the soil samples. Sampling made from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105,105-120, 120-135 and 135-150 cm depths. About 2 kg of soil from each depth were taken in clean polythene bags separately by khurpi, scale and bucket. After well processing soil samples were ready to analysis in the laboratory. Soil samples was analysed for pH by use of 1:2.5 soil water suspension by glass electrode. Electrical conductivity (EC) was estimated by 1:2.5 soil-water suspension using conductivity electrode and expressed as dSm^{-1} [2]. Calcium carbonate ($CaCO_3$) was determined by rapid titration method [3]. Bulk density was determined by the method described by Kanwar and Chopra (1998).

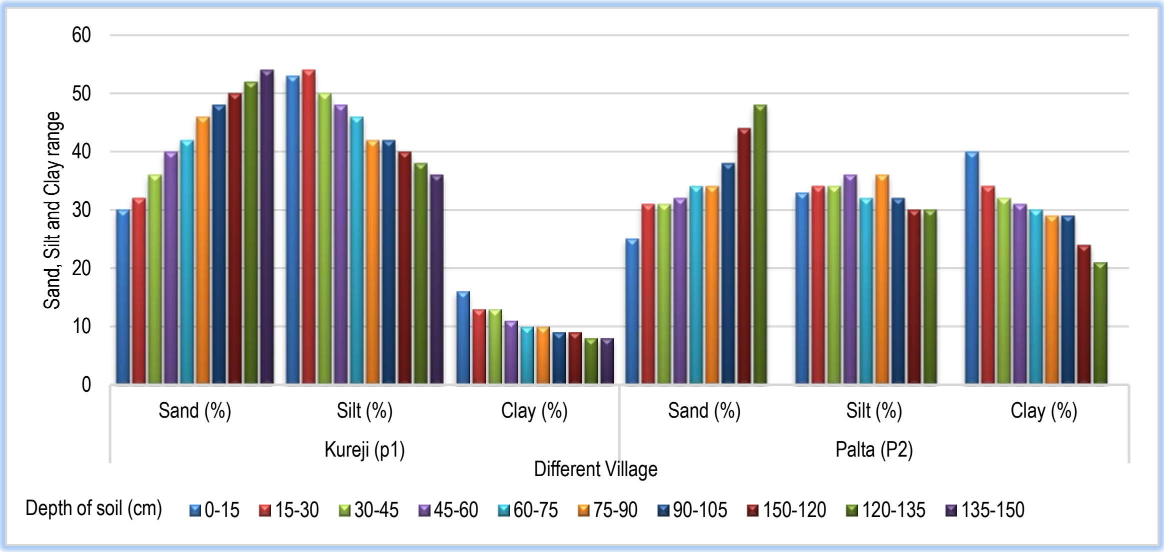

Fig-1 The soil texture (percent sand, silt and clay) of soil at different depth of pedons of Kureji and Palta village of Chilkahar Block of Ballia district

Table-1 *Status of soil pH, EC, B.D., W.H.C, O.C., $CaCO_3$, N, P, K and S of soils of pedon of Kureji village of Chilkahar Block of Ballia district*

Depth (cm)	pH (1:2.5)	EC (dSm^{-1})	B.D. ($Mg\ m^{-3}$)	W.H.C (%)	O.C. (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)
0-15	7.2	1.004	1.57	45.2	0.37	4.6	257.1	12.8	340.6	12.4
15-30	6.8	1.003	1.59	44.2	0.24	4.2	238.3	11.9	328.4	12.2
30-45	7.3	1.002	1.60	43.8	0.18	4.0	210.1	11.4	322.1	11.6
45-60	6.8	1.003	1.60	43.5	0.15	3.9	191.3	11.0	318.3	11.8
60-75	6.6	1.003	1.62	43.1	0.10	2.2	175.6	10.7	308.5	11.4
75-90	6.5	1.002	1.63	41.0	0.07	2.4	150.5	10.1	308.7	11.4
90-105	6.5	1.002	1.64	37.8	0.06	4.5	144.2	9.3	296.1	10.8
105-120	6.3	1.001	1.59	37.4	0.04	2.5	131.7	9.3	284.3	10.2
120-135	6.2	1.001	1.65	37.1	0.04	4.4	120.3	8.7	272.8	9.6
135-150	6.3	1.001	1.66	37.2	0.03	2.2	100.3	8.6	266.4	9.6

Table-2 *Status of soil pH, EC, B.D., W.H.C, O.C., $CaCO_3$, N, P, K and S of soils of pedon of Palta village of Chilkahar Block of Ballia district*

