Plant Archives Vol. 24, No. 2, 2024 pp. 1735-1742 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.248

UNRAVELING PHYSICO-CHEMICAL AND BIOLOGICAL PROPERTIES OF SEMI-ARID TROPICAL SOILS UNDER SELECTED LAND USE SYSTEMS

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(Date of Receiving-09-08-2024; Date of Acceptance-07-10-2024)

ABSTRACT

Soil is a dynamic natural body formed due to action of natural forces on parent material. The features soil developed over a period of time is a result of geologic, physiographic, climatic and ecological characters. Numerous studies have noted variation in soils due to variation in land cover. The present experiment was undertaken to compare physico-chemical and biological status of soils from selected land use systems (Agriculture, permanent horticulture, pasture, agroforestry, salt affected, dryland horticulture and fallow land) in semi-arid tropics of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, MH, India. Samples from seven land use systems were collected at three depths (0-15, 15-30, 30-45 cm) and replicated thrice to statistically analyse using factorial complete randomized design (FCRD). The lowest bulk density was reported in Agroforestry, while highest porosity and maximum water holding capacity was noted in agriculture land, meanwhile significantly highest soil organic carbon (0.71 %) was seen in permanent horticulture. Available macronutrients were highest in agroforestry land, whereas micronutrient status was better in pasture land. The agroforestry land reported significantly superior bacterial (83.22 cfu × 10^6 g^{-1} soil) and actinomycetes count (56.22 cfu × 10^5 g^{-1} soil) and pasture land reported significantly superior fungal (35.22 cfu × 10^4 g^{-1} soil) count. The significantly superior dehydrogenase (38.07 µg TPF g^{-1} soil h^{-1}), glucosidase (235.62 µg PNG g^{-1} day^{-1}), acid (66.22 µg PNP g^{-1} soil h^{-1}) and alkaline phosphatase (70.26 µg PNP g^{-1} soil h^{-1}) was seen under agroforestry land except urease (62.22 µg NH_4-N g^{-1} soil h^{-1}) which was highest in permanent horticulture. Based on the generated results study further concluded that the land use type and soil depth significantly affect physico-chemical and biological properties of soil in semi-arid tropics and shows following sequence: Agroforestry > Permanent horticulture > Pasture land > Dry-land horticulture > Agriculture > Salt affected land > Fallow land.

***Key words*: Land use system, physico-chemical, biological properties and Semi-arid tropics**

Introduction

Soil has been identified as a three-dimensional entity made of organic and mineral matter, functionally it is the reservoir for water and nutrients, a water filtration medium, a decomposer of organic and toxic waste, an active component in the carbon cycle and other things. Maharashtra is the third largest state in India, divided into three natural regions *viz*; Konkan region (coastal area of the state), Sahyadri hills region (Western Ghats) and Deccan plateau region etc. (Aparajit, 2012). Most area of the state falls under semi-arid category having three distinct seasons however, it receives about 89 % annual rainfall from southwest monsoon during the month of June to September (Guhathakurta *et al.*, 2020). Geographically Western Maharashtra comprises total 89,853 sq. km area of the state and has hot and dry climates however it receives about 608-635 mm average rainfall (Aparajit, 2012). The vegetation covers also differ from area to area due to variations in topography, soils and climate, (Deshmukh, 2012).

The way human utilizes a piece of land is nothing but its land use pattern. Majority of land use is based on production capacity of soils. India has total 328.7 Mha geographical area, out of that, nearly 264.5 Mha is utilized for agriculture, pasture, forestry and other biomass production (Bhattacharyya *et al.*, 2015). The type of vegetation and ecosystem present in an area severely impacts quality of soils. Healthy soils are responsible for providing a good habitat for microorganisms that play a vital role in biogeochemical cycling of plant nutrients and preventing it from erosion and loss of soil organic matter (Bhowmik *et al.*, 2017). Many studies reveal that land use changes and subsequent conversion lead to a deterioration in the physical and chemical properties of soil, causing degradation of the land. Rapid conversion of agricultural land into non-agricultural land in the study area have raised concerns of faster physical, chemical and biological deterioration of soil and subsequent decline of agricultural productivity and deterioration of environment have taken place within this region.

