Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; Sp 9(5): 621-625
Received: 17-07-2020
Accepted: 02-10-2020

Girdhari Lal Jakhar
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Peeyush Sharma
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Vikas Abrol
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Vikas Sharma
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Shubham Chadha
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Corresponding Author:
Peeyush Sharma
Division of Soil Science, Sher-e-Kashmir University of Agriculture Science and Technology Jammu, Jammu and Kashmir, India

Soil physical limitations in different land use systems

Girdhari Lal Jakhar, Peeyush Sharma, Vikas Abrol, Vikas Sharma and Shubham Chadha

Abstract
Soil degradation and alleviation of soil physical constraints and the subsequent decline in crop production are the major issues to feed the increasing population. The present study was undertaken in order to identify soil physical constraints under different land use systems namely agriculture, horticulture, forest, pasture, and wasteland in Udhampur district of Jammu and Kashmir. Composite surface soil samples from different locations across the whole of the district were collected using global positioning systems (GPS). Dominant texture class of the study area was sandy loam. Soils of wasteland had had higher sand content than those of agriculture, horticulture, pasture and forest land. The bulk density (BD) was none limiting (<1.40 g cm^{-3}) under forest and pasture. The maximum non limiting mean value of porosity, maximum water holding (MWHC), and available water retention capacity (AWRC) was recorded under pasture and forest land use and the minimum was found in wasteland soils. Multiple regression equation was used to determine the soil physical health along with the estimation of relative magnitude of their severity. Results revealed that soil compaction and available water content and clay percent are important parameters to affect the soil organic carbon and want special attention to improve soil health and better utilization of water and nutrients. From the view point of aggradations of soil physical health, the forest land use system was most superior followed by pasture, horticulture, agriculture and least in the soil of wasteland system.

Keywords: Physical limitation, land use, soil organic carbon, water holding capacity

Introduction
Soil is a non-renewable resource and it is thus important to maintain its quality, in order to sustain crop productivity and quality of human life. As the soil is continuously cultivated, decline in soil fertility and land degradation has been considered as some of the major constrains (Kong *et al*., 2005) [20]. Soil degradation and restoration depends not only on soil inherent characteristics but also on magnitude, intensity and duration of stress such as low water retention capacity, high compaction level, and poor aggregation due to low soil organic carbon (OC) level (Haynes, 2005) [15]. Soil degradation may be greatly affected by different land use and soil management practices and thus play an important role in to sustaining soil quality (Ezeaku, 2015) [11]. Soil physical degradation is linked very closely to the physical environment that governs water and nutrients movement, aeration and plant root penetration. Soil compaction degrades soil physical quality (Dexter, 2004: Whitmore and Whalley, 2011) [7, 29]. The Bulk density depends on several factors such as soil organic matter, compaction, consolidation, soil texture, the density of soil mineral (sand, silt, and clay) and their packing (Blanco, H. anqui and Benjamin). The type and magnitude of soil deformation depends on external factors that determine the applied stress as well as on soil physical and mechanical properties, of which texture, organic matter content, and water content exert the greatest influence. Texture determines how easily soil particles are rearranged when certain stress is applied. The content and type of organic matter determines the binding forces between particles and aggregates. The content of water determines the magnitude of soil deformation when certain stress is applied because water controls soil particles movement. Therefore, texture, organic matter content, and water content control the physical degradation that soils will undergo. Plants depend on soil for survival, as it provides physical support and nutrients and studies have shown that particularly physical soil properties are changing with time within a growing season, depending on the soil type, climate conditions, and agricultural and soil management practices. Case studies have been conducted in different agro-ecological zones by identifying minimum set of data on soil indicators and relevant sampling strategies so as to assess soil quality (Doran and Jones 1996, Hussain *et al*. 1999, Schjonning *et al*. 2004, Aparicio and Costa 2007) [8, 3]. In a given agro-climatic region, the measurable soil attributes that are primarily influenced are- soil-depth, organic matter, respiration, aggregation, texture, bulk density, infiltration, nutrient availability and retention capacity, microbial

