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Research Article

MORPHOLOGICAL CHARACTERISTICS OF SOILS UNDER DIFFERENT LAND USE SYSTEMS IN NANDURBAR DISTRICT

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Abstract: Present study was undertaken in Nandurbar district of Maharashtra State during the year 2019-20. The Climate of Nandurbar District is generally hot and dry. The average annual rainfall is 767 mm throughout the district. Agriculture, Horticulture, Forest and Pasture land use systems were selected being the most predominant. Two sampling sites were selected under each land use system at different locations of Nandurbar district. The soil samples were collected at a vertical interval of 20 cm from surface to the bedrock. The depth of the soil under agriculture, horticulture and forest land use system is deep up to 100 cm, whereas, under pasture it is up to 80 cm. The colour of the soils varied from very dark grayish brown (10YR 3/2) to very dark gray (10YR 3/1), except yellowish brown (10YR 5/4) in pasture land use system and grayish brown (10YR 5/2) in horticulture land use systems. Structure of soil was sub-angular blocky to angular blocky. The soils texture varied from clay to silty clay. The consistence varied from slightly hard to very hard, friable to very firm and slightly stick to slightly plastic in dry, moist and wet conditions. Most of the soils showed slight to violent effervescence. The pores were fine to medium in size and few to common in quantity. Available soil moisture content varied from 13.03 to 19.1 per cent and it increases with depth of soil.

Keywords: *Soil morphology, Available soil moisture, Land use system*

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Introduction

Soil is the most basic natural resource that determined the ultimate suitability and sustainability of any agricultural system. Soil plays a profound and vital role in influencing the crop productivity as well as cropping pattern of that region. Thus, a good knowledge of the soil resources to any given territory is indispensable for planning it's agricultural development. Characterization, classification and evaluation of soils for different land uses are most common to develop sustainable and eco-friendly land use model. Characterization helps in determining the soil potentials and identification of constraints in crop production. Besides giving details information about different soil properties. This knowledge helps to harvest the nutrients from the soil with sustainable replenishment of nutrients. Further, soil classification helps in grouping of soils with similar properties and suggesting suitable management practices for increasing the productivity of soils. The combination of soil characterization, soil classification and soil mapping create a valuable resource for mankind, especially in the areas of food security and environmental sustainability. Soil characterization provides data on the morphological, physical, chemical, mineralogical and microbiological properties of the soils we depend on to grow crops, maintain forests and grasslands and support homes and society structures. On the other hand, soil classification aids in the organisation of our expertise, the transfer of experience and technology from one location to another and the comparison of soil properties. Besides giving details information about different soil properties, this knowledge helps to harvest the nutrients from the soil with sustainable replenishment of nutrients. Further, soil classification helps in grouping of soils with similar properties and suggesting suitable management practices for increasing the productivity of soils.

Material and Methods

The present investigation was taken up to characterize, classify and evaluate the soils in different land use systems of Nandurbar district Nandurbar has a total geographical area of about 5,955 km^2 (2,299 sq mi^2) and comprises of 6 Tehsils Shahada, Nandurbar, Navapur, Taloda, Akkalkuwa and Dhadgaon. Nandurbar is located at 21.37°N 74.25°E. It has an average elevation of 210 meters (688 feet). Nandurbar is a hilly region Toranmal situated about 75 km from Nandurbar is a well-known hill station succeeding Matheran in Maharashtra. The district has two rivers Tapi and Narmada. Narmada river forms north and north-eastern boundary of the district. Collection of depth wise soil samples at 20 cm interval vertically up to bedrock from each land use system. Selection of two sites under each land use system at different locations (Agriculture, Horticulture, Forest and Pasture land) of Nandurbar district and collection of two soil sample form each land use system for laboratory analysis. Eight soil sampling sites were studied from the study area. After opening of the sampling site, morphology of the soil was studied and morphological data on soil colour, texture, structure, consistency, pores, roots, effervescence, cracks, pressure faces, concretions/ nodules was recorded. Morphological examination of soil sampling sites was carried out by the procedure suggested by USDA [1]. With the assistance of the Global Positioning System, the exact location of different sampling sites were Agriculture site 1 (21°26'42" N 74°16'34" E), Agriculture site 2 (21°28'7.50" N 74°13'57.6" E), Horticulture site 1 (21°28'03" N 74°14'39" E), Horticulture site 2 (21°28'12" N 74°13'53" E), Forest site 1 (21°37'44.9" N 74°0'56.1" E), Forest site 2 (21°33'44" N 74°13'31" E), Pasture site 1 (21°34'33.1" N 74°09'58.2" E) and Pasture site 2 (21°33'19.4" N 74°01'55.4" E). Eight soil sampling sites were studied from the study area. Available soil moisture was estimated by pressure plate membrane apparatus [2].