Depth (cm)	pH (1:2.5)	EC (dSm^{-1})	B.D. ($Mg\ m^{-3}$)	W.H.C (%)	O.C. (%)	$CaCO_3$ (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)
0-15	7.4	1.006	1.52	48.8	0.40	2.45	276.0	13.4	375.8	12.8
15-30	7.2	1.004	1.54	46.1	0.34	2.40	251.2	13.0	366.6	12.6
30-45	7.2	1.004	1.56	46.1	0.31	2.32	244.6	12.6	340.1	12.6
45-60	7.0	1.003	1.55	45.3	0.24	2.20	224.8	11.1	334.4	11.2
60-75	6.8	1.002	1.56	45.3	0.19	2.27	210.1	10.5	308.7	11.4
75-90	6.6	1.002	1.54	45.0	0.16	2.22	194.4	10.3	306.5	10.8
90-105	6.6	1.001	1.57	44.9	0.10	2.2	178.7	9.8	292.9	10.2
105-120	6.8	1.002	1.58	44.9	0.06	2.3	163.1	9.6	286.2	9.8
120-135	6.9	1.001	1.58	42.8	0.04	2.27	150.5	9.6	258.3	9.6

Organic carbon (OC) was determined by rapid titration method [4]. Available nitrogen (N) was determined by alkali extractable nitrogen method [5], available phosphorus (P) by Olsen's *et al*., (1954) [6] and available potash (K) ammonium acetate extractable method described by Muhr *et al*., (1965) [7]. Available sulphur (S) was extracted using 0.15 per cent calcium chloride solution [8]. Soil texture (sand, silt and clay %) determined by International Pipette method.

Results and discussion

Soil pH

The data presented in of in [Table-1] & [Table-2] of soil pH of two pedon. Pedon 1 showed highest pH 7.3 at 30-45 cm depth there after decreased and lowest 6.2 at 120-135 cm soil depth and pedon 2 was showed highest pH 7.4 at 0-15 cm depth there after decreased 6.9 at 120-135 cm. The higher biological activities might be responsible for the pH attributed to determine of neutral soluble salt [9].

Electrical conductivity (dSm^{-1})

The data of [Table-1] & [Table-2] revealed that the EC of soil samples. EC of soil under study ranged from 1.001 to 1.006 dSm^{-1} indicated very small variation between the two pedon. The relatively lower EC 1.001 dSm^{-1} was recorded in lower layer compared to surface soil 1.006 dSm^{-1}. The difference in EC at pedon-1 and pedon-2 might be ascribed to the lateral movement of water-soluble salt [10].

Bulk density ($Mg\ m^{-3}$)

The bulk density of soil was measured by the depth wise soil for both soil profile presented in [Table-1] & [Table-2]. Bulk density was varied between the values of 1.52 to 1.66 $Mg\ m^{-3}$ among the both soil profile. Bulk density of pedon-1, 1.57 to 1.66 $Mg\ m^{-3}$ and pedon-2, 1.52 to 1.66 $Mg\ m^{-3}$ increasing soil depths increased bulk density was observed in both pedon. The increase in bulk density at different depth of among the pedons might be due to greater mineral content from upper horizon to lower horizon, both pedon might be due to translocation of clay and other minerals develop the compaction. The similar finding has been given by Singh *et al*., (2020) [11].

Water Holding Capacity (%)

The data of [Table-1] & [Table-2] reported that the water holding capacity was varied between the values of 37.18 to 48.86 % among the different soil depth respectively. Water holding capacity of soil was decreased in increased with horizon depth at both pedon.

The pedon 1 was showed 37.18 % on 135-150 cm depth to 45.19 % on 0-15 cm surface horizon and pedon 2 was showed 42.78 % on lower depth and 48.86 % on surface horizon. The similar finding has been given by Singh *et al*., (2019) [12].

Soil Texture

The soil texture (percent sand, silt and clay) data were presented in [Fig-1] showed from two pedon of Chilkahar (Kureji and Palta Village) block soil. The per cent value of sand, silt and clay decreased with increasing in both pedons horizons. The percentage of sand, silt and clay in both pedon varied, pedon-1 (Kureji) showed sand 30 to 54 %, silt 36 to 53 % and clay 8 to 16 % and in pedon-2 (Palta) resulted sand 25 to 48 %, silt 30 to 36 % and clay 21 to 40 % respectively, according the textural class of these soils varied from loamy sand to silty loam [13]. Irrespective of the land use systems soil texture was finer in the sub-surface horizons than in the surface horizons and this might be due to the pedogenic process *viz*., clay illuviation.

Organic carbon (%)

Data of soil organic carbon in [Table-1] & [Table-2] revealed that content at different depth of soil in two pedons. The organic carbon content showed maximum 0.37 % at 0-15 cm and minimum 0.03 % at 135- 150 cm depth of pedon-1 whereas organic carbon 0.40 % at 0-15 cm and 0.40 % at 120-135 cm depth was recorded in pedon-2. The lowest organic carbon content was fairly in both profile and the similar finding has given by Gupta *et al*., (2020).

