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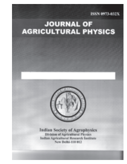

Research Article

Effect of Topo-sequence on Physical and Chemical Soil Properties of Hazaribagh, Jharkhand

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ABSTRACT

Present study was undertaken to characterize physico-chemical properties of soil under upland, midland and lowland agro-ecosystems of Hazaribagh district, Jharkhand. Ten representative blocks of the district were selected for soil sample collection. Representative soil samples and soil cores were collected from each agro-ecosystem in selected blocks for determining soil physical and chemical properties by standard protocol. Analysis of obtained data showed significant difference in physical and chemical properties of upland, midland and lowland soil. Soil textural class varied from loamy sand to sandy clay loam. The clay content was found significantly high in lowland soil (20.48±0.74%) followed by midland (15.75±0.85%) and upland (11.28±0.74) soil. Therefore, available water content was significantly higher in low land soil as compared to upland and midland soil. The soil of lowland was relatively higher in available NPK and soil organic carbon as compared to upland and midland soil.

Key words: Soil, Upland, Lowland, Midland, Topo-sequence

Introduction

Jharkhand state is consists of plateau and sub-plateau region with highly undulating terrain. Therefore crop cultivation is mainly practiced on different topo-sequences which are broadly classified as upland, midland and lowland agro-ecosystem. Within this, the suitable land for cultivation is about 2.85 million hectare (Mha) with 1.34 Mha upland and 1.06 Mha lowlands (Day and Sarkar, 2011). Upland agro-ecosystem is gentle sloppy to sloppy land situated on upper part of topo-sequence and generally immediately adjacent to the homestead. These soils are mainly cultivated for vegetable, maize and raising rice seedling. Midland occupies middle position and lowland lowest position in the topo-sequence. The lowland agro-ecosystem remains mono-cropped with rice cultivation. The major constraint for agriculture in this region is that more than 80% cultivated area is under rainfed condition (Day and Sarkar, 2011). Therefore, proper management of soil become important planning for ensuring better crop production. Soils are highly heterogeneous in nature and their physical-chemical property varied with space and time (Srivastava *et al.,* 2017 and Saha *et al.,* 2017). Therefore, characterization of soil in a particular agro-ecosystem becomes necessary for sustainable land use planning as well as tracking change in the future. Decisions about selecting the crops pattern become more complex only on chemical properties basis as physical properties directly affect the amount of water needed for achieving

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optimum crop yield, provides the basis for *in situ* moisture conservation and runoff management. Therefore, present study was undertaken to characterize the physical and chemical properties of soil of the upland, medium land and lowland agro-ecosystem of Hazaribagh district.

Materials and Methods

Study area

The Hazaribagh district covers an area of about 4310.33 sq. km and is bounded by 23°5′ to 24°4′ N latitudes and 85°1′ to 85°9′ E longitudes. It is 6th largest districts in terms of area in the state and located under sub-zone IV (Central and North Eastern Plateau Zone of Jharkhand). The district forms part of Chhota Nagpur plateau and therefore it is a region of plateaus, residual hills and intermittent valley. The district comes under tropical monsoon region. The minimum annual temperature of the district varied from 15.3°C to 20.6°C with 19.5°C average minimum temperature while maximum annual temperature varied from 27.4°C to 31.1°C with 29.3°C average maximum temperature. The coolest month was January with 10.9°C lowest average minimum temperature while April and May were the hottest months (avg. 35.5°C) in the district. The normal rainfall of Hazaribagh district is 1206 mm. Cultivable area forms about 39 per cent of the total area of the district which may be divided into three parts namely - Upper land, Middle land and Lower land. The lands situated on the banks of rivers are fertile.