The microbial populations and activity of microorganisms in soil were altered by conventional tillage, irrigation, fertilizer application, and anthropogenic activities (Arunachalam, 2003; Liebig *et al.*, 2004). Different land uses, ongoing cultivation, and the loss of soil organic matter in cultivated soil are the causes of the modification of the microbial population (Srivastava and Singh, 1989). Due to the addition of high-quality crops and organic residue to the soil, agroforestry and management practices have an impact on the physico-chemical, biological features of degraded land (Mendonça *et al.*, 2001). According to Fisher (1995), the use of land dominated by trees affected the biological qualities of the soil in a variety of ways. For example, many tree species fix atmospheric nitrogen, which raises the amount of nitrogen in the soil. Trees may also change the biological characteristics of the soil and improve the microclimate both above and below ground surrounding plant roots.

The current study was aimed to determine and measure how soil qualities are affected by patterns of land use. To enhance land management and stop additional degradation in the study region and elsewhere, variations in land use should be thoroughly documented.

Materials and Methods

Study area details and soil sampling

The present study was conducted in jurisdiction of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. The research area has a hot, dry climate with 608-635 mm of mean annual precipitation, falling within the scarce agroclimatic zone. The annual average temperature falls between 10 and 20°C for the minimum and between 30 and 40°C for the highest. The humidity is extremely low, never rising above 60% during the wet season (Anonymous, 2020). The mean annual weather data for year 2023 is represented in graphical form in Fig. 1. The soil samples

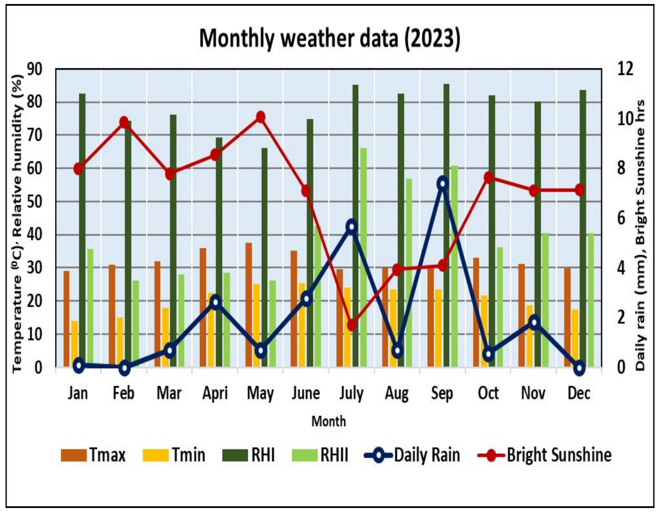

Fig. 1: Monthly average weather data of year 2023.

were taken in January 2023, during the winter season, at three different places within each land use system, at depths of 0-15 cm, 15-30 cm, and 30-45 cm. Sixty-three soil samples in total were taken and placed in individual sterile sample bags. The location, date of collection, and type of land use were accurately labelled on each sample bag. These places' GPS measurements were also noted. The details of selected land use systems along with details of its vegetation cover is given in Table 1.

Soil analysis techniques

Soil texture analysis was done using International pipette method, while dynamic physical properties were quantified using Hilgard dish method suggested by Piper (1966) and Keen and Rackowski (1921), respectively. The pH and electrical conductivity of soil samples was determined with the help of pH and EC meter using 1:2.5 soil water suspension ratio (Jackson, 1973). The soil organic carbon content in soil (0.5 mm sieved) was

Table 1: Details of land use cover of selected land use systems.

Tr. No.	Land use system	Vegetation of last five years	Irrigated / Rainfed
T_1	Agriculture	Wheat/ Groundnut/ Chickpea/vegetables	Irrigated
T_2	Permanent horticulture	Sapota plantation	Rainfed
T_3	Pasture land	Marwel/ kusli/ kathur	Rainfed
T_4	Agro-forestry land	Eucalyptus + pasture	Rainfed
T_5	Salt affected land	Wheat/ soyabean/ sugarcane/pearl millet	Irrigated
T_6	Fallow land	Natural seasonal small grass patches	Rainfed
T_7	Dryland horticulture	Ber (*Ziziphus mauritiana*)	Irrigated

