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Assessment of soil health and soil quality analysis of Robertsganj tehsil in Sonbhadra district, Uttar Pradesh

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Abstract

An evaluation of Physico-chemical properties of soil of Robertsganj tehsil of Sonbhadra district, Uttar Pradesh was carried out in 2017-18. Eleven soil sampling points in Dalla villages was selected for the analysis. Soil samples were collected at depths of 0-15 and 15-30 cm. The colour of soil changed between the two depths of 0-15 and 15-30 cm at all the locations. The study revealed that range of particle density was from 1.38 to 2.40 g cm⁻³, bulk density from 1.03 to 1.17 g cm⁻³, water retaining capacity from 73.30 to 81.25 per cent and of specific gravity from 1.95 to 2.68. The sand, silt and clay ranges from 51.4 – 68.0, 8.6 – 13.5 and 31.7 – 39.0 % respectively. The pH ranges from 7.29 to 8.07. The highest mean value recorded is 7.71 and the least mean value is 7.66 and the Skewness propounded is negative. The EC ranges from 0.852 to 0.990 ds m⁻¹. The Organic Carbon ranges from 0.30 to 0.60 %. The Organic Matter ranges from 0.5172 to 1.0344 %. The Nitrogen ranges from 254.57 to 314.36 kg ha⁻¹. The Phosphorus ranges from 9.0 to 24.0 kg ha⁻¹. The Potassium ranges from 112.5 to 192.2 kg ha⁻¹. The Zinc ranges from 0.51 to 1.76 ppm. It is concluded that soil physico-chemical parameters were studied during the course of investigation presented good physical properties and pH, EC, Organic carbon and Zinc higher values. Phosphorus, Nitrogen and Potassium contains was medium value.

Keywords: Chemical properties of soil, Robertsganj. Skewness, Kurtosis, Standard deviation

Introduction

Sonbhadra district are region represents broadly 3 major soil groups: alfisols, ultisols, and vertisols. The alfisols and ultisols are formed in the northern and central part of Sonbhadra district. Soils of the floodplains and low terraces are formed from recent river alluvium of varying parent material composition brought by the river Son along with their tributaries (Ghaghar, Rihand, Bijul, Kanhar, Panda). They make very fertile soil at the places along the banks of Son River. Thick piles of sediments brought by River Ghaghar have been dumped at Patwadh and Chopan, where they make alfisols. The fine texture of soil supports the water-holding capacity and facilitates chemical weathering, which results in release of mineral nutrients (Banfield and Eggleton, 1988) [4]. The ultisols type of soils are developed in the southern part of Sonbhadra District, with Dudhi complex granite gneissic parent rock. The chemical weathering of granite gneiss releases important nutrients like potassium, sodium, calcium, aluminium, iron, magnesium and silica, all important for agriculture. These granitic parent rocks have undergone intense weathering under hot and humid climate to the extent that they have developed laterites. Soil production ranges from very high for certain to very low for those forming in shifting sand or on steep rocky slopes (Auden, 1933) [1]. Sonbhadra and Mirzapur districts in eastern Uttar Pradesh, experience the similar climatic conditions i.e., temperature and rainfall, but the complexity of rock types in Sonbhadra District results in a wide variety of soils. Thus the geology and lithological diversity of Sonbhadra District provide parent/ bed rock are responsible for the development varieties of soils making the soil more fertile as compared to Mirzapur District (Prakash, 1975) [16].

The terrain in Mirzapur District is hard rocky and the soils are residual, well-drained entisols and alfisols, derived from recent alluvium and Kaimur sandstones (Dhandraul orthoquartzites), sandy to sandy loam texture and reddish to reddish brown in colour (Singh *et al.* 2002) [19]. The physical and chemical parameters of our ecosystem are directly or indirectly controlled by the geological setup of the region, which in turn affects landscape development, to a greater extent. The chemical parameters, most importantly the soil and water are affected by the bed rock lithology because the geologic materials and processes control the availability of nutrients to the life systems. Geological setup of the region importantly controls the potential for the occurrence of mineral deposits thereby, increasing the prospects of socio-economic

development of a particular region. The development and exploitation of mineral resources is not only helpful in creating high-paying jobs and tax revenues in the local area, but in providing secondary jobs and contributing to regional and national economic growth. The socio-economic status of Mirzapur and Sonbhadra districts of eastern Uttar Pradesh have been taken into consideration in relation to their geological setting, natural and mineral resources of the region (Bajarangi 1995)^[3].

