



# Study of Physio-chemical Properties of Soil in Various Land Use Systems of Krishna District, Andhra Pradesh, India

V. J. Vandana <sup>a++\*</sup>, A. M. Latare <sup>b#</sup>, Kuldeep Patel <sup>c++</sup>,  
Anand Kumar Diwakar <sup>a++</sup>, Sunil Kumar Prajapati <sup>dt†</sup>,  
Dhruvendra Singh Sachan <sup>e‡</sup> and Ram Lakhan Soni <sup>f++</sup>

<sup>a</sup> Department of Soil Science-Soil and Water Conservation, Institute of Agricultural Science, Banaras Hindu University, Varanasi, Uttar Pradesh, India.

<sup>b</sup> Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Science, Banaras Hindu University, Varanasi, Uttar Pradesh, India.

<sup>c</sup> Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore-03, India.

<sup>d</sup> Division of Agronomy, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi-110012, India.

<sup>e</sup> Department of Agronomy, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, India.

<sup>f</sup> Department of Soil Science and Agricultural Chemistry, Nandini Nagar P. G. College, Nawabganj, Gonda, Uttar Pradesh, India.

## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/IJPSS/2023/v35i112959

### Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/99567>

Original Research Article

Received: 01/03/2023

Accepted: 03/05/2023

Published: 08/05/2023

<sup>++</sup> M.Sc. (Ag.);

<sup>#</sup> Assistant Professor;

<sup>†</sup> Ph.D. Research Scholar;

<sup>‡</sup> Research Scholar;

\*Corresponding author;

## ABSTRACT

A study was carried out to evaluate the impact of various land use systems on the physiochemical characteristics of the soil of Krishna District, Andhra Pradesh. The samples were collected from various land use systems (normally cultivated land, plantation, forest, fruit and vegetable) at two different depths (0-15 cm and 15-30 cm) and analysed at the Soil Science - Soil and Water Conservation Laboratory at the Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Uttar Pradesh. Geographically, the experimental site is located under the tropical zone at the coordinates of 16.4° N and 81.0° E. The obtained results showed that the maximum bulk density (1.58 Mg/m<sup>3</sup>), particle density (2.7 Mg/m<sup>3</sup>) at lower depth of 15-30 cm, water holding capacity (49.70%) and highest porosity (48.68%) in upper soil layer (0-15 cm) in normally cultivated land. Forest land had showed the highest organic carbon content of 0.77% and 0.71% soil in two different study depths of 0-15 cm and 15-30 cm, respectively. Also, the maximum availability of nitrogen (280.17 kg/ha), phosphorus (18.63 kg/ha), potassium (212.65 kg/ha) and sulphur (8.64 mg/kg of soil) were reported in forest, Vegetable, fruit and cultivated land respectively, in upper soil layer (0-15 cm), also all were found to depleting with increasing soil depths. The results of this study showed that land use patterns had considerable impact on many soil physiochemical properties. This study have a great importance for improving the standard of the produce, raising crop yields by a greater percentage through nutrient management, appropriate soil conservation practices and also, for better prevention of the environment.

*Keywords: Physio-chemical properties; soil; land use systems.*

## 1. INTRODUCTION

For every living being, soil is a highly important and valuable resource. Climatic condition, topography, flora, time, and several other life-forms are all factors to consider important components in determining the soil's qualities. A soil horizon is a soil layer that runs parallel to its crust as well as unique physiochemical properties than the layers above and below it. Major soil constituents like granules, compost, moisture and atmosphere are all influenced by the environment. Soils constitute a significant carbon sink and a huge carbon reservoir. Carbon sequestration is a method of reducing carbon dioxide enrichment in the atmosphere. Soil organic carbon (SOC) storage has long been thought of as a means of combat global climatic change is caused by storing carbon in the soil. Carbon sequestration in the soils can be accomplished in a number a variety of land-use and management strategies.

Organic matter in the soil is crucial for preserving the stability of the soil's structure, facilitating air and water infiltration, enhancing water retention, and preventing erosion. Soil carbon loss due to cultivation is typically associated with the deterioration of the soil's physical characteristics. According to [1], soil erodibility and soil organic matter are closely related. In addition to aggregate stability and size distribution, soil organic matter, soil particle density, and soil

porosity all play a role in soil bulk density and porosity. A decrease in organic matter would result in an increase in bulk density and a decrease in porosity, which would decrease soil infiltration and the capacity to store both water and air [2].