Population (Chen *et al*. 2006, Masto *et al*. 2007) [6, 23]. Reynolds *et al*. (2008) [25] assessed soil physical quality (SPQ) by comparing values of “indicator” soil properties (e.g. bulk density, air capacity). A study was undertaken by Amirinejad *et al*. (2011) [2] in order to measure relevant soil physical parameter. Total 145 observation sites were chosen covering a total area of 19.6 ha. The coordinates of each sampling location were recorded using a differential global positioning system unit (GPS). Indicators for soil physical health assessment included bulk density (BD), field saturated hydraulic conductivity (Kfs), available water retention capacity (AWRC), organic carbon content (OC) and non-capillary porosity (NCP). Results revealed that overall soil physical health of the farm was medium to good for paddy cultivation but was not suitable for succeeding wheat crop mainly because of increased BD and reduced Kfs, NCP and AWRC of the farm. The present investigation was undertaken to assess the soil physical limitations under different land use system of Udhampur district, Jammu.

Materials and Methods

Discription of Study area

Udhampur district is situated in south eastern part of Jammu and Kashmir State. The district lies between 32° 34' to 39° 30' N of latitude and 74° 16' to 75° 38' E of longitude. Due to variation in altitude from 600 to 3,000 meters above mean sea level, there is a wide variation in climatic conditions in different parts of the district experiencing a typical temperate climate in high altitude which experience snowfall and cold winter whereas sub-tropical climate at low altitude. The district has 960.58 sq.km under the forest, 111.30 sq.km under horticulture, 438.00 sq.km under barren and uncultivated land and 55.72 sq.km under permanent pasture and other grazing land (Fig 1).

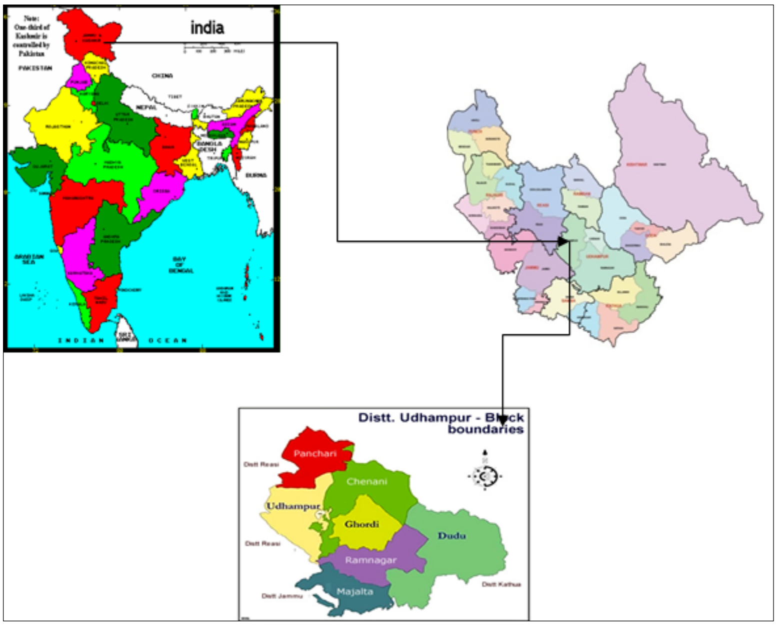

Fig 1: Location map of the study area

Soil sample collection

A total of 248 surface soil samples (0-15cm), representing agriculture, horticulture, forest, pasture, and wasteland were collected randomly from different elevation across whole of the district by using global positioning systems (GPS). Collected soil samples were air-dried and grinded with the help of wooden hammer. Processed soil samples passed through a 2 mm sieve and were analysed for pH. Sand, silt and clay content (Bouyoucos 1962) [4], electrical conductivity of the soil samples was determined by 1:2.5 soils water suspension with EC meter and expressed in dSm^{-1} (Jackson 1967) [17], organic carbon (OC) (Walkly and Black 1934). Soil compaction level was determined from undisturbed soil samples by the core method after drying a defined volume of soil in an oven at 105 °C to constant weight using the following relationship:

$$\text{Bulk density (g/cc)} = \frac{\text{Oven dry weight of soil}}{\text{Volume of Soil}},$$

Porosity of soil was calculated using the formula;

$$\text{Porosity (\%)} = 1 - \frac{\text{Bulk density}}{\text{Partical density}} \times 100$$

The maximum water holding capacity of soil was determined by the Keen-Raczkowski Box Method (Keen and Raczkowski 1921). Available water retention capacity was determined by pressure plate apparatus. Simple correlation coefficients were made to relate physical properties of soils withy soil organic carbon. A multiple regression equation was used to determine the soil physical health.