Mirzapur District is located between 25.8°N to 25.15°N latitude and 82.34°E to 82.58°E longitude, with the geographical area of 4521 sq. Kms and the population of 205, 264 (2001 census). Sonbhadra district of Uttar Pradesh, lying between 23.52 & 25.32°N latitude and 82.72 & 83.33°E longitude, towards the extreme southeast of the state is bound by Mirzapur District to the northwest, Chandoli District to the north, Bihar state to the northeast, Jharkhand state to the east, Chhattisgarh state to the south, and Madhya Pradesh state to the west. Sonbhadra has the geographical area of 6788 sq km² and the population of 1,463,468 (2001 census). Sonbhadra district can be called the power capital of India, as the region has many power (energy) stations at Shaktinagar, Anpara, Obra, Renuagar and Pipri (Dwivedi *et.al.* 1995)^[5].

Materials and methods

Sonbhadra district is located between 83°03'33.00" E latitude and 24°41'13.79" N longitude, with the district has an area of

6788 km² and a population of 1,862,559 (2011 census), with a population density of 270 persons per km². The collected soil sample is located between 83° 03' 12.7" E latitude 24° 27' 14.0" N longitude in the Dalla village.

The climate is tropical monsoonal, with the year divisible into winter (November-February), summer (April-mid June) and rainy (late June-October) seasons. The mean monthly minimum temperature ranges between 13.4 - 30.7°C and the mean monthly maximum between 23.4 - 40.2°C. About 9 months of the year are dry and 3 months are moist, the later receiving about 87% of the total annual rainfall (mm) due to the south-west monsoon. The average rainfall varies between 850 and 1300 mm. About 85% of the annual rainfall occurs during the rainy season from the southwest monsoon.

The entire eleven soil samples were collected from study area. Surface soil samples were collected to a depth of 0-15cm in "V" shape with the help of khurpi from different locations of Robertsganj tehsil. Along with the soil sample collection the GPS coordinates values were noted down for precise location specific soil fertility evaluation. Garmin GPS device was used to locate the geo-referenced points of soil sample collection and latitude and longitude reading were recorded. Collected soil samples were analyzed Soil texture, soil colour, particle density, bulk density, water retaining capacity, specific gravity, organic carbon, nitrogen, phosphorus, potassium and Zinc by following methods (Table¹).

Table 1: Procedure used for physico-chemical analysis of soil

Particulars	Methods(Scientist)
Sand (%)	Bouyoucous hydrometer (Bouyoucous 1927)
Silt (%)	
Clay (%)	
Texture of soil	
Particle density (g cm ⁻³)	Graduated measuring cylinder (Muthuaval <i>et al.</i> 1992)
Bulk density (g cm ⁻³)	Core method (Muthuaval <i>et al.</i> 1992)
Specific gravity	Graduated measuring cylinder (Muthuaval <i>et al.</i> 1992)
Water retaining capacity	Graduated measuring cylinder (Muthuaval <i>et al.</i> 1992)
Soil pH	Digital pH meter (Jackson 1958)
EC (ds m ⁻¹)	Digital conductivity meter (Wilcox 1950)
Organic carbon (%)	Rapid titration method (Walkley and Black 1947)
Available Nitrogen (kg ha ⁻¹)	Available Nitrogen (Subbair and Asija 1956)
Available Phosphorus (kg ha ⁻¹)	Colorimetric method (Olsen <i>et al.</i> 1954) ^[22]
Available Potassium (kg ha ⁻¹)	Flame photometric method (Toth and prince 1949)
Available.Zinc (ppm)	Lindsay and Norvell (1978) ^[15]

Source: Soil, Water and Plant analysis, Manual Practical (Jaiswal, 2006)

Results and discussion

Table 2: Physical properties Analysis of Dalla village

S. No.	PD (mg m ⁻³)		BD (mg m ⁻³)		SG		WHC (%)		% Sand	% Silt	% Clay	Textural Class
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm				
1	2.10	2.12	1.08	1.10	2.30	2.45	75.00	73.30	51.4	12.3	33.3	Clay loam
2	2.22	2.18	1.10	1.12	2.45	2.50	75.00	81.25	68.0	11.0	39.0	Sandy clay
3	2.12	2.10	1.05	1.06	2.60	2.68	80.64	78.68	56.5	13.5	34.0	Sandy clay loam
4	2.08	2.08	1.03	1.06	2.15	2.35	77.92	76.77	65.0	8.6	31.7	Sandy clay loam
5	2.25	2.20	1.09	1.11	2.18	2.40	79.73	78.66	67.0	12.0	38.0	Sandy clay
6	2.38	2.35	1.11	1.14	2.05	2.50	78.99	77.50	-	-	-	-
7	2.29	2.27	1.10	1.12	1.95	2.40	77.50	76.80	-	-	-	-
8	2.35	2.33	1.12	1.14	2.10	2.45	77.00	76.25	-	-	-	-
9	1.38	2.36	1.12	1.17	1.95	2.50	76.94	75.80	-	-	-	-
10	2.31	2.30	1.11	1.18	2.05	2.40	77.41	70.27	-	-	-	-
11	2.40	2.40	1.10	1.15	2.10	2.35	76.92	75.27	-	-	-	-
Mean	2.170	2.244	1.091	1.122	2.170	2.452	77.550	2.170	-	-	-	-
Std. Deviation	0.284	0.113	0.029	0.039	0.204	0.094	1.749	0.204	-	-	-	-
Skewness	-2.452	-0.207	-1.324	-0.370	1.110	2.40	0.207	1.110	-	-	-	-
Kurtosis	6.895	-1.556	1.108	-0.485	0.650	2.796	-0.194	0.650	-	-	-	-