A lack of an essential nutrient makes it impossible for a plant to complete the vegetative and reproductive stages of its life cycle because the plant needs those nutrients to complete its life cycle. In order to add the proper amount of nutrients and identify the nutrients that are lacking, it will be necessary to analyse the soils. In comparison to micronutrients, macronutrient requirements are relatively higher in plants [3]. The ability of soil to work as a vital living system within the constraints of ecosystems and land uses, to support plant and animal productivity, maintain or improve water and air quality, and to promote plant and animal health [4].

Chlorophyll, nucleic acids, enzymes, amino acids, and proteins all include nitrogen, which is crucial for root development and the induction of vegetative growth. Phosphorus serves as a plant's energy reserve and promotes the growth of seeds and roots. Potassium works as an enzyme activator, aids in stomata function, aids in disease and drought tolerance in plants, and aids in the synthesis and transport of sugar and carbohydrates. The secondary nutrients Ca, Mg, and S are crucial for plant growth and

development because they encourage the production of nodules in the roots of leguminous plants [5].

The Krishna district is located near the Krishna River in peninsular India, which causes significant dirt removal by natural forces such as wind and water in such a way that the soil-forming process cannot restore it. Top soil contains a high proportion of the nutrients required for plant growth. The soil's fertility declines with depth. By washing away the fertile top layer, erosion reduces the fertility of the soil. Soil erosion occurs at a considerably higher rate than soil formation, resulting in a steady deterioration of soil quality. Most of the area of this district is under agricultural which consider 69.76%, forest (7.18%), plantation (3.80%) and scrubs / shrubs land (1.45%) of the whole district area.

In Krishna district, the soil problem is the consequence of a multiples of factors working together, including both natural and human activities. Kuderu is a Krishna district settlement where farmed soils degrade into waste soils. Due to human activity or climate change, desert-like conditions are spreading over arid and semi-arid areas. Wind causes the most erosion in desert soil. Wind-borne sand is deposited on fertile soils or lands adjacent to waste land or desert lands. The rate of soil fertility in these soils decreases due to an imbalance in soil nutrient availability, resulting in crop harm.

## 2. MATERIALS AND METHODS

### 2.1 Location

Geographically the experimental site located under the tropical zone with latitude of 16.4°N and longitude of 81.0° E. The samples were collected from various land use systems of Krishna district, Andhra Pradesh, India. The samples were analysed at the Soil Science - Soil and Water Conservation laboratory at the Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Uttar Pradesh.

#### 2.1.1 Climate and weather

The experimental area comes under the hot-humid condition of Krishna district. According to Koppen - Geiger climate classification is Aw. The average annual temperature is 28.1°C with the annual rainfall is 966 mm. Maximum temperature of 33.3°C was record in the month of May and

minimum temperature of 24.1°C is recorded in the month of December.

### 2.1.2 Land use and soil of the study area

The sampling sites were selected on the basis of different Land Use Systems such as Forest Land, Turmeric(*Curcuma longa*), Plantation Cultivation [Coconut(*Cocos nucifera*)], Fruits Cultivation [Guava (*Psidium guajava*), Lemon(*Citrus limon*), Banana(*Musa acumnata*)], Cultivation crops [Cotton (*Gossypium spp*), Jowar(*Sorghum bicolor*)], Vegetable Cultivation [*Okra(Abelmoschus esculentus)*]. In the KRISHNA district mostly black cotton soils arefound with low soil fertility, and poor organic matter.

## 2.2 Soil Analysis

### 2.2.1 Water Holding Capacity

Water holding capacity of the soil samples done according [6], using following equation-

$$\text{Water Holding Capacity (\%)} = \frac{\text{Wet wt.} - \text{Dry wt.}}{\text{Dry wt.}} \times 100$$

Where:

Wet wt. - Wet weight of oil

Dry wt. - Dry weight of soil

### 2.2.2 Soil bulk density and particle density

The particle density and bulk density of collected soil samples of were determined following the Pycnometer method , as suggested [7].

$$\text{Particle density} = \frac{W_s}{(W_2 + W_s) - W_3}$$

$$\text{Bulk density} = \frac{\text{Mass of the soil}}{\text{Volume of the soil}}$$

Where,  $W_s$  = Mass of soil

$W_2$  = Mass of pycnometer + water

$W_3$  = Mass of pycnometer + water + soil

### 2.2.3 Soil pH

Soil pH was measured by a pH meter in 1:2.5 soil: water suspension [8]

### 2.2.4 Soil electrical conductivity

The electrical conductivity of a soil sample was determined using a soil water suspension prepared for pH. The electrical conductivity (EC) was determined using EC metre and expressed as dS/m [9].

