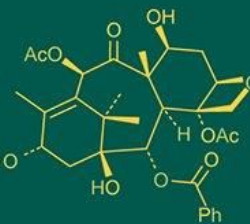
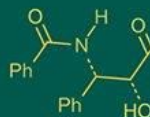
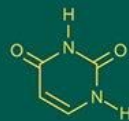
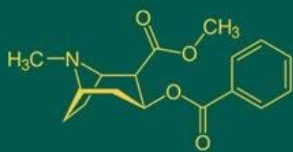


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(10): 757-760
www.biochemjournal.com
Received: 18-07-2024
Accepted: 22-08-2024

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Fertility status of soils under different land use systems in Nandurbar district of Maharashtra

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i10Si.2548>

Abstract

Agriculture, Horticulture, Forest and Pasture land use systems being the most predominant were selected from the Nandurbar district of Maharashtra State during the year 2019-20. Two sampling sites were selected under each land use system at different locations of the district. The soil samples were collected at a vertical interval of 20 cm from surface to the bedrock. The soils are slightly acidic to slightly alkaline in reaction and pH of soil increased with soil depth. The soils are non saline and did not show any significant trend with increase in depth of soil. The organic carbon content categorised as low to moderately high and it decrease with soil depth. Available Nitrogen content of soils is low in range. Available phosphorus content of soils is low to medium in range. Available Potassium content of soils is high in range. Available Sulphur content in the soils is medium to high.

Keywords: Soil fertility, land use system and Nandurbar district

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 its 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. The combination of soil characterization, soil classification and soil mapping creates a valuable resource for mankind, especially in the areas of food security and environmental sustainability. Further, soil classification helps in grouping of soils with similar properties and suggesting suitable management practices for increasing the productivity of soils. Macronutrients are important for plant growth as they play major roles in biological processes. These nutrients are the building block of all proteins, including the enzymes, which actually control the biological processes. Root growth and development of plant is enhanced with a good supply of macronutrients. Uptake of other nutrients is also influenced by the application of macronutrients. Soil macronutrients are important for improving crop growth. Out of sixteen plant nutrients, N, P, K and S are referred as macronutrients as they are required in a large number of physiological processes of the plant.

Materials and Methods

The present investigation was undertaken 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 km² (2,299 sq mi²) and comprises of 6 tehsil. (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). It has mainly a hilly region and has 'Toranmal' hill station which is 75 km from the Nandurbar district. It is the 2nd hill station after Matheran in Maharashtra. Tapi River is located at 12 km from city. Narmada River forms the district's boundary on the northern and north-eastern side. 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 Nandubar district and collection of two soil sample from each land use system for laboratory analysis. Eight soil sampling sites were studied from the study area. With the assistance of the Global Positioning System (GPS), 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).

Chemical study of soil the soil pH was determined by digital pH meter using glass electrodes and 1:2.5 Soil: Water ratio as described by Jackson (1973) [5], electrical conductivity (EC) was determined with conductivity meter using 1:2.5 soil water suspension as described by Jackson (1973) [5], organic carbon content of the soils was determined by Walkley and Black method as described by Nelson and Sommers (1982) [12]. Available nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija (1956) [16]. Available phosphorus was determined by Olsen method (Watanabe and Olsen, 1965) [22]. Available potassium was determined flame photometrically using 1N ammonium acetate (pH-7.0) as an extractant as described by Knudsen and Peterson (1982) [8]. Available sulphur in the soil samples was extracted with 0.15 per cent $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ method given by Chesnin, L and Yien, C. H. (1951) [3].

Results and Discussion

Soil reaction (pH)

The pH of soils under different land use systems varied from 6.63 to 7.86 indicating slightly acidic to slightly alkaline in reaction and pH of soil increased with soil depth. Highest soil pH was recorded at 80-100 cm depth under the horticulture land use system and lowest pH was noticed in 0-20 cm depth under the forest land use system and 20-40 cm depth under agriculture land use system. Increasing trend of pH with depth in these soils might be due to the release of organic acids during decomposition of organic matter and these acids might have brought down the pH in the surface soils. Increasing trend of pH with depth of soils due to accumulation of exchangeable bases and/ or CaCO_3 content. Similar results are reported by Naik (2014) [11] and Wani *et al.*, (2017) [21].