Morphological properties

The Soil Colour (Dry Method) in Dalla village of soil varied from Yellowish brown, strong brown, dark brown, brownish yellow, light yellowish brown, pale brown, light grayish brown, Dark grayish brown and Soil Colour (Wet Method) is Very dark grayish brown, Dark brown, brown, yellowish brown and strong brown.

Physical properties

The Table 2 shows the particle density varies in between 1.38 to 2.40 mg m⁻³ at the depth of 0-15cm. The partial density varies in between 2.08 to 2.48 mg m⁻³ at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 2.1709, 2.2500, 1.38, -2.452, 6.895 at 0-15cm depth, at the depth of 15-30cm 2.2445, 2.2700, 2.08, -0.207, -1.556. In this partial density was high at the depth of 15-30cm compared to 0-15cm depth.

The bulk density varies in between 1.03 to 1.12 mg m⁻³ at 0-15cm of depth and 1.06 to 1.18 mg m⁻³ at the depth of 15-30cm. Mean, Median, Mode Skewness and Kurtosis value are

respectively 1.0918, 1.1000, 1.10, -1.324, 1.108 at the depth of 0-15cm depth and at the depth of 15-30cm value are 1.1227, 1.1200, 1.06, -0.370, -0.485. The bulk density was high at 15-30cm depth compared to 0-15cm depth.

The specific gravity varies in between 1.95 to 2.60 at the depth of 0-15cm. The specific gravity varies in between 2.35 to 2.68 at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 2.1709, 2.1000, 1.95, 1.110, 0.650 at 0-15cm depth, at the depth of 15-30cm 2.4527, 2.4500, 2.40, 2.40, 2.796. In this specific gravity was high at the depth of 15-30cm compared to 0-15cm depth.

The water holding capacity varies in between 75.00 to 80.64 % at 0-15cm of depth and 70.27 to 81.25 % at the depth of 15-30cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 2.4527, 2.4500, 2.40, 2.40, 2.796 at the depth of 0-15cm depth and at the depth of 15-30cm value are 2.1709, 2.1000, 1.95, 1.110, 0.650. The water holding capacity was high at 0-15cm depth compared to 15-30cm depth.

Table 3: Chemical Properties Analysis in Dalla village

S. No.	pH		EC (dS m ⁻¹)		OC (%)		N (kg ha ⁻¹)		P (kg ha ⁻¹)		K (kg ha ⁻¹)		Zn (ppm)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
1	7.56	7.55	0.918	0.856	0.60	0.52	298.50	280.55	18.0	12.3	170.2	138.1	1.32	0.82
2	7.61	7.62	0.977	0.921	0.45	0.45	267.20	260.62	14.4	10.0	159.1	131.0	0.87	0.51
3	7.89	7.86	1.025	0.971	0.45	0.30	310.15	308.42	24.0	15.4	150.4	122.4	1.07	0.89
4	7.61	7.58	0.852	0.895	0.45	0.37	250.18	235.72	10.5	08.4	165.7	112.5	1.34	0.98
5	7.65	7.61	0.900	0.912	0.30	0.37	265.75	250.80	14.4	10.2	169.4	119.3	1.76	1.32
6	7.94	7.89	0.991	0.944	0.30	0.22	315.01	308.12	09.0	08.8	196.5	128.1	1.06	0.90
7	7.78	7.90	0.857	0.867	0.37	0.33	305.65	298.03	22.3	18.2	175.2	125.2	1.02	0.87
8	7.95	7.57	0.853	0.832	0.60	0.30	314.36	302.94	24.0	19.4	192.2	132.3	0.78	0.62
9	7.48	7.44	0.914	0.990	0.37	0.37	254.57	240.18	12.0	10.1	176.3	132.3	1.01	0.74
10	7.29	7.23	0.920	0.920	0.37	0.30	288.51	254.57	15.9	11.5	190.2	145.0	1.10	0.79
11	8.05	8.07	1.030	0.984	0.37	0.37	300.12	270.00	16.4	13.3	188.4	138.2	1.14	1.03
Mean	7.710	7.665	0.930	7.710	0.420	0.354	288.18	273.63	16.445	12.509	175.78	129.49	1.133	0.860
Std. Deviation	0.232	0.241	0.066	0.232	0.103	0.080	24.411	27.432	5.196	3.714	14.705	9.336	0.265	0.214
Skewness	-0.199	0.004	0.318	-0.199	0.836	0.577	-0.482	0.060	0.295	0.889	-0.159	-0.199	1.275	0.548
Kurtosis	-0.681	-0.238	-1.289	-0.681	-0.087	0.974	-1.506	-1.666	-1.039	-0.362	-0.909	-0.156	2.430	1.434