### 2.2.5 Soil porosity

The formula was used to calculate porosity using bulk density and particle density measurements.

$$\text{Per cent Porosity} = f = \left(1 - \frac{\rho_b}{\rho_s}\right) = \left(1 - \frac{v_s}{v_t}\right)$$

where,  $\rho_b$  = Bulk Density of soil  
 $\rho_s$  = Particle Density of soil

### 2.2.6 Available nitrogen

The alkaline Potassium permanganate method proposed by Subbiah and Asija was used to determine the available Nitrogen content in soil using a Kjeldhal semi-auto Nitrogen analyser.

$$\text{Mineralization N (Kg/ha)} = (S-V) \times 125.44$$

Where, S = Sample titration reading  
 V = Blank titration reading

### 2.2.7 Soil available phosphorus

Available phosphorus was extracted by 0.5 M Na HCO<sub>3</sub> at pH 8.5 (Olsen *et al.*, 1954). Phosphorus was determined colorimetrically according to the chlorostannous phosphomolybdic acid method (Jackson, 1973)

$$\text{Available P (kg/ha)} = \frac{\text{Absorbency} \times \text{dilution factor} \times 2.24}{\text{Slope of the standard curve}}$$

### 2.2.8 Available potassium

Available potassium was extracted with 1N NH<sub>4</sub>OAc at pH 7.0 as described by Jackson

(1973) and measured using flamephotometer (Hanway and Heidel, 1952) [10].

$$\text{Available K (kg/ha)} = C \times \text{dilution factor} \times 2.24$$

Where, C= Concentration of K in the sample from standard curve against the reading

### 2.2.9 Available sulphur

Estimation of Sulphur in the soil by Turbidity method (Chesnin and Yien, 1950) [11],

$$\text{Available Sulphur (mg Kg}^{-1}\text{)} = R \times \frac{50}{10} \times \frac{1}{10}$$

Where, R stands for S content in  $\mu\text{g}$  as read on X-axis

### 2.2.10 Organic carbon

Organic carbon of soil sample was estimated by Walkey and Black [12] method of wet oxidation, using the formula-

$$\% \text{ Organic carbon} = \frac{\text{Organic Carbon (B-C)}}{\text{Weight of the soil}} \times 0.0003 \times 100$$

Where, A = Volume of 0.5N ferrous ammonium sulphate required to neutralize 10 ml of 1N of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> i.e. blank titration (blank reading).

B = Volume of 0.5N ferrous ammonium sulphate needed for titration of soil sample (reading with soil).

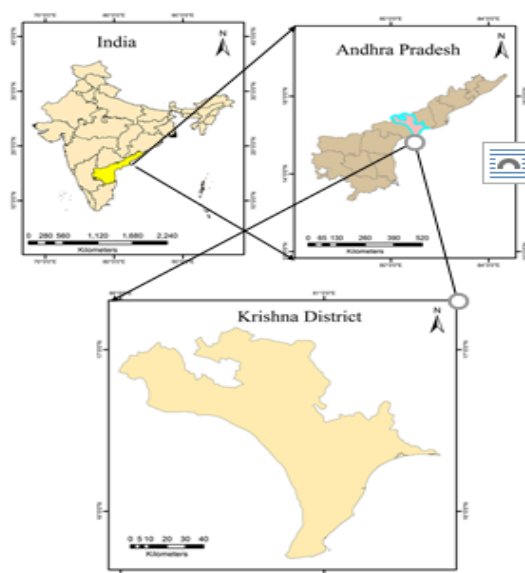


Fig. 1. Study area location

**Table 1. Rating of the soils test values for different Nutrients**

Nutrients	Testing Values		
	Low	Medium	High
Organic Carbon (%)	< 0.5	0.5 - 0.75	> 0.75
Available Nitrogen (kg/ha)	< 280	280 - 560	> 560
Available Phosphorus (kg/ha)	< 10	10 – 25	> 25
Available Potassium (kg/ha)	< 118	118 - 280	> 280
Available Sulphur (mg/kg)	< 10	10 – 20	> 20

### 3. RESULTS AND DISSCUSION

The purpose of this chapter is to identify the degree of variation seen in the various depth levels of distinct land use systems. The physiochemical characteristics of soil and the pools of soil organic carbon were determined.

