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Assessment of Soil Physico-Chemical Traits in Soil Profile from Maheshgad Watershed

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Abstract

Soil profile studies was conducted in Maheshgad watershed, central campus MPKV, Rahuri, two soil orders *viz.*, Entisol and Inceptisol were analysed for soil physical and chemical properties. These orders were shallow (entisol), and moderately deep (Inceptisol) and identified as Inceptisols (*Vertic Haplustepts*), Entisols (*Typic Ustifluvents*) and Entisols (*Typic Ustorthents*), respectively. The pH of the profile soil samples ranged between 6.59 to 7.56, the EC ranged from 0.17 to 0.21 dSm^{-1}. The SOC content of the soils ranged from 0.31 % to 0.46%. The $CaCO_3$ content was 6.89% to 10.32%. The Bulk density varied between 1.08 Mg m^{-3} to 1.54 Mg m^{-1}. The available nitrogen, phosphorus and potassium content was 134 kg ha^{-1} to 185 kg ha^{-1}, 10.5 kg ha^{-1} to 13.4 kg ha^{-1} and 467 kg ha^{-1} to 589 kg ha^{-1} respectively. The objective of the current study is to provide detailed resource inventory about the soil properties from profiles of the Maheshgad watershed in order to develop appropriate strategies for managing the soil and water in order to maximize and maintain agricultural productivity.

Key words : *Ustorthents*, *Ustifluvents*, *Haplustepts*, physico-chemical properties.

Studying soil profiles in watershed areas is crucial for understanding soil health, water retention, and nutrient cycling, which are essential for sustainable land management and agricultural productivity. Soil profiles provide insights into soil physico-chemical properties, and drainage properties, all of which influence water infiltration and runoff patterns within a watershed. This information helps in predicting erosion risks, managing irrigation practices, and planning conservation efforts. According to the USDA Natural Resources Conservation Service (NRCS), comprehensive soil profile analysis is vital for developing effective watershed management plans that ensure water quality and ecosystem stability.

Maharashtra State's soils can be roughly categorized as follows: 1) Laterites and lateritic soils 2) The soils that are alluvial and saline along the coast 3) Deep black dirt and a shallow medium 4) Soils with mixed parent materials that are grey or red; and 5) Soils that are saline, saline-alkaline, or non-saline-alkaline (Raychaudhuri and Chakravarty, 1943).

The quality of soil needs to be investigated because natural resources are currently being overexploited. Soils in Maharashtra State are classified as poor in fertility and vary widely in genetic, morphological, physical, chemical, and biological characteristics. Soil is a vital natural resource and should be used judiciously according to its potential to meet the increasing demands of an ever-growing population. To ensure optimum agricultural production, this knowledge is essential. (Challa, 1995). After the green revolution, the advent of intensive production systems caused nutritional deficits in many locations because of the greater net removal rates of micronutrients by crops under intensive productivity regimes. (Kanwar, 2004). The condition of nutritional deficits was exacerbated by the inconsistent and varied use of chemical fertilizers and organic manures.

A soil profile serves as a historical log of all soil farming operations and serves as the research unit for pedological studies. It also aids in the classification of soils and serves as the foundation for actual soil research. From the perspective of crop husbandry, a study of the soil profile is crucial because it shows the surface and subsurface traits and qualities-that is, depth, texture, structure, drainage conditions, and soil-moisture relationships-that have a direct impact on plant growth. Understanding soil, moisture, and plant relationships as well as classifying the soils are aided by it.

Study area : The Maheshgad watershed boundary was located between 19°19'27"N latitude and 74°36'50"E longitude to 19°21'35" N latitude and 74°37'49"E longitude along with elevation of 605.6 m to 528.6 m. Basalt (Deccan trap) which was basic in nature containing mainly feldspars, augite and small amount of titaniferous magnetite mineral. The soils come under the cultivation of Sorghum, Pearl millet, Wheat, Chick pea, Pigeon Pea, Soybean, Black Gram, Safflower, Sugarcane and Cotton. The natural vegetation grown comprised of dry deciduous tree species and some grasses. The climate was usually hot and potential evapotranspiration (PET) far excess of the precipitation and classified as semi-aired tropical.