Soil sampling and analysis

Ten blocks *viz*. Barhi, Barkgaon, Barkheta, Bisnugarh, Chauparan, Churchu, Hazaribagh, Ichak, Katkamsandi and Keredari were selected for the collection of the soil samples. Representative soil samples were collected in such a way that the composite soil sample uniformly represents the soil characteristics of the selected blocks. Therefore, the soil samples were collected from upland, midland and lowland agricultural ecosystems of villages situated at north, south, east, west and central portion of each block. From each selected blocks, 15 composite samples (5 from upland, 5 from midland and 5 from lowland) from 0-15 cm soil depth were collected during 2018-2019. The collected soil samples were processed and analysed for determining soil physical (soil texture, bulk density, field capacity, permanent wilting point and available water capacity) and chemical (available N, P, K, pH and Organic carbon) parameters by standard protocols in the laboratory of Department of Agro-meteorology and Soil physics, Birsa Agricultural University, Ranchi. The geo-positions of each soil sampling sites were taken with the help of GPS (GARMIN). Separate undisturbed soil core were collected for determining bulk density of soils. Soil texture was determined by hydrometer as described by Bouyoucos, 1927. The USDA textural triangle was used for determination of textural class of the soils. Field capacity and permanent wilting point were determined by Pressure plate apparatus (Richard, 1949). Soil moisture held between 0.033 and 1.5 M Pa was considered to be available moisture in the soil (Peterson *et al*., 1971). Soil pH was determined in soil-water suspension of 1: 2.5 (w/v), using glass electrode by digital pH meter (ELICO 1614) (Jackson, 1973). Organic carbon of the soil was estimated by chromic acid wet digestion method as outlined by Walkley and Black (1934). Available nitrogen was estimated by distillation of soil with alkaline potassium permanganate as per method suggested by Subbiah and Asija (1956). Available phosphorus was extracted with Bray-P1 extractant (0.03 NH_4F in 0.025 HCL solutions) (Bray and Krutz 1945) and was determined as described by Jackson (1973) by double beam digital spectrophotometer (SPECTRA SCAN UV 2600). Available K was determined by Flame photometer after extraction of soil with 1N NH_4OAc (pH 7.0) soil and solution ratio was maintained at 1.5 (w/v) as described by Jackson (1973). Analysis of variance (ANOVA) was done at 95% confidence level for comparing difference in the mean of soil physical and chemical parameters of upland, midland and lowland soil.

Results and Discussion

Soil physical properties

Significant difference was found in physical as well as chemical properties of upland, midland and lowland agricultural field (Table 1 and Fig. 1). The clay content was found significantly increasing from upland to lowland. Percentage of sand, silt and clay was 73.4±2.42, 15.32±1.85 and 11.28±0.74 respectively in upland soil, while it was 65.84±2.82, 18.91±2.09 and 15.75±0.78 respectively in midland soil and 56.54 ± 2.21, 22.98 ± 1.64 and 20.48 ± 0.85 respectively in lowland soil (Fig. 1). Kumar *et al.* (2012) and Gupta *et al.* (2019) also observed higher clay content in lowland soil as compared to upland soil in the different agro-climatic zone and Garhwa district of Jharkhand. Similar difference in distribution of soil particles in the soil of upper and lower topo-sequence has also been observed in other studies (Singh 1969, Kumar, 2013, Raj *et al*., 2017).

Lowland soil had low bulk density and high field capacity, permanent wilting point and soil moisture availability as compared to upland and midland soil. The bulk density of lowland, midland and upland soil was 1.51±0.01 Mg m^{-3}, 1.59 ±0.03 Mg m^{-3} and 1.67±0.03 Mg m^{-3} respectively (Table 1). Variation in bulk density due to clay content has also been reported by Brar (1991). The water availability for crop in the lowland, midland and upland was 10.89± 0.39, 9.34±0.54 and 8.02±0.48 percentage respectively. Similar results on water retention with respect to topography and texture have been reported by Chaudhry and Somawanshi (2000), Verma *et al.* (2001) and Gupta *et al*. (2019). The result indicated that, lowland soils with medium texture have relatively more available water, therefore, these lands are suitable for high water requiring crops like paddy (dry seeding and transplanted). On the other hand, upland soils had relatively coarser soil texture and low water retention, therefore, less water requiring crops like pulses, oilseeds and maize are grown successfully.