Electrical conductivity (EC)

The electrical conductivity of soil water extract in the different land use systems were varied from 0.11 to 0.32 dSm^{-1} and indicating that soil were non saline and did not show any significant trend with increase in depth of soil. The lowest value 0.11 dSm^{-1} was registered at 20-40 cm depth under forest land use system and 0-20 cm depth under pasture land use system, whereas, the highest value 0.32 dSm^{-1} was recorded at 20-40 cm depth under horticulture land use system. Similar results were reported by Ramprasad *et al.*, (2013) [13]. The electrical conductivity showed an erratic trend with an increase in soil depth however significantly higher electrical conductivity was recorded in sub-surface soils. Results was in accordance with the findings of Tuba and Kaleem (2016) [18].

Organic carbon Content

The organic carbon content in different land use systems varied from 0.36 to 0.76 per cent and categories as low to moderately high. The lowest value 0.36 percent are observed

at 60-80 cm under pasture land use system while the highest value 0.76 percent was recorded at 0-20 cm under forest land use system. All land use systems showed a decreasing trend in organic carbon with depth, which may be due to the addition of plant residues and farm yard manure to surface horizons which resulted in higher organic carbon content in surface horizons than in the lower horizons. This observation was in accordance with results of Basavaraju *et al.*, (2005) [1] in soils of Chandragiri mandal in Chittoor district of Andhra Pradesh. Similar results are reported by Kirmani *et al.*, (2013) [7] and Wani *et al.*, (2016) [20].

Available Nitrogen

The available nitrogen in the soils under different land use systems ranged from 149.75 to 236.19 kg ha^{-1} , indicating that the soils were low in available nitrogen content. The lowest value of 149.75 kg ha^{-1} available N soil was observed at 60-80 cm depth under pasture land use system. The highest value of 236.19 kg ha^{-1} soil was observed at 0-20 cm depth under forest land use system. All the land use systems exhibited a regular decreasing trend with depth.

The available nitrogen was found to be highest at the surface layers of all land use systems and reduced with depth, might be due to the decreasing trend of organic carbon with depth. This observation was in agreement with the results of Hijbeek *et al.*, (2018) [4].

The reason for the maximum available nitrogen content reported in the surface soils could be attributed to the fact that cultivation of crops were mainly confined to the surface layers (rhizosphere) only and at regular interval the depleted nitrogen content was supplemented by the fertilizers during crop cultivation. Similar results were reported by Thangasamy *et al.*, (2005) [17] and Naidu and Sireesha (2013) [10].

Available Phosphorus

The available phosphorus in the soils under different land use systems varied from 10.04 to 16.96 kg ha^{-1} , indicating that the soils were low to medium in available phosphorus content. The lowest value of 10.04 kg ha^{-1} available phosphorus was observed at 80-100 cm depth under horticulture land use system and the highest value of 16.96 kg ha^{-1} soil was noticed at 0-20 cm under pasture land use system. All land use systems showed a regular decreasing trend with depth.

The amount of available phosphorus at the surface layers was large, and it decreases when depth increases. The increased phosphorus in surface soils was attributed to increased organic carbon, which was further substantiated by a positive relationship between available phosphorus and organic carbon. The other reason for higher phosphorus in surface horizons might possibly be due to the confinement of crop cultivation to the rhizosphere and supplementing the depleted phosphorus by external sources. i.e., fertilizers and presence of smaller amounts of free iron oxide and exchangeable Al^{3+} in surface soils (Thangasamy *et al.*, 2005) [17]. The lower phosphorus content in sub-surface soil might be attributed to the fixation of released phosphorus by clay minerals and oxides of iron and aluminum. Similar results were reported by Singh *et al.*, (2013) [15] and Khanday (2017) [6].

Available Potassium

The available potassium in soils under different land use systems ranged from 276.38 to 488.84 kg ha^{-1} and these soils

had a high to very high available potassium content. The lowest value of 276.38 kg ha⁻¹ soil was observed at 80-100 cm depth under agriculture land use system and the highest value of 488.84 kg ha⁻¹ soil was noticed at 0-20 cm depth under forest land use system. All land use systems exhibited decreasing trend with depth.

The higher available potassium content in surface soils might be due to more intense weathering of potash bearing minerals, release of labile K from organic residues, upward translocation of K from lower depth with capillary rise of ground water. Similar results were reported by Rosemary *et al.*, (2017)^[14] and Vedadri and Naidu (2018)^[19].