Results and Discussion

Basic Soil Properties

Soil pH

Soil pH of major parts of the district ranged from 6.6 to 7.2 (Fig 2a). Results revealed that soils of forest land were slightly acidic (pH 6.6). The lower pH under forest soils may be attributed to the presence of high OM. Similar trend was revaluated by Abbasi and Rassol (2007) [13] in the hilly area of Rawalakot Azad Jammu and Kashmir. Islam and Weil (2000) [16] explained that the pre-weathered parent materials, the amphoteric nature of aluminum and the intense leaching of basic cations during rainfall are all the most likely contributing factors to decreasing pH in forest soil. Similarly, a persistent solvent action of acids on the mineral constituents of the soil is responsible for the removal of base forming cations through dissolution and leaching resulting in decrease in pH (Brady and Weil 1996) [5].

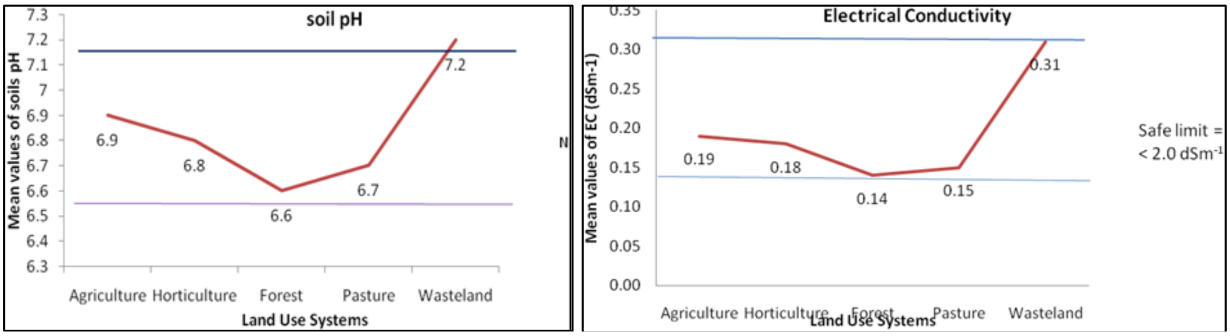

Fig 2: Mean value of soil pH and EC under different land use systems

Electrical conductivity

The electrical conductivity of all soils of different land use systems was within safe limit below 1 dSm^{-1}. The forest and pasture land has lower EC (0.14, 0.15), respectively than the other land use systems. Highest EC values were found in wasteland and agriculture land use systems. The accumulation of soluble salts in mountainous regions is unlikely because of the climatic conditions of the region, e.g. heavy rainfall that cause leaching of all the salts into the subsoil below the root zone (Abbasi and Rassol 2007) [1].

Soil texture

Results revealed that sand, silt and clay percent varied from 56.64-68.28; 17.65- 25.41 and 15.09-18.67 percent, respectively under different land use system (Fig 3 a-c). Prominent texture class of the study area was sandy loam. The clay content was higher in soils of forest followed by those under cultivated unmanaged and least in soil of waste land. Similar findings have also been reported by Gupta *et al*. (2010) [12]. This could be ascribed to different levels of erosion of the soils depending upon the slope and management practices in alluvial soils of hilly region in North India (Singh and Prakash 1985) [26]. Cultivated soils were considerably lower in silt and slightly lower in clay content than the adjacent soils under forest, most likely as result of preferential removal of silt by accelerated water erosion during the monsoon months (Hassan and Majumder 1990) [14].