Resources and Methods

The survey and sampling were carried out at Maheshgad watershed, central campus MPKV, Rahuri. Three soil profile sites were selected by using GPS (Global Position System) for study after travelling through the area. Profiles were dug at selected sites and detailed morphological examination was carried out as per procedure laid down in USDA soil survey manual. Soil sample were collected horizon wise. Thesoil samples from selected site were collected by using screw auger. Total 7 samples collected from the different horizons. Soil samples were brought to the laboratory and air dried under shade avoiding contamination with foreign materials and then pounded with a wooden mortar and pestle. The samplesiswere screened through 2mm sieve and the pebbles, stones and roots were separated. About 0.5 to 1kg of air-dried crushed soil sample was put in the plastic sample bottle, labelled and stacked on the open sample racks for analysis. Each soil sample was analysed for following physical, chemical properties of soil using standard analytical methods (Table 1).

Result and discussion

The soil profile study was conducted on two soil orders of Maheshgad watershed, central

Table 1. Standard analytical methods

Parameter	Method	Reference
Soil physical properties		
Bulk density (Mg m^{-3})	Hilgard dish method	Keen and Rackowski (1921)
Soil chemical properties		
pH (1:2.5)	Potentiometry	Jackson (1973)
EC	Conductometry	Jackson (1973)
Calcium carbonate	Rapid titration method	Jackson (1973)
Soil Organic Carbon	Wet oxidation	Nelson and Sommer (1982)
Available nutrients		
Available N	Modified alkaline permanganate	Subbiah and Asija (1956)
Available P	0.5 M $NaHCO_3$ (pH 8.5)	Watanabeand Olsen. (1954)
Available K	Neutral N NH_4OAc	Knudsen *et al.* (1982)

campus MPKV, Rahuri. The result of the investigation is described under following heading.

Physical properties of soil profile : Details of data regarding the physical properties are presented in Table 1.

Bulk density : The bulk density of 7 different profile soil samples were recorded for the performed research. It was found that the bulk density in the Maheshgad watershed for Entisol (Typic Ustifluvents) was 1.08 Mg m^{-3} to 1.23 Mg m^{-3}, for Entisol (Typic Ustorthents) 1.28 Mg m^{-3} to 1.33 Mg m^{-3} and 1.38 Mg m^{-3} to 1.54 Mg m^{-3} for Inceptisols (Vertic Haplustepts). The observation recorded given in Table 2. The similar trend in bulk density was reportedby Rajagopal *et al*. (2013) in soils of Warangal district of Telangana.

Chemical properties of soil profile : Details of data regarding chemical properties are presented in Table 2.

Soil organic carbon : The SOC content of the soils ranged from 0.36% to 0.38% in Entisols (Typic Ustifluvents), 0.31 % to 0.33% in Entisols (Typic Ustorthents), 0.39% to 0.46% in Inceptisols (Vertic Ustifluvents). (Table 2).The soil organic carbon observed low to high status, often resulting from factors such as poor vegetation cover, limited organic matter inputs, high rates of decomposition, erosion, intensive agricultural practices that might be depleted organic carbon of soil. The results were in conformity with Titirmare (2019).

pH and EC : The pH of the soils (1:2.5) ranged from 6.98 to 7.44 in Entisols (Typic Ustifluvents), 6.59 to 7.11 in Entisols (Typic Ustorthents) and 7.13 to 7.56 in Inceptisols (Vertic Haplustepts).The EC value of Entisols (Typic Ustifluvents) was 0.19 to 0.20 dSm^{-1}, while in Entisols (Typic Ustorthents) it was ranged from 0.17 to 0.18 dSm^{-1}. In Inceptisols (*Vertic Haplustepts*) it was ranged from 0.19 to 0.21 dSm^{-1} (Table 2). The pH of soil ranged fromneutral to slightly alkaline conditions, often influenced by factors such as the soil's mineral composition, organic matter content, climate, and agricultural practices and application of fertilizers and lime.The similar variations in results were also observed by Patil *et al*. (2019), Das *et al*. (2022) and Tiwari *et al*. (2023)