determined by using Walkley and Black wet digestion method as described by Black (1965). The available nitrogen was determined by alkaline permanganate (0.32% $KMnO_4$) method as explained by Subbiah and Asija (1956), while available phosphorus was determined by Olsen method as outlined by Watanabe and Olsen (1965). Potassium in soil was determined with the help of flame photometer by extracting sample using neutral normal ammonium acetate. The available micronutrients (Fe, Mn, Cu, Zn) were extracted using DTPA extractant and were quantified using atomic absorption spectrophotometer. The serial dilution pour plate technique was utilized for quantifying microbial population. Nutrient Agar, Potato Dextrous Agar and Ken knight's media were utilised for bacteria, fungi and actinomycetes, respectively. The enzymatic activity of dehydrogenase, β- glucosidase, acid and alkaline phosphatase was analysed calorimetrically, whereas urease activity was quantified by titration.

The data was statistically analyzed to calculate standard error and cumulative difference in factorial complete randomised design (FCRD) using OPSTAT.

Results and Discussion

Soil physical properties

Soil texture

The per cent quantification of soil separates (Sand, silt, clay) is given in Table 2. Based on the results, clayey texture was noted in soils of agriculture, permanent horticulture and salt affected land. These cultivation practices were majorly utilizing productive black cotton soils having swell shrink properties having dominance of montmorillonite minerals. The soil of pasture, dryland horticulture was sandy clay loam, while fallow land had sandy loam texture. The equal distribution of sand, silt and clay properties was observed in agroforestry land that noted loam texture. These textural results followed patterns reported by Kale (2022) and Deshmukh (2024) who studied land use systems in semi-arid tropics of Ahmednagar.

Table 2: Effect of land use systems on soil texture.

Treatments	Sand (%)	Silt (%)	Clay (%)	Textural Class
T_1 (Agri)	13.52	25.43	58.89	Clay
T_2 (Pr Hort)	11.86	21.85	64.42	Clay
T_3 (Pasture)	64.26	15.4	20.34	Sandy clay loam
T_4 (Agroforest)	45.89	28.81	25.30	Loam
T_5 (Salt affected)	11.50	22.60	62.80	Clay
T_6 (Fallow)	47.69	17.31	32.08	Sandy loam
T_7 (Dry Hort)	55.4	18.7	22.4	Sandy clay loam

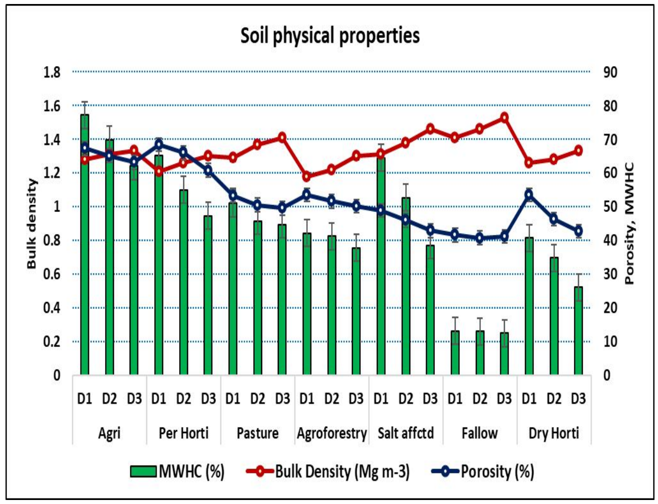

Fig. 2: Effect of land use systems on bulk density, porosity and MWHC.

Dynamic physical properties

The data of dynamic physical properties such as bulk density, porosity and maximum water holding capacity is represented in Fig. 2. The significantly lowest bulk density was reported in agroforestry land followed by permanent horticulture and dryland horticulture. Porosity and maximum water holding capacity followed similar trend *i.e.*, agriculture land followed by permanent horticulture that could be due to its clay dominated texture. Salt affected soils in spite of having clay texture comparatively had low porosity and better water holding capacity which could be due to dispersion of stable micro aggregates caused due sodium ions. Pasture land and agroforestry land reported moderately suitable porosity and maximum water holding capacity. The significantly lowest porosity, water holding capacity and highest bulk density was seen in fallow land, which also could be impact of potentially lowest vegetation cover and minimum soil development. The depth wise increase in bulk density and porosity, MWHC was also observed. According to Singh *et al.*,