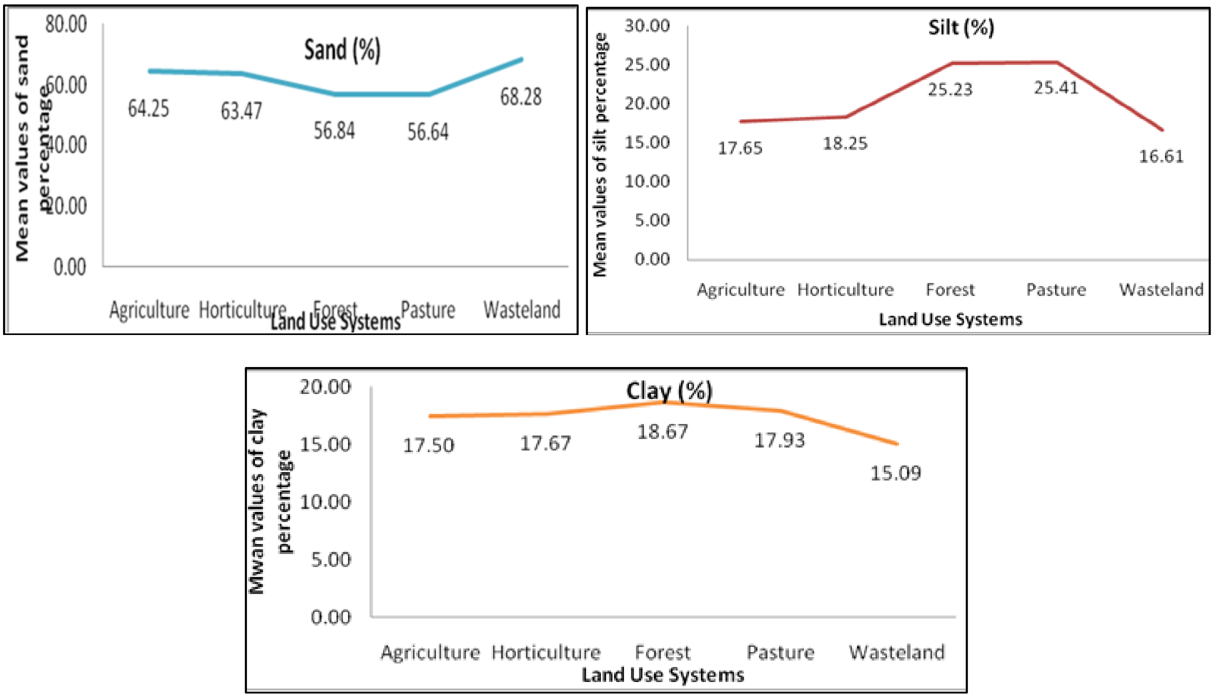

Fig 3: Mean value of soil sand %, silt % and clay % under different land use systems

Soil organic carbon

Highest organic carbon content (1.14 per cent) was observed under forest lands as compare to the other land use system and the lowest was observed in wasteland soils (0.45 per cent, Fig 4). Accumulation of more OM in forest may also be due to the higher clay content (30-40 per cent), which forms clay-humus complexes which protect the OM against oxidation and degradation (Quiroga *et al*. 1996) [24]. Marshman and Marshall (1991) [21] reported that clay particles act as an adsorption sink of OM, therefore the increase in clay contributed to increase in OM of forest soil. In contrast, the loss of a proper micro-environment in arable soil due to uncovered surface reduces the decomposition process and ultimately results in poor organic carbon stock and other nutrients in the soil. Rapid OM breakdown due to mineralization occur when soil becomes uncovered soils (Matinez-Mena *et al*. 2002; Voun dinkana and Tonye 2003) [27].