#### 3.1 Soil Physical Parameter under Different Land use Systems

##### 3.1.1 Particle Density

Soil ranged from 1.4 to 2.7 Mg/m<sup>3</sup> depending on different depth and land use system. The maximum particle density of 2.7 Mg/m<sup>3</sup> was found in cultivated land at depths of 15-30 cm whereas, the minimum particle density of 1.4 Mg/m<sup>3</sup> was found at 0-15 cm depth in forest terrain. Rigorous examination of the analysis data showed that the particle density of soil varied significantly with different land use system and depth. The leaf litter becomes a part of soil and reduce the particle density of soil in land use regimes, which are richer sources of organic matter. As Li et al. [13] showed soil particle density was significantly affected by land use at all depths. Cultivation had substantially decreased total organic C concentration in soil at depths ranging from 0–30 cm, as consistent with other reports by Wu and Tiessen [14].

##### 3.1.2 Bulk density

The bulk density of soil found to be varied significantly with the different land use systems and depth. The bulk density ranged from 1.30 to 1.58 Mg/m<sup>3</sup>. The maximum bulk density of 1.58 Mg/m<sup>3</sup> was found in crop cultivated land at depths of 15-30 cm whereas, the minimum bulk density of 1.30 Mg/m<sup>3</sup> was found between 0 and 15 cm in forest land. Bulk density and porosity were significantly affected by land use only when averaged across all depths. Bulk density is largely controlled by soil organic matter content [15]. Soil bulk density is a function of soil organic matter, aggregate stability and size distribution, and soil particle density [16].

##### 3.1.3 Water holding capacity

The water holding capacity for different depth of the soil ranged from 42.18 to 49.70 per cent (Table 2). The maximum water holding capacity of 49.70 per cent was found in cultivated land followed at 0-15 cm depth and the minimum water holding capacity of 42.18% was found at 15-30 cm in fruit cultivated land A close examination of the data revealed that the water holding capacity of soil changed considerably with soil depth. It is widely accepted that both soil water holding capacity is directly accepted with the soil organic matter content [17].

##### 3.1.4 Porosity

The soil porosity varied from 41.43 to 48.68 per cent depending on the depth of the soil (Table 2). The highest porosity of 48.68 per cent was found in cultivated land between 0-15 cm depth and the minimum porosity of 41.43 per cent was found in a plantation crop between 15-30 cm depth. A close examination of the data revealed that the porosity of soil changed considerably with soil depth. Changes in porosity were highly sensitive to soil water content. A decrease in organic matter would cause a decrease in porosity, thereby reducing soil infiltration, and water and air storage capacities [18].

#### 3.2 Analysis of Soil Chemical Parameter under Different Land Use Systems

##### 3.2.1 Soil pH

Soil pH values ranged from 6.2 to 7.7 at different depths and land use system as shown in Table 3. The highest pH of 7.7 was found in vegetable cultivated land at the depth of 15-30 cm whereas, the minimum pH was observed at the depth of 0-15 cm in the fruit cultivated land. The pH of the soil is among the most helpful and widely determined soil chemical characteristics and it has a direct impact on plant growth. It is a significant determinant of plant element availability.

**Table 2. Particle Density, Bulk Density, Porosity and Water Holding capacity under different land use systems in Krishna District, Andhra Pradesh**

Land Use System	Bulk Density (Mg/m <sup>3</sup> )		Particle Density (Mg/m <sup>3</sup> )		Porosity %		WHC %	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
<b>Soil Depth ( cm)</b>								
Cultivated	1.44	1.58	2.4	2.7	48.68	47.22	49.70	47.60
Plantation	1.33	1.36	1.5	1.9	42.54	41.43	43.18	42.30
Forest	1.30	1.32	1.4	1.8	43.76	42.54	42.49	40.83
Fruit	1.47	1.48	2.1	2.3	45.84	43.16	43.92	42.18
Vegetable	1.37	1.40	1.8	2.0	45.94	43.68	48.12	45.20
SE	0.06	0.05	0.15	0.09	2.0	1.87	1.56	1.42
CD	N/A	0.16	0.45	0.28	N/A	N/A	4.74	4.29