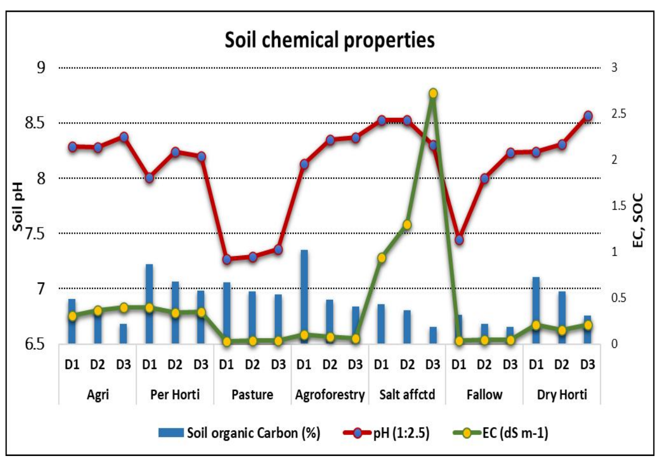

Fig. 3: Effect of land use systems on soil pH, Electrical conductivity and soil organic carbon content.

Table 3: Effect of land use systems on available nitrogen, phosphorous and potassium content of soils.

	Available N (kg ha^{-1})				Available P (kg ha^{-1})				Available K (kg ha^{-1})			
T/D	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
T_1	199.7	186.1	164.1	183.3	16.08	13.90	12.53	14.17	594.7	490.6	409.9	498.4
T_2	276.0	224.7	187.1	229.3	29.97	26.02	21.03	25.67	702.2	430.1	305.8	479.4
T_3	249.8	236.2	219.5	235.2	27.76	21.14	19.11	22.67	383.0	336.0	302.4	340.5
T_4	270.7	216.4	192.3	226.5	43.91	32.56	22.18	32.88	880.3	635.0	567.8	694.4
T_5	169.3	132.8	98.3	133.5	12.90	10.72	8.76	10.79	480.5	352.8	255.4	362.9
T_6	129.6	123.3	94.1	115.7	9.54	8.32	6.10	7.98	272.2	198.2	151.2	207.2
T_7	218.5	197.6	165.2	193.7	13.31	11.79	10.20	11.77	453.6	322.6	221.8	332.6
Mean	216.2	188.2	160.1		21.92	17.78	14.27		538.1	395.0	316.3	
Inte	**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**	
T	4.45		12.77		0.680		1.95		24.578		70.39	
D	2.91		8.36		0.445		1.27		16.090		46.08	
T × D	7.72		22.12		1.178		3.37		42.571		NS	

(T_1: Agriculture land; T_2: Permanent Horticulture land; T_3: Pasture land; T_4: Agroforestry Land; T_5: Salt affected land; T_6: Fallow land; T_7: Dryland horticulture land)

(2021), the Acacia nilotica-based agroforestry system had the lowest bulk density, whereas cropland at 0-15 cm depth had the maximum bulk density. The bulk density increased depth-wise in a manner similar to that reported by Biro *et al*., (2011) and Getahun *et al*., (2014). While Moghimian *et al*., (2017) observed the maximum water content under alder plantation as compared to natural forest and fallow, Liu *et al*., (2022) reported increased soil moisture content following the conversion of maize field to forest land.

Soil chemical properties

Soil pH, Soil EC, Soil organic carbon content

The analytical results of basic chemical properties showed (Fig. 3) that all the samples were slightly to moderately alkaline in condition. The lowest and near neutral pH was observed in pasture land followed by fallow land having sand dominated texture with high topographic location. Salt affected land was alkaline in condition with pH more than 8.5. The results of electrical conductivity showed significantly highest salt content in salt affected land (1.66 ds m^{-1}), whereas lowest electrical conductivity was observed in pasture and agroforestry, which can be attributed to low clay content facilitating comparatively better drainage conditions as compared to clay dominated salt affected, agriculture and permanent horticulture land.

Significantly at par soil organic carbon content was seen in permanent horticulture and agroforestry land followed by pasture and dryland horticulture land which are at par with each other which could be due to variation in type of biomass added in soils over the years. The litter fall of eucalyptus and sapota had high to moderate lignin content contributing to high organic carbon, whereas

Table 4: Effect of land use systems on DTPA extractable iron and manganese content.