Results and Discussion

Morphology is a term used to define and quantify a wide range of soil qualities, including the evaluation of soil particles and aggregates to determine soil void characteristics and hydraulic properties. The morphology refers to the inherent characteristics of the soil such as, soil colour, texture, structure, consistency, presence or absence of pans, concretion and other such features of soil sampling site.

Table-1 *Morphological characteristics of soil under different land use systems*

Land use system	Depth (cm)	Munsell Colour (Moist)	Texture	Structure			Consistence's			Effervescence	Pores		Roots		Special features
				S	G	T	D	M	W		S	Q	S	Q	
Agriculture1	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	f	f	Slickensides at 60-80 cm depth
	20-40	10YR 3/2	C	m	2	sbk	sh	fi	ssps	e	f	C	m	f	
	40-60	10YR 3/1	C	m	2	abk	h	fi	sp	es	f	C	f	f	
	60-80	10YR 3/1	C	m	3	abk	h	fi	sp	es	f	F	f	f	
	80-100	10YR 3/2	C	m	2	abk	h	fi	sp	ev	f	F	-	-	
Agriculture 2	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	m	f	Slickensides at 60-80 cm depth
	20-40	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	c	f	
	40-60	10YR 3/1	C	m	2	abk	h	fi	sp	es	f	C	f	f	
	60-80	10YR 3/1	C	m	3	abk	h	fi	sp	ev	f	F	f	f	
	80-100	10YR 3/2	C	m	2	abk	h	fi	sp	ev	f	F	-	-	
Horticulture 1	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	f	f	Slickensides at 50-70 cm depth
	20-40	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	m	f	
	40-60	10YR 3/1	C	m	2	abk	h	fi	sp	es	f	F	f	f	
	60-80	10YR 3/2	C	m	3	abk	h	fi	sp	ev	f	F	-	-	
	80-100	10YR 5/2	C	m	2	sbk	h	fi	sp	ev	m	F	-	-	
Horticulture 2	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	f	C	f	f	
	20-40	10YR 3/1	C	m	2	sbk	sh	fr	ssps	e	f	C	m	f	
	40-60	10YR 3/1	C	m	2	abk	h	fi	sp	es	f	F	f	f	
	60-80	10YR 3/2	C	m	2	sbk	h	fi	sp	ev	f	F	-	-	
	80-100	10YR 5/2	C	m	2	sbk	h	fi	sp	ev	m	F	-	-	

Land use system	Depth (cm)	Munsell Colour (Moist)	Texture	Structure			Consistence's			Effervescence	Pores		Roots		Special features
				S	G	T	D	M	W		S	Q	S	Q	
Forest 1	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	e	F	c	m	f	Slickensides at 50-70 cm depth
	20-40	10YR 3/2	C	m	2	sbk	sh	fi	ssps	e	F	c	m	f	
	40-60	10YR 3/1	C	m	3	abk	h	fi	sp	es	F	f	f	f	
	60-80	10YR 3/1	C	m	3	abk	h	fi	sp	es	F	f	f	f	
	80-100	10YR 3/2	C	m	2	abk	h	fi	sp	ev	F	f	-	-	
Forest 2	Typic Haplusterts (Vertisols)														
	0-20	10YR 3/1	C	m	2	sbk	sh	fr	ssps	e	F	c	f	C	
	20-40	10YR 3/2	C	m	2	sbk	sh	fi	ssps	e	F	c	m	F	
	40-60	10YR 3/1	C	m	2	abk	h	fi	sp	es	F	f	m	F	
	60-80	10YR 3/1	C	m	3	abk	h	fi	sp	es	F	f	f	F	
	80-100	10YR 3/2	C	m	2	abk	h	fi	sp	ev	F	f	-	-	
Pasture 1	Vertic Haplustepts (Inceptisols)														
	0-20	10YR 3/2	C	m	2	sbk	sh	fr	ssps	es	F	c	f	F	Cracks 1-2 cm width, upto 30 cm pressure faces
	20-40	10YR 3/1	C	m	2	abk	h	fi	sp	es	F	f	f	F	
	40-60	10YR 3/2	C	m	2	sbk	h	fi	sp	ev	F	f	f	F	
	60-80	10YR 5/4	Sicl	c	3	abk	vh	vfi	sp	ev	-	-	-	-	
Pasture 2	Vertic Haplustepts (Inceptisols)														
	0-20	10YR 3/1	C	m	2	sbk	sh	fr	ssps	es	F	c	f	F	
	20-40	10YR 3/2	C	m	2	abk	h	fi	sp	es	F	f	f	F	
	40-60	10YR 3/2	C	m	2	sbk	h	fi	sp	ev	M	f	f	F	
	60-80	10YR 5/4	Sicl	c	3	abk	vh	vfi	sp	ev	-	-	-	-	