Calcium carbonate (%)

The small variation was found in amount of $CaCO_3$ [Table-1] & [Table-2] in both pedon. The data of $CaCO_3$ revealed that the calcium carbonate content in soil of pedon-1 ranged from 4.6% to 2.25% throughout the depth whereas it varied from 2.45 % to 2.2 % in pedon-2. However, $CaCO_3$ content decreased with increasing soil depth in both pedon.

Available nitrogen content (kg ha^{-1})

Data pertaining to available nitrogen is presented in [Table-1] & [Table-2]. The available nitrogen content in soil of two pedons depth were showed decreased with increasing soil depth. The pedon-1 soil was ranged from 257.15 to 100.26 kg ha^{-1}, from surface (0-15 cm) horizons to lower depth (135-150 cm) horizons. Pedon-2 was showed for available nitrogen value 275.96 to 150.52 kg ha^{-1} from surface (0-15 cm) horizons to lower depth of (120-135 cm) horizons. Its might be due to continuous application of imbalance chemical fertilizer and cultural practices extent of increased available N status at Chilkahar block of soil Ballia, a partial decomposition of crop residues and build of available N use of inorganic and organic sources of fertilizer have also been reported by Singh *et al*., (2017) [14].

Available phosphorus content (kg ha^{-1})

The small variation in amount of available phosphorus dada in [Table-1] & [Table-2]. was found in both pedons. The pedon-2 showed greater amount of available phosphorus (13.4 kg ha^{-1}) in 0-15 cm depth and it was decreased with increasing horizon depth up to 120- 135 cm of 9.6 kg ha^{-1}. The amount of available phosphorus was found in pedon-1 of 12.8 kg ha^{-1} in 0-15 cm and 8.6 at 135–150cm depth in pedon-1. Higher available phosphorus was observed in the surface horizon and decreased regularly with depth. Similarly, Gupta *et al*., (2019) also reported in the Bairia block of Ballia district soil status of available P was higher in top soil compared to sub soil. Similar finding has been given by Verma and Singh, (2020) [15].

Available potassium content (kg ha^{-1})

The available potassium content presented in [Table-1] & [Table-2]. Available potassium in pedon-1 was varied from 340.6 on surface horizon to 266.4 kg ha^{-1} at lower horizon and in pedon-2 was showed 375.8 kg ha^{-1} on surface horizon and 258.3 kg ha^{-1} on 120-135 cm depth. There was great difference of available potassium content in Chilkahar block soil between the both pedon of Kureji and Palta village. The maximum available potassium content was found in the surface horizons and showed decreasing trend with increasing horizons depths. Similar finding has been given by Verma and Singh, (2020).

Available sulphur content (mg kg^{-1})

The available sulphur content presented in [Table-1] & [Table-2]. Available sulphur was varied with the horizon depth depending upon soil pH and organic carbon material of soil of both pedons of land use system. Available sulphur in horizons showed 12.4 to 9.6 mg ha^{-1} in pedon-1 and pedon-2 was showed 12.8 to 9.6 mg ha^{-1} found with increasing the profile depth, from 0-15 to 135-150 cm. Amount of available sulphur decreased respectively in both pedon. Greater amount of available sulphur was found in surface soil than in sub surface soil resulted from its recycling over the years by plant and subsequent organic matter accumulation [16-19]. Similar finding has been given by Verma and Singh, (2020).

Conclusion

On the basis of percentage of sand, silt and clay in both pedons have appeared as loamy sand texture, soil pH of both pedons revealed that their ranges in alkaline in nature throughout all depth of profile. The electrical conductivity of both pedons were found in considerable range. The bulk density of both pedons soil was found towards hardness, similarly water holding capacity of both pedons soil was found decreased generally with increasing soil depth. The maximum amount of organic carbon was high in top soil than sub soil irrespective of pedon. The calcium carbonate content in pedon-1 and 2, indicated the possibilities of hard imperious layer in the pedon. The available nitrogen, phosphorus and sulphar content in soil of both pedons were decreases with increasing depth while available potassium content was increases with increasing depth of pedon upto 135 cm depth. The amount of exchangeable calcium and magnesium in both pedons was found in varied proportion as per soil depth. Therefore, Chilkahar (Kureji and Palta village) block soil properties were appeared no distinction of horizonation, both pedons soils were new alluvium under Inceptisols order.

Application of research: The vertical distribution of soil properties are helpful to provide the information of each horizon of soil profile and their morphological and pedological nature.
Use for land use planning and future prospects of particular soil.

Research Category: Soil Science for pedology and edaphology

Abbreviations: P1- Pedon 1, P2- Pedon 2

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Study area / Sample Collection: Two village of Chilkahar bock of Ballia district

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
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