	Iron (Fe) mg kg^{-1}				Manganese (Mn) mg kg^{-1}				Copper (Cu) mg kg^{-1}				Zinc (Zn) mg kg^{-1}			
T/D	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
T_1	2.95	2.62	2.23	2.60	16.48	15.47	14.65	15.53	2.82	2.63	1.96	2.47	1.21	0.80	0.36	0.79
T_2	4.51	4.06	3.80	4.12	28.12	20.60	20.34	23.02	6.00	3.98	2.77	4.25	0.77	0.38	0.29	0.48
T_3	15.79	11.37	12.07	13.08	24.03	21.53	17.45	21.00	7.19	6.29	5.48	6.32	0.53	0.41	0.28	0.41
T_4	5.04	4.26	3.13	4.14	7.62	7.42	6.92	7.32	3.59	2.41	1.51	2.50	0.62	0.08	0.10	0.27
T_5	2.51	2.07	1.48	2.02	12.72	12.42	11.08	12.07	2.36	1.99	1.33	1.89	0.54	0.52	0.22	0.43
T_6	9.07	8.80	8.05	8.64	7.94	6.51	3.69	6.04	2.81	2.06	1.18	2.02	0.91	0.19	0.19	0.43
T_7	5.88	6.61	5.59	6.03	10.66	9.97	6.95	9.19	2.38	1.64	1.10	1.71	0.73	0.34	0.30	0.45
Mean	11.44	9.95	9.09		15.37	13.41	11.58		3.88	3.00	2.19		0.87	0.39	0.25	
Inte	**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**	
T	0.666		1.90		1.723		4.93		0.333		0.95		0.110		NS	
D	0.436		NS		1.128		NS		0.218		0.63		0.072		0.20	
T × D	1.153		NS		2.984		NS		0.577		NS		0.191		NS	

(T_1: Agriculture land; T_2: Permanent Horticulture land; T_3: Pasture land; T_4: Agroforestry Land; T_5: Salt affected land; T_6: Fallow land; T_7: Dryland horticulture land)

Table 5: Effect of land use systems on soil microbial population.

	Bacterial count (cfu × 10^6 g^{-1} soil)				Fungal count(cfu × 10^4 g^{-1} soil)				Actinomycetes count (cfu × 10^5 g^{-1} soil)			
T/D	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
T_1	44.00	38.33	29.33	37.22	32.00	30.33	24.00	28.78	32.67	24.67	20.33	25.89
T_2	80.67	75.00	66.67	74.11	38.67	28.33	19.67	28.89	44.33	36.00	26.67	35.67
T_3	68.00	53.00	41.67	54.22	46.00	34.67	25.00	35.22	61.67	45.33	33.33	46.78
T_4	102.67	90.00	57.00	83.22	34.33	31.33	25.00	30.22	66.67	58.67	43.33	56.22
T_5	37.67	26.33	23.00	29.00	25.67	19.67	12.33	19.22	20.67	17.33	12.67	16.89
T_6	14.33	13.00	11.33	12.89	21.67	21.00	9.00	17.22	17.67	14.67	11.33	14.56
T_7	22.00	18.00	13.67	17.89	31.00	23.00	18.33	24.11	30.67	26.33	19.00	25.33
Mean	52.76	44.81	34.67		32.76	26.90	19.05		39.19	31.86	23.81	
Inte	**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**		**S. E. ±**		**C. D. at 5%**	
T	2.027		5.80		1.089		3.12		2.13		6.10	
D	1.327		3.80		1.008		2.04		1.39		3.40	
T × D	3.511		10.05		2.667		5.40		3.69		NS	

(T_1: Agriculture land; T_2: Permanent Horticulture land; T_3: Pasture land; T_4: Agroforestry Land; T_5: Salt affected land; T_6: Fallow land; T_7: Dryland horticulture land)

grasses of pasture and leaf fall of ber also has moderate to low lignin content. As majority of the litter is turned back into the soil it has helped to improve organic matter and associated quality parameters such as porosity, water holding capacity, pH and nutrient content. Similar soil pH, electrical conductivity and soil organic carbon content levels were reported by Gudla *et al.*, (2021), Mahadule (2023) and Fulpagare (2024) who studied physico-chemical properties of black cotton soils od deccan plateau.