[Texture: C- clay, Sicl- Silty clay] [strcture: S=size; m-medium, c-coarse; G=grade; 2-moderate, 3-strong; T-type; sbk-sub angular blocky, abk-angular blocky] [effervescence: e- slightly effervescence, es- strong effervescence, ev- violent effervescence] [consistence's: D= dry; h-hard, sh-slightly hard, vh-very hard; M=moist; fr-friable, fi-firm, vfi-very firm; W=wet; ssps-slightly sticky slightly plastic, sp-slightly plastic] [pores: s=size; F-fine, M-medium; Q=quantity; c-common, f-few] [roots: S=size; m-medium, f-fine Q=quantity; c-common, f-few]

The summary of morphological features of sampling site in the study area is presented in [Table-1]. The importance of soil morphology, its inherent properties, functions and distributions are discussed here.

Soil colour

Soil colour is one of the most important morphological parameters utilized in the field for soil identification and categorization. The colour in land use systems is varied from very dark gray, dark grayish brown, yellowish brown to grayish brown with a hue of 10YR, value of 3 to 5 and chroma in the range of 1 to 4. The colour of agriculture and forest land use system is very dark grayish brown (10YR 3/2) to very dark gray (10YR 3/1), horticulture land use system is very dark grayish brown (10YR 3/2) to grayish brown (10YR 5/2) and pasture land use system is very dark grayish brown (10YR 3/2) to yellowish brown (10YR 5/4). Similar results are reported by Gabhane, *et al*., (2006) [3], Kumar, *et al*., (2019) [4] and Nasre, *et al*., (2013) [5].

Soil texture

One can refer soil texture as the relative percentage of soil particles viz; sand, silt and clay. Texture is an important soil characteristic because it will partly determine water intake rates, water storage in the soil, and the ease of tillage operation, aeration status etc. and combinedly influence soil fertility.

The soils texture of the different land use systems varied from clay to silty clay. Agriculture, Horticulture and Forest land use systems show clay texture throughout the depth, except silty clay texture in pasture land use system at lower depth. Similar results reported by Gabhane, *et al*., (2006) [2] and Reddy and Naidu, (2016) [6].

Soil structure

Soil structure refers to the arrangement of primary soil particles and their aggregates into a certain definite pattern. There are three classes of soil structure based on size, shape and grade respectively.

The surface of all land use systems has sub-angular blocky structure, whereas, subsurface has angular blocky structure. The soil forming slickensides have coarse, strong and angular blocky structures. Similar results are reported by Nalge, *et al*., (2020) [7]. Sub-angular blocky and angular blocky structures founded in the different land use systems in the research area. The availability of higher quantities of clay fractions is linked with to the blocky structures, *i.e*., sub-angular and angular blocky. Similar observations were reported by Vedadri and Naidu, (2018) [8].

Table-2 *Available soil moisture of soil under different land use systems*

Land use system	Depth (cm)	Available soil moisture		
		FC (%) 33kPa	PWP (%) 1500kPa	AWC (%)
Agriculture 1	0-20	39.90	22.5	17.40
	20-40	41.10	22.87	18.23
	40-60	41.07	23.24	17.83
	60-80	42.20	23.42	18.78
	80-100	38.69	22.98	15.71
Agriculture 2	0-20	39.89	22.03	17.86
	20-40	40.86	22.43	18.43
	40-60	41.38	23.60	17.78
	60-80	42.69	23.84	18.85
	80-100	39.42	23.17	16.25
Horticulture 1	0-20	41.26	23.65	17.61
	20-40	41.70	23.87	17.83
	40-60	42.61	24.01	18.60
	60-80	43.51	24.64	18.87
	80-100	40.09	23.77	16.32
Horticulture 2	0-20	41.12	23.73	17.39
	20-40	41.51	24.08	17.43
	40-60	42.66	24.25	18.41
	60-80	43.02	24.67	18.35
	80-100	40.90	25.03	15.87
Forest 1	0-20	40.88	23.48	17.40
	20-40	40.59	23.69	16.90
	40-60	42.86	24.53	18.03
	60-80	43.01	24.36	18.65
	80-100	43.27	24.49	18.78
Forest 2	0-20	40.96	23.29	17.67
	20-40	42.13	24.08	18.05
	40-60	42.43	24.67	17.76
	60-80	43.73	24.63	19.10
	80-100	43.04	24.58	18.46
Pasture 1	0-20	38.76	25.73	13.03
	20-40	38.97	25.41	13.56
	40-60	40.53	26.23	14.30
	60-80	39.71	26.01	13.70
Pasture 2	0-20	39.07	25.40	13.67
	20-40	39.13	25.70	13.43
	40-60	40.66	26.10	14.56
	60-80	40.02	26.20	13.82

Soil consistence

Consistence is the behavior of soil under stress. It can be commonly recognised by feeling the soil by hand. The consistence of the soils varied from slightly hard to very hard (dry), friable to very friable (moist) and nonstick and non-plastic to very sticky and very plastic (wet). The consistence of different land use systems varied from slightly hard to very hard, friable to very firm and slightly stick to slightly plastic in dry, moist and wet conditions.