Calcium carbonate : The results of

Table 2. Physico-chemical properties of soil profile samples

Horizon	Depth (cm)	Chemical properties				B.D. (Mg m^{-3})	Available nutrients		
		pH (1:2.5)	EC (dS m^{-1})	SOC (%)	$CaCO_3$ (%)		N	P	K
							(Kg ha^{-1})		
Pedon 1: ***Vertic Haplustepts*** **(Inceptisol)**									
A_p	0-32	7.13	0.21	0.46	6.89	1.39	185	13.4	546
B1	32-70	7.56	0.19	0.41	7.32	1.54	179	13.1	556
BC	70-95	7.21	0.20	0.39	10.32	1.38	169	11.4	498
Pedon 2: ***Typic Ustifluvents*** **(Entisol)**									
A_p	0-35	6.98	0.19	0.38	7.98	1.23	149	12.5	571
A_1	35-65	7.44	0.20	0.36	8.35	1.08	142	11.8	467
Pedon 3: ***Typic Ustorthents*** **(Entisol)**									
A_p	0-28	6.59	0.18	0.33	7.23	1.28	146	11.5	537
A_1	28-65	7.11	0.17	0.31	9.87	1.33	134	10.5	589

calcium carbonate status presented in Table 2. The $CaCO_3$ content of Entisol (*Typic Ustifluvents*) was 7.98% to 8.356%, for Entisol (*Typic Ustorthents*) it was 7.23% to 9.87% and for Inceptisol (*Vertic Ustifluvents*) 6.89% to 10.32%. It might be due to presence of calcareous parent material and limited leaching semi-arid climate. The results were corroborated with Bharati *et al*. (2013), Chadar *et al*. (2018), Patil *et al.* (2019).

Available nitrogen : The results ofsoil available nitrogen presented in Table 2. The nitrogen content observed in Inceptisols (*Vertic Haplustepts*) was185 kg ha^{-1} to 169 kg ha^{-1} followed by Entisol (*Typic Ustifluvents*) 142 kg ha^{-1} to 149 kg ha^{-1} and Entisol (*Typic Ustorthents*) 134 kg ha^{-1} to 146 kg ha^{-1}. All the profile soil samples collected in Maheshgad watershed were very low to low in available nitrogen, might be due to organic matter decomposition, nitrogen-fixing crops, fertilization practices, microbial activity, reflecting moderate to high nitrogen availability for plant growth and low nitrogen fixing process. Similar line of results was also recorded by Subramaniam and Kumarswami (1989).

Available phosphorus : The available phosphorus content in Maheshgad watershed presented in Table 2. The depth wise available P content in Inceptisols (*Vertic Haplustepts*) was 11.4 kg ha^{-1} to 13.4 kg ha^{-1}, in Entisol (*Typic Ustifluvents*) it was ranged 11.8 kg ha^{-1} to 12.5 kg ha^{-1}, and in Entisol ($^{-1}$) it was varied from 10.5 kg ha^{-1} to 11.5 kg ha^{-1}.The factors like mineral composition of soil, organic matter content, past fertilization practices, pH and presenceof phosphorus-fixing compounds, affect the phosphorus availability for plant.Low status of available P in the soil might be due to alkaline condition and high content of $CaCO_3$ in the soil. The results were in conformity withVaidya *et al*., (2014).

Available potassium : The available potassium status are presented in Table 2. Available K content in Inceptisols (*Vertic Haplustepts*) was 498 kg ha^{-1} to 556 kg ha^{-1}. In Entisols (*Typic Ustifluvents*), it was ranged from 467 kgha-1 to 571 kg ha^{-1}, In respect of Entisol (*Typic Ustorthents*) it was ranged from 537 to 589 kg ha^{-1}. The high content of available potassium in the soil could be attributed to the dissolution and diffusion of potassium from internal crystal lattice of silicate clay minerals and due to high clay content and presence montmorillonite clay minerals.The results were in agreement with Meena *et al*. (2010), Bhoyar *et al*. (2023).

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