Available Macronutrients

The status of available nitrogen, phosphorous and potassium is given in Table 3. The highest available nitrogen content was reported in pasture land (235.20 kg ha^{-1}) and was at par with permanent horticulture land (229.28 kg ha^{-1}) and agroforestry land (226.49 kg ha^{-1}). The significantly superior available phosphorous (32.88 kg ha^{-1}) and potassium content was (694.40 kg ha^{-1}) reported in agroforestry land followed by permanent horticulture (25.67 kg ha^{-1}, 479.4 kg ha^{-1}). The lowest macronutrient content was reported in fallow land. Depth wise decrease and statistically significant difference in available nutrient content was observed for all the macronutrients. The plant biomass with high nutrient content getting added in soils through litterfall explains comparatively higher macro nutrient content in plantation soils over field crop soils. Highest available nitrogen, potassium and phosphorous was reported in forest land followed by karonda and pond land use system, respectively (Yadav, 2019). The land use systems studied in Tarai region by Pal, (2017) noted depth wise decrease in macronutrient content with following trend: Forest > fallow > tea garden > agriculture. As per Lepcha and Devi (2020) in upper soil layer highest macronutrient content was seen in natural forest followed by agroforestry and paddy crop.

Available micronutrients

The data given in Table 4 an represents depth wise available micronutrient status of land use systems. The highest iron content (13.08 mg kg^{-1}) was observed in pasture land followed by fallow land and dryland horticulture. The significantly highest manganese content (23.02 mg kg^{-1}) was reported in permanent horticulture at par with pasture land (21 mg kg^{-1}). The maximum extractable copper content was observed in pasture land (6.32 mg $kg^{-1)}$ and was followed by permanent horticulture (4.25 mg kg^{-1}). A statistically non-significant difference was observed in extractable zinc content over the treatments. The depth wise gradual decrease in micronutrient contents was observed in all the parameters. Statistically non-significant difference was reported in depth wise extractable Fe and Mn and non- significant interaction effect for all the micronutrients.

Navnage (2022) studied land use systems in swell shrink soil reported significant difference in micronutrient status and depth wise decrease with lowest micronutrients in fallow land. Comparable observations were noted by Gathala *et al.*, (2004); Kumar (2007) and Shukla *et al.*, (2015). The favourable microbial richness caused due to higher organic matter accumulation may have helped to release available micronutrients in soils. However, as litter decomposes, Zn is released into the soil solution, although it may be leached into the deeper layers of soil or absorbed by the organic matter of the soil surface (Scheid *et al.*, 2009).

Table 6: Effect of land use systems on dehydrogenase and β-glucosidase activity.

	DHA (μg TPF g^{-1} soil h^{-1})				β- Glucosidase (μg PNG g^{-1} day^{-1})			
T/D	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
T_1	12.33	11.32	10.23	11.29	102.88	94.83	85.79	94.50
T_2	37.05	33.03	27.37	32.48	196.99	188.46	161.33	182.26
T_3	28.68	23.43	18.35	23.49	146.04	137.03	120.77	134.61
T_4	43.50	37.23	33.48	38.07	249.08	237.52	220.26	235.62
T_5	7.65	6.62	5.73	6.67	68.90	61.73	45.18	58.60
T_6	3.18	2.80	2.28	2.76	17.27	10.75	7.05	11.69
T_7	32.03	27.77	23.07	27.62	166.40	153.78	139.05	153.08
Mean	23.49	20.31	17.22		135.36	126.30	111.35	
Int.	S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%	
T	0.268		0.768		1.708		4.891	
D	0.175		0.502		1.118		3.202	
T × D	0.464		1.329		2.958		8.471	

(T_1: Agriculture land; T_2: Permanent Horticulture land; T_3: Pasture land; T_4: Agroforestry Land; T_5: Salt affected land; T_6: Fallow land; T_7: Dryland horticulture land)

Soil biological properties

Soil microbial count

The significantly superior bacterial population (83.22 cfu × 10^6 g^{-1} soil) and actinomycetes (56.22 cfu × 10^5 g^{-1} soil) count was observed in agroforestry land which was followed by permanent horticulture land (74.11 cfu × 10^6 g^{-1} soil) and pasture land (46.78 cfu × 10^5 g^{-1} soil), respectively. The highest fungal (35.22 cfu × 10^4 g^{-1} soil) was reported in pasture land which was followed by statistically at par group of agroforestry land, permanent horticulture land and agriculture. The lowest microbial population was observed in fallow land.