Soil chemical properties

Similar to physical characteristics, chemical properties of upland, midland and low land soil was also significantly different. Lowland soil was

Table 1. Phisico-chemical properties of soils of upland, midland and lowland agro-ecosystem in Hazaribagh

Agro-ecosystem	Textural class	Bulk density (Mg m^{-3})		Field capacity (%)		Permanent wilting point (%)		Available water (%)	
		Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Upland	LS to SL	1.67	0.03	16.90	0.88	8.88	0.45	8.02	0.48
Midland	SL	1.59	0.03	20.71	0.90	11.37	0.44	9.34	0.54
Lowland	SL to SCL	1.51	0.01	24.85	0.80	13.68	0.44	10.89	0.39
C.D.		0.07		2.51		1.29		1.38	
C.V.		4.71		13.06		12.38		15.88	

Soil chemical properties

Agro-ecosystem	pH		Ava. Nitrogen (kg ha^{-1})		Ava. Phosphorus (kg ha^{-1})		Ava. Potassium (kg ha^{-1})		Organic carbon (g kg^{-1})	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Upland	5.20	0.11	278.00	21.46	9.88	0.83	111.46	11.05	4.68	0.41
Midland	5.82	0.16	354.00	22.46	12.01	1.13	161.70	21.62	6.31	0.28
Lowland	6.45	0.17	445.00	6.06	17.48	2.56	231.29	24.64	8.00	0.12
C.D.	0.43		53.31		4.91		58.26		0.86	
C.V.	7.93		16.10		40.59		37.56		14.75	

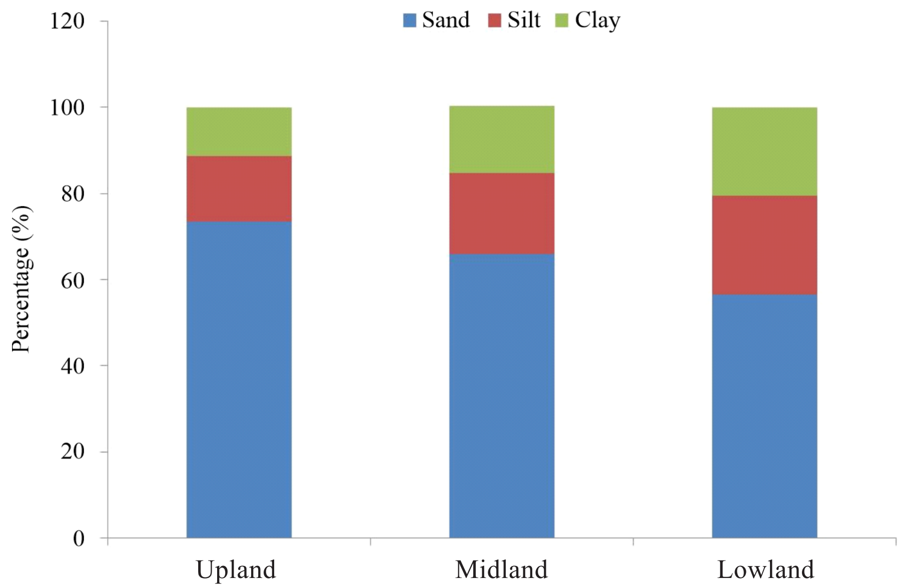

Fig. 1. Percentage distribution (mean) of sand, silt and clay in upland, midland and lowland soil

near neutral pH while midland and upland soils were slightly acidic in nature. The mean soil pH value for lowland soil was 6.45±0.17 while it was 5.28±0.16 and 5.2±0.11 for midland and upland soil (Table 1). As compared to three agro-ecosystems, lowland soil had significantly higher soil organic carbon, nitrogen, phosphorus and potassium content. The N, P, K and soil organic carbon was 445.0 kg N ha^{-1}, 17.5 kg P ha^{-1}, 231.3 kg K ha^{-1} and 8.0 g C kg^{-1} respectively in lowland soil, while it was 354.0 kg N ha^{-1}, 12.0 kg P ha^{-1}, 161.7 kg P ha^{-1} and 6.3 g C kg^{-1} respectively in midland soil and 278.0 kg N ha^{-1}, 9.9 kg P ha^{-1} 111.5 kg k ha^{-1} and 4.7 g C kg^{-1} (Table 1). Higher soil pH and soil organic carbon in lowland soil as compared to upland soil has also been reported by Kumar *et al*. (2012) and Gupta *et al*. (2019) in different districts of Jharkhand.

Conclusion

The soil of lowland, midland and upland differs significantly in physical and chemical properties. Therefore agricultural land situated on different topo-sequence in the studied blocks requires differential management strategies for better crop production and soil and water conservation. The result indicated that, upland soil has low soil pH, N, P and K content while lowland and midland soil have medium range of NPK content. Therefore upland soil needs suitable soil and water management strategies for better crop production. To enhance the soil pH and fertility, liming and balanced fertilization respectively may be recommended in upland soil.

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