The Table 3 shows in Dalla village, the pH range in between 7.29 to 8.05 at the depth of 0-15cm. The pH varies in between 7.23 to 8.07 range at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 7.7100, 7.6500, 7.61, -0.199, -0.681 at 0-15cm depth, at the depth of 15-30cm 7.6655, 7.6100, 7.23, 0.0004, -0.238 In this pH was high at the depth of 0-15cm compared to 15-30 cm depth.

The EC range in between 0.852 to 1.030 ds m⁻¹ at 0-15cm of depth and 0.832 to 0.990 ds m⁻¹ range at the depth of 15-30cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 0.9306, 0.9180, 0.85, 0.318, -1.289 at the depth of 0-15cm depth and at the depth of 15-30cm value are 7.7100, 7.6500, 7.61, -0.199, -0.681. The EC was high at 15-30cm depth compared to 0-15cm depth.

The soil organic carbon varies in between 0.30 to 0.60 % at the depth of 0-15cm. The soil organic carbon varies in between 0.22 to 0.52 % at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 0.4209, 0.3700, 0.37, 0.836, -0.087 at 0-15cm depth, at the depth of 15-30cm 0.3545, 0.370, 0.37, 0.577, 0.974. In this soil organic carbon (%) was high at the depth of 0-15cm compared to 15-30 cm depth.

The N varies in between 265.75 to 315.01 kg ha⁻¹ at the depth of 0-15cm. The N varies in between 235.72 to 308.42 kg ha⁻¹ at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 288.1818, 298.5000, 250.18, -

0.482, -1.506 at 0-15cm depth, at the depth of 15-30cm 273.6318, 270.0000, 235.72, 0.060, -1.666. In this soil N was high at the depth of 0-15cm compared to 15-30 cm depth.

The P varies in between 10.5 to 18.0 ppm at 0-15cm of depth and 10.0 to 19.4 ppm at the depth of 15-30cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 16.4455, 15.9000, 14.40, 0.295, -1.039 at the depth of 0-15cm depth and at the depth of 15-30cm value are 12.5091, 11.5000, 8.40, 0.889, -0.362. The P was high at 0-15cm depth compared to 15-30cm depth.

The K varies in between 150.4 to 196.5 ppm at 0-15cm of depth and 112.0 to 138.2 ppm at the depth of 15-30cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 21.2636, 22.3000, 14.40, 0.641, 0.226 at the depth of 0-15cm depth and at the depth of 15-30cm value are 19.9636, 20.3000, 12.10, 1.404, 2.546. The K was high at 0-15cm depth compared to 15-30cm depth.

The Zn range in between 0.87 to 1.32 ppm at the depth of 0-15cm. The Zn range in between 0.51 to 1.03 ppm at the depth of 15-30 cm. Mean, Median, Mode Skewness and Kurtosis value are respectively 1.1336, 1.0700, 0.78, 1.275, 2.430 at 0-15cm depth, at the depth of 15-30cm 0.8609, 0.8700, 0.51, 0.548, 1.434. In this soil Zn was high at the depth of 0-15cm compared to 15-30 cm depth.

Conclusion

There are three soil texture classes Clay loam, Sandy clay, and Sandy clay loam in Dalla village. pH ranges between 7.29 to 8.07 means slightly acidic to slightly saline. Soil contains various major nutrient elements like N, P, K and micro nutrients Zn decreases with increasing of depths because of the plant uptake and leaching. Amount of N, P and K was medium in soil and Zn was high.

Amount of organic matter was medium in soil pH of the soil plays an important role in soil, Amount of macro and micro nutrients present in soil depends on ranges of pH. Based on this analysis soil from Dalla village was good for cultivation and soil is having good fertility and productivity. Wheat, Rice, Paddy, Arhar, Gram, Lentil, Linseed and vegetables like Tomato, Brinjal, Chilli, Broad beans can grow.

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