**Table 3. Soil pH and Electrical Conductivity under different Land Use Systems in Krishna District, Andhra Pradesh**

Land Use System	pH		EC (dS/m)	
	0-15	15-30	0-15	15-30
<b>Soil Depth ( cm)</b>				
Cultivated	7.1	7.3	0.34	0.12
Plantation	6.4	6.6	0.39	0.17
Forest	6.3	6.5	0.35	0.28
Fruit	6.2	6.5	0.27	0.11
Vegetable	6.8	7.7	0.44	0.23
SE	0.19	0.36	N/A	N/A
CD	0.59	N/A	0.04	0.05

**Table 4. Soil Organic Carbon, Available Nitrogen, Phosphorous, Potassium and Sulphur content**

Land Use System	Organic Carbon (%)		Nitrogen (kg/ha)		Phosphorous (kg/ha)		Potassium (kg/ha)		Sulphur (mg/kg of soil)	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
<b>Soil Depth ( cm)</b>										
Cultivated	0.49	0.38	260.32	236.91	15.67	13.83	202.34	169.93	8.64	8.05
Plantation	0.62	0.53	250.41	237.85	13.72	13.67	152.43	139.82	6.56	6.38
Forest	0.77	0.71	280.17	251.47	14.63	14.07	162.37	157.74	6.91	6.61
Fruit	0.56	0.38	222.99	218.62	14.37	11.61	213.65	207.28	7.54	7.17
Vegetable	0.31	0.22	243.59	236.27	18.63	16.96	203.84	183.68	7.96	7.81
SE	0.12	0.09	12.66	9.21	3.13	3.18	11.82	20.78	0.47	0.53
CD	N/A	0.28	N/A	N/A	1.03	1.05	35.74	N/A	1.42	N/A

### 3.2.2 Electrical conductivity

The electrical conductivity of the soils varied from 0.11 to 0.44 dS/m. Vegetable crops soils had the highest electrical conductivity value 0.44 dS/m between 0-15 cm depths. The minimum electrical conductivity of 0.11 dS/m was observed in a fruit cultivated land at a depth of 15-30 cm. Further analysis of the data showed that the EC of soil varied non-significantly with different land use regimes. The chemical property of soil electrical conductivity has a direct impact on crop productivity. As cations or anions, the plant receives all of the major and minor nutrients it needs to grow. Soil Electrical Conductivity is

linked to certain soil factors which impact crops output, such as the depth of the topsoil, the pH, the levels of salt, and the ability to store water [19].

### 3.3 Analysis of Organic Carbon and Soil Available Nutrients under Different Land Use Systems

#### 3.3.1 Soil organic carbon

At different depths, the soil organic carbon levels varied from 0.22 to 0.77 per cent as shown in Table 4. The highest level of organic carbon 0.77 per cent was found in forest land between top 0-

15 cm soil profile. The lowest level (0.22 per cent) of the soil organic carbon content was found at 15-30 cm depth in the vegetable cultivated land. As per the findings fruit and cultivated crops had a medium content at 0-15 cm depth, whereas cultivated and fruit crops had low organic carbon content. Analysis revealed that the soil organic carbon content varied significantly with different Land Use systems and as the depth of soil increased, the soil organic carbon content reduced. The high organic load of plant litter in forest and plantations could explain the rise in organic carbon content and soil with a high organic matter concentration has better physical and chemical qualities [20,21].

### 3.3.2 Available nitrogen

The amount of available nitrogen at two different depths in the soil ranged from 280 to 218 kg/ha (Table 4). Forest soils have the highest available nitrogen content of 280 kg/ha in top soil (0-15 cm) whereas, lowest available nitrogen content of 218 kg/ha found between the depth of 15-30 cm in the Fruits cultivated land. Further examination of the data showed that the topsoil available nitrogen concentration varied non-significantly with different Land Use systems and the nitrogen content decreases with depth [22].