Available Sulphur

The available sulphur content in soil under different land use

systems ranged from 10.71 to 20.68 mg kg⁻¹ soil, indicating that these soils have medium to high available Sulphur. The lowest available sulphur value of 10.71 mg kg⁻¹ soil was noticed at 60-80 cm depth under agriculture land use system and the highest value of 20.68 mg kg⁻¹ soil was noticed at 0-20 cm depth under forest land use system. All land use systems showed a decreasing trend with increasing depth. Surface layers contained more available sulphur than sub-surface layers which might be due to higher amount of organic matter in surface layers than in deeper layers. The positive relationship between available sulphur and organic carbon supported these findings. Similar results were reported by Kulhanek *et al.*, (2016)^[9] and Bier and Singh (2018)^[12].

Table 1: Fertility status of soil under different land use systems.

Land use system	Depth (cm)	pH (1:2.5)	EC (1:2.5)	OC (%)	Available macronutrients			
					N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	S (mg kg ⁻¹)
Agriculture 1	0-20	7.22	0.18	0.60	184.93	14.96	479.77	19.77
	20-40	7.51	0.18	0.54	169.77	13.01	391.49	20.30
	40-60	7.57	0.19	0.47	165.35	12.71	368.19	14.19
	60-80	7.51	0.23	0.42	156.79	12.32	293.15	10.71
	80-100	7.63	0.24	0.43	153.53	11.16	276.38	12.13
Agriculture 2	0-20	7.11	0.12	0.62	189.91	14.63	455.55	20.36
	20-40	6.63	0.19	0.59	177.63	12.77	402.30	19.51
	40-60	7.23	0.21	0.47	180.15	12.63	367.20	17.56
	60-80	7.31	0.24	0.43	163.17	12.46	356.16	16.88
	80-100	7.42	0.27	0.43	154.13	10.93	298.14	13.83
Horticulture 1	0-20	7.58	0.19	0.59	193.15	13.71	461.27	19.04
	20-40	7.61	0.18	0.55	186.17	13.53	380.16	16.59
	40-60	7.68	0.17	0.47	175.26	12.63	364.14	15.40
	60-80	7.76	0.19	0.41	157.44	11.65	341.10	16.17
	80-100	7.80	0.21	0.42	154.31	10.04	313.11	12.36
Horticulture 2	0-20	7.05	0.14	0.61	187.53	14.13	448.20	20.18
	20-40	7.52	0.32	0.58	192.73	13.73	409.12	18.55
	40-60	7.62	0.19	0.52	176.83	12.43	375.12	18.27
	60-80	7.73	0.20	0.47	158.93	11.26	329.12	17.95
	80-100	7.86	0.30	0.46	157.76	11.19	337.31	11.5
Forest 1	0-20	6.90	0.16	0.76	227.77	16.26	470.70	20.58
	20-40	7.00	0.18	0.59	207.96	15.83	329.22	19.79
	40-60	7.34	0.19	0.42	191.56	15.23	306.20	17.33
	60-80	7.43	0.20	0.46	180.17	13.39	295.20	16.41
	80-100	7.35	0.22	0.43	171.73	12.64	288.80	14.13
Forest 2	0-20	6.63	0.25	0.73	236.19	16.63	488.84	20.68
	20-40	6.72	0.11	0.65	214.63	16.12	403.25	17.63
	40-60	6.91	0.26	0.46	185.33	14.88	342.21	15.36
	60-80	7.21	0.21	0.44	161.91	13.56	318.18	12.19
	80-100	7.37	0.23	0.43	152.13	12.23	301.22	11.66
Pasture 1	0-20	6.77	0.11	0.66	201.61	16.96	392.19	17.41
	20-40	7.41	0.14	0.50	175.61	13.71	388.88	18.51
	40-60	7.49	0.18	0.46	180.63	12.36	369.96	17.03
	60-80	7.53	0.15	0.39	163.21	11.39	290.10	15.22
Pasture 2	0-20	6.81	0.13	0.60	193.35	15.87	432.33	18.95
	20-40	7.30	0.17	0.54	187.80	12.91	395.15	16.98
	40-60	7.36	0.20	0.43	162.72	12.17	377.17	13.67
	60-80	7.46	0.16	0.36	149.75	10.77	285.18	11.05

Conclusions

The study of soils of the different land use systems (Agriculture, Horticulture, Forest land and Pasture land) of Nandurbar district revealed that the soils are slightly acidic to slightly alkaline in reaction, non saline and medium to moderately high in organic carbon. Low in available N, low to medium in available P, high in available K and available S ranges from medium to high. All the available macronutrients

(N, P, K and S) decreases as the depth increases in all land use systems.

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