The most favourable physico-chemical soil properties of agroforestry land such as loamy texture, moderately alkaline pH and better nutrient status facilitates microbial multiplication. It almost followed the trend of organic carbon content indicating microbial richness was dependent on availability of substrate. The decrease of biomass and increasing compaction across depth caused reduced microbial population. The near neutral pH of pasture land could be the cause of harbouring higher fungal population. These results obtained are in consonance with Bhavya *et al.*, (2018), Wani *et al.*, (2018), Ram *et al.*, (2022) and Pandey *et al.*, (2023) Similarly, the positive impact of greater litter fall addition on soil organic carbon accumulation and increase in microbial population has been reported earlier by Negi (2003).

Soil enzymatic activity

The data regarding soil enzymes such as dehydrogenase, β- Glucosidase urease, alkaline and acid phosphatase content is given in Table 6 and 7. The significantly superior dehydrogenase and β- Glucosidase content was reported in agroforestry land. It was followed by permanent horticulture, dryland horticulture and pasture land. The significantly superior urease in prm horticulture, while alkaline and acid phosphatase was reported in agroforestry land. It was followed by permanent horticulture, dryland horticulture and pasture land. The enzyme content significantly and gradually reduced with the depth across all the treatments. Vegetation cover influences the quality and quantity of litter accumulation, therefore affects soil organic matter decomposition (Tiwari *et al.*, 2017).

Table 7: Effect of land use systems on urease, acid phosphatase and alkaline phosphatase activity.

	Urease (μg NH_4-N g^{-1} soil h^{-1})				Acid Phosphatase (μg PNP g^{-1} soil h^{-1})				Alkaline Phosphatase (μg PNP g^{-1} soil h^{-1})			
T/D	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
T_1	30.92	26.25	21.00	26.06	11.18	10.61	10.16	10.65	13.68	12.73	12.28	12.89
T_2	71.17	60.67	54.83	62.22	53.97	51.11	48.32	51.13	63.89	60.93	56.27	60.36
T_3	39.67	28.58	21.58	29.94	29.31	27.96	26.48	27.92	33.70	31.71	27.72	31.04
T_4	60.67	49.58	39.08	49.78	68.89	66.53	63.23	66.22	73.09	70.68	67.00	70.26
T_5	23.33	12.83	8.17	14.78	7.14	6.30	5.41	6.28	9.81	9.11	8.06	8.99
T_6	11.67	5.83	1.75	6.42	3.18	2.85	2.51	2.84	4.38	3.95	3.32	3.88
T_7	49.58	39.08	32.08	40.25	35.68	34.56	33.00	34.41	40.97	36.63	33.99	37.19
Mean	41.00	31.83	25.50		29.91	28.56	27.02		34.22	32.25	29.80	
Inte	S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%		S. E. ±		C. D. at 5%	
T	0.969		2.777		0.247		0.708		0.246		0.705	
D	0.635		1.818		0.162		0.464		0.161		0.462	
T × D	1.679		NS		0.428		1.226		0.427		1.222	

(T_1: Agriculture land; T_2: Permanent Horticulture land; T_3: Pasture land; T_4: Agroforestry Land; T_5: Salt affected land; T_6: Fallow land; T_7: Dryland horticulture land)

The biomass added in agroforestry and permanent horticulture has higher cellulose and lignin content providing sufficient substrate with highest microbial population which explains the highest enzyme activity being quantified. The above results are in line with studies conducted by Mharajan *et al.*, (2017), Pereira *et al*., (2018) and Reddy *et al*., (2020). The urea application in permanent horticulture and dry land horticulture as part of management practices explains higher urease content. In agroforestry the high amount of litterfall acts as a favourable substrate.

Conclusion

The present study generated data regarding soil physical, chemical and biological properties as influenced by Agriculture, permanent horticulture, pasture, agroforestry, salt affected, dryland horticulture and fallow land in semi- arid tropics. It further inferred that in region receiving 600 to 700 mm annual rainfall, type of vegetation cover significantly affects soil physical conditions and nutrient status that directly favors soil health by improving soil microbial population and enzymatic activity and vice versa. Based on the observations following sequence of selected land use systems was concluded: Agroforestry > Permanent horticulture > Pasture land > Dry-land horticulture > Agriculture > Salt affected land > Fallow land in terms of soil quality parameters.

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