### 3.3.3 Available phosphorus

The available phosphorus content of soil changed significantly for different land use system and soil depth. The available phosphorus varied from 18.63 to 11.61 kg/ha (Table 4). Vegetable land showed the highest available phosphorus content of 18.63 kg/ha at 0-15 cm depth. Deep down, at 15-30 cm the Fruit cultivated land soils had the least available phosphorus content of 11.61 kg/ha. The accessible phosphorus concentration in soils of all plantings was in the medium range and gradually decreases with increasing soil depth. Organic P was highest on the surface soil of the virgin land followed by the farmer's field. The largest depletion organic phosphorus occurred due to long term cultivation compared with the soils under natural forest vegetation [23].

### 3.3.4 Exchangeable potassium

At varying depths and land use system of soil, exchangeable potassium ranged from 213.65 to 139.82 kg/ha (Table 4). Fruit cropped land soils showed the highest level of exchangeable potassium 213.65 kg/ha at 0-15 cm. At a depth of

15-30 cm, the least exchangeable potassium concentration of 139.82 kg/ha was found under plantation soils. The exchangeable potassium concentration in all land use system was in the medium to high range and with increasing soil depth, it gradually decreased. The exchangeable potassium content of soil varied greatly with different land use systems and soil depth. Available phosphorus content in surface layer soil in all land use types was higher than that of the sub-surface horizons [24].

### 3.3.5 Available sulphur

The available sulphur content at various soil depths and land use system varied from 6.38 to 8.64 mg/kg. The maximum available sulphur 8.64 mg/kg was recorded in the soils of cultivated crops at 0-15 cm soil layer followed by vegetable soils (7.96 mg/kg). The minimum available sulphur content of 6.38 mg/kg was recorded under plantation land use, at 15-30 cm depth. The available Sulphur content in different land use system were under low category and it progressively decreased as soil depth increased. The available sulphur content of soil varied non-significantly with various land use system. Jiang et al., 2007 [25] also reported non-significantly distribution of total sulphur under different land uses.

## 4. CONCLUSION

Experimental results, revealed the physiochemical properties of Krishna district of Andhra Pradesh under different five different land use system at two different depths of 0-15 cm and 15-30 cm. Maximum bulk density, particle density and water holding capacity was recorded in normally cultivation land at lower depth of 15-30 cm and highest porosity was reported in cultivation land use system at upper soil layer (0-15 cm). It had been observed that soil bulk density and particle density increased with depth, and water holding capacity decreased with depth. Forest land had showed the maximum organic carbon content in upper soil (0-15 cm) as well as lower soil (15-30 cm) due high organic load of plant litter in forest whereas least carbon content was found in cultivated land soil. More availability of nitrogen, phosphorus, potassium and sulphur were reported in upper soil layer (0-15 cm) in all land use system considered in this study and also, found to depleting with depth. Due to varying levels of soil Organic Carbon and aggregation dynamics, different land uses have varying carbon sequestration potentials. Thorough

understanding of the spatial variability of soil nutrients in relation to site properties such as climate, land use, topography, and other variables required for understanding the functioning of the ecosystem and determining the effects of further land use change on soil properties. The results of this study indicate that land use has an impact on many soil physiochemical properties. This study have a great importance for improving the standard of the produce, raising crop yields by a greater percentage through soil conservation and better preservation of the environment.