The consistence of Agriculture, horticulture and forest land use systems varied from slightly hard to hard, friable to firm and slightly sticky to slightly plastic in dry, moist and wet conditions, whereas, pasture land use system is varied from slightly hard to very hard, friable to very firm and slightly sticky to slightly plastic in dry, moist and wet conditions. Consistence of land use systems increases as depth of soil. Similar results reported by Devi, *et al*., (2015) [9] and Sashikala, *et al*., 2020) [10].

Soil effervescence

Most of the soils in different land use systems are showed slight to violent effervescence with 10% HCl indicating that these soils were calcareous in nature. Agriculture, Horticulture and Forest land use system are slightly effervescence at surface soil and strong to violent effervescence at depth of soils, whereas, Pasture land use system varied from strong effervescence at surface and violent effervescence at sub surface soil. Effervescence of the soils increases as depth of soil increases in all land use systems. Similar results reported by Vedadri and Naidu, (2018) [8] and Zalte, (2019) [11].

Porosity

The pores were fine to medium in size and few to common in quantity in different layers of land use systems. The finer texture of the soils was attributed to their high porosity. In general, the pore space distribution indicated that the majority of the soils in the study area were well drained. Porosity of soils decrease with depth in all land use systems. Surface soil contains more pore space due to high organic matter and low bulk density. Similar results are reported by Vedadri and Naidu, (2018) [8].

A decreasing trend in the pore space with depth was observed in all the land use systems in the study area. The decrease in pore space with depth might be due to increase in coarse fraction or coarse fragments in Inceptisols and Entisols and filling up of pores by eluvial materials in Vertisols. Similar results were reported by Ramprasad, *et al*., (2013) [12].

Roots

The roots of all land use systems varied from fine, medium and coarse in size and few to common in quantity. The roots of Agriculture and Horticulture land use system varied from fine to medium in size and few in number, in Forest land use system varied from fine to medium in size and few to common in number, whereas, in Pasture land use system fine in size and few in number. The roots of all land use systems are decreased as soil depth increased. The roots were found in all of the sampling sites up to a depth of 1.0 m. The distribution of roots in the soils of the area suggested that the vegetation of the area consists primarily of annuals and grasses, with some bushes and perennial trees. Similar results are reported by Nalge, *et al*., (2020) [7] and Sashikala, *et al*., (2020) [10].

Slickensides

The slickensides observed in Agriculture, Horticulture and Forest land use systems at subsurface layers. In Agriculture land use system slickensides show at 60-80 cm depth, whereas, Horticulture and Forest land use systems slickensides show at 50-70 cm depth. The formation of slicken-sides might be due to the presence of high amount of expanding clay minerals, alternate wetting and drying cycles and soil depth more than 0.5 m [13]. Similar results are reported by Gabhane, *et al*., (2006) [3] and Nasre, *et al*., (2013) [5].

Available Soil Moisture

[Table-2] shows the moisture retention at 33 kPa and 1500 kPa suctions, as well as the available water content in different land use systems. The amount of water retained at 33 kPa and 1500 kPa suction varied from 38.69 to 43.73 and 22.03 to 26.23 percent, respectively, and the available water capacity varied from 13.03 to 19.1 percent. In all land use systems, a constant increase in the available water capacity in the soil with increasing depth was observed. Similar results were reported by Punekar Sweta, *et al*., (2017) [14].

Conclusion

The morphological study of soils of the different land use systems (Agriculture, Horticulture, Forest land and Pasture land) of Nandurbar district revealed that colour of most of the soils varied from very dark grayish brown to very dark gray, except yellowish brown in pasture land use system and grayish brown in horticulture land use systems. Soil texture was clayey in all land use systems, except silty clay in pasture land system. Structure of soil was sub-angular blocky in the upper layer of each soil, whereas, angular blocky in the subsurface soils. Most of the soils in different land use systems are showed slight to violent effervescence. The pores were fine to medium in size and few to common in quantity in different layers of land use systems. The roots of all land use systems varied from fine, medium and coarse in size and few to common in quantity.

The slickensides observed in Agriculture, Horticulture and Forest land use systems at subsurface layers. Available soil moisture content varied from 13.03 to 19.1 per cent and it increased with depth.

Application of research: A good knowledge of the soil resources to any given territory is indispensable for planning it's agricultural development. Characterization, classification and evaluation of soils for different land uses are most common to develop sustainable and eco-friendly land use model

Research Category: Soil morphology

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Study area / Sample Collection: Nandurbar District of Maharashtra

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

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