### ACKNOWLEDGEMENT

I feel golden opportunity with great pleasure in acknowledging my profound sense of veneration and gratitude to my major advisor and Chairman. The authors are thankful to the department for providing the required research facilities. I gratefully express my deep sense gratifies to my respected senior, at Banaras Hindu University, Varanasi, Uttar Pradesh, India for his keen interest, valuable guidance, and constructive criticism throughout the pursuit of the present research paper and vital suggestion during preparation of this manuscript.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. Karami E, Ghorbani Dashtaki S, Bijan Khalilimoghadam. Effects of land management on soil erodibility-A case study in part of Zayandeh-Rood watershed. *Journal of Agricultural Engineering Soil Science and Agricultural Mechanization,(Scientific Journal of Agriculture)*. 2018;40(2):105-119.
2. Franzluebbers, Alan J. Water infiltration and soil structure related to organic matter and its stratification with depth. *Soil and Tillage Research*. 2002;66(2):197-205.
3. Roosta Hamid R, Mohsen Hamidpour. Effects of foliar application of some macro- and micro-nutrients on tomato plants in aquaponic and hydroponic systems. *Scientia Horticulturae*. 2011;129(3):396-402.
4. Doran John W, Michael R. Zeiss. Soil health and sustainability: managing the biotic component of soil quality. *Applied Soil Ecology*. 2000;15(1):3-11.
5. Vatansever Recep, Ibrahim Ilker Ozyigit, Ertugrul Filiz. Essential and beneficial trace elements in plants, and their transport in roots: a review. *Applied Biochemistry and Biotechnology*. 2017;181:464-482.
6. Piper CS. *Soil and plant analysis*. Inter Science Publication Inc., New York. 1966;368.
7. Black James W, Duncan WA, Shanks RG. Comparison of some properties of pronethalol and propranolol. *British Journal of Pharmacology and Chemotherapy*. 1965;25(3):577.
8. Jackson ML. *Soil chemical analysis*, pentice hall of India Pvt. Ltd., New Delhi, India. 1973;498:151-4.
9. Scheidegger AM, Sparks DL. A critical assessment of sorption-desorption mechanisms at the soil mineral/water interface. *Soil Science*. 1996;161(12):813-31.
10. Hanway JJ, Heidel H. *Soil analysis methods as used in the iowa state college soil testing laboratory*, bulletin 57. Iowa State College of Agriculture, Iowa, USA. 1952;131.
11. Chesnin L, Yien CH. Turbid metric method for determination of sulphur. In *Proc. Soil Sci. Soc. Am.* 1950;14:149-151.
12. Walkley Aldous, I. Armstrong Black. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*. 1934;37(1):29-38.
13. Li Xiao-Gang, Feng-Min Li, Rengel Zed, Zheng-Yan Zhan. Soil physical properties and their relations to organic carbon pools as affected by land use in an alpine pastureland. *Geoderma*. 2007;139(1-2):98-105.
14. Wu Ronggui, Holm Tiessen. Effect of land use on soil degradation in alpine grassland soil, China. *Soil Science Society of America Journal*. 2002;66(5):1648-55.
15. Keller Thomas, Inge Håkansson. Estimation of reference bulk density from soil particle size distribution and soil organic matter content. *Geoderma*. 2010;154(3-4):398-406.
16. Baldock JA, Skjemstad JO. Role of the soil matrix and minerals in protecting natural organic materials against biological



- attack. *Organic Geochemistry*. 2000;31(7-8):697-710.
17. Williams A, Jordan NR, Smith RG, Hunter MC, Kammerer M, Kane DA, Koide RT, Davis ASA. Regionally-adapted implementation of conservation agriculture delivers rapid improvements to soil properties associated with crop yield stability. *Sci. Rep.* 2018;8:1–8.
  18. Celik I. Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. *Soil and Tillage Research*. 2005; 83(2):270-277.
  19. Gupta Sapna, Manoj K. Mahapatra, Prabhakar Singh. Phase transformation, thermal expansion and electrical conductivity of lanthanum chromite. *Materials Research Bulletin*. 2013;48(9): 3262-7.
  20. Veeresh H, Tripathy S, Chaudhuri D, Hart BR, Powell MA. Competitive adsorption behavior of selected heavy metals in three soil types of India amended with fly ash and sewage sludge. *Environmental Geology*. 2003;44:363-70.
  21. Fernández José M, César Plaza, Juan C. García-Gil, Alfredo Polo. Biochemical properties and barley yield in a semiarid Mediterranean soil amended with two kinds of sewage sludge. *Applied Soil Ecology*. 2009;42(1):18-24.
  22. Dad, Javaid M, Lotfollah Abdollahi. Changes in soil organic carbon, nitrogen and sulphur along a slope gradient in apple orchard soils of Kashmir Himalaya. *Journal of Mountain Science*. 2021;18(9):2377-87.
  23. Negassa Wakene, Heluf Gebrekidan. Forms of phosphorus and status of available micronutrients under different land-use systems of Alfisols in Bako area of Ethiopia. *Ethiopian Journal of Natural Resources*. 2003;5(1):17-37.
  24. Kiflu Alemayehu, Sheleme Beyene. Effects of different land use systems on selected soil properties in South Ethiopia. *Journal of Soil Science and Environmental Management*. 2013;4(5):100-7.
  25. Jiang Yong, Yuge Zhang, Wenju Liang. Land use effect on the profile distribution of sulfur in an aquic brown soil. *Agricultural Journal*. 2007;2(1):49-54.

© 2023 Vandana et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<https://www.sdiarticle5.com/review-history/99567>