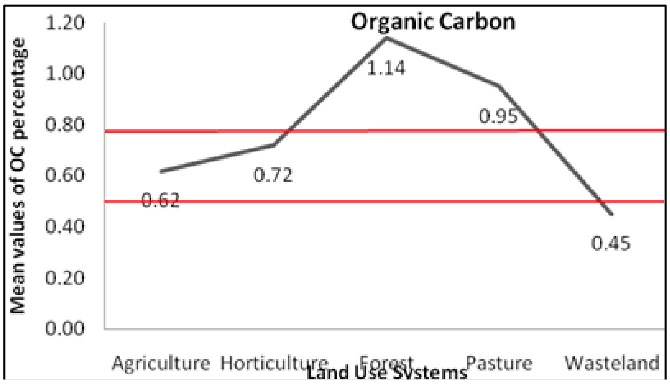

Fig 4: Mean value of soil Organic carbon under different land use systems

Soil Physical Properties

Bulk density

The bulk density of soil was generally lower in forest (1.30 Mg m^{-3}) and pasture (1.31Mg m^{-3}) land as compare to the agriculture, horticulture, and wasteland soils (Fig 5a) may be due to low clay and high sand content and low amount of organic carbon. Similar findings were reported by Emadi *et al*. 2008 [9]. These results are in agreement with those of Gupta *et al*. (2010) [12]. Sharma and Qahar (1989) have also reported a negative correlation between bulk density with organic carbon and clay content in eroded forest soils of outer Himalayas.

Porosity

The soils of forest and pasture lands had slightly higher values of porosity as compared to those of wasteland and cultivated lands indicating that soils rich in organic carbon and clay content had high total porosity which resulted into rapid permeability (Fig 5b). 1.26 times higher porosity was observed in forest than the waste lend. These results corroborate with the findings of Singh & Prakash (1985) [26] and Sharma & Qahar (1989). Emadi *et al*. (2008) [9] was also reported that total porosity under forest and pasture land use systems were higher than cultivated soils.

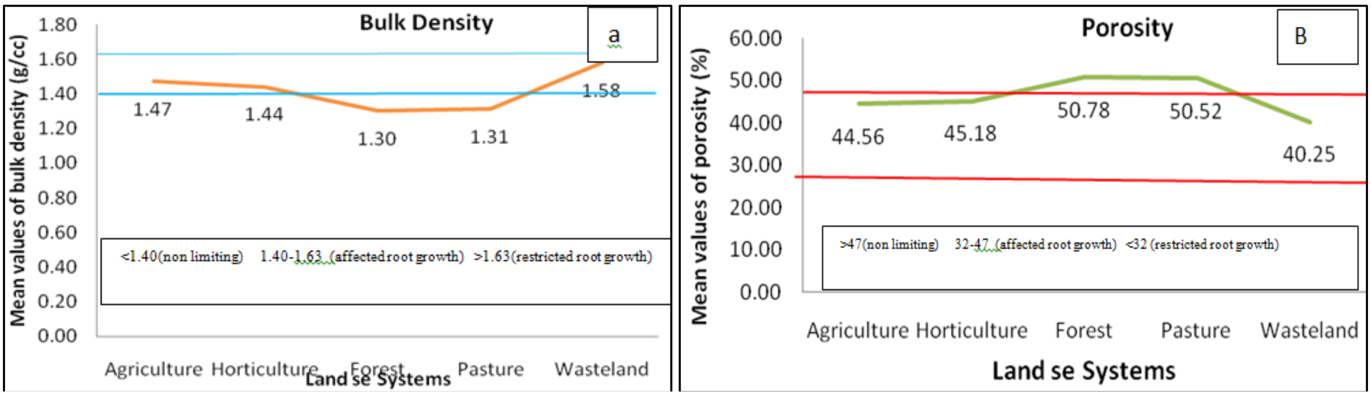

Fig 5: Mean value of Bulk density and Porosity under different land use systems

Maximum water holding capacity and available water retention capacity

Higher mean value of MWHC and AWRC was found under forest and pasture land followed by soils of horticulture, agriculture, and wasteland, respectively (Fig 6a-b). Approximate two times higher MWHC was found in pasture than the wasteland. It might be ascribed to presence of higher organic matter and clay fractions (Gupta *et al*. 2010) [12]. Hajabbasi *et al*. (1997) [13] and Evrendik *et al*. (2004) [10] have also reported increase in water retention capacity in forest soils. Similar trend was also found by Islam and Weil (2000) [16] under different land use systems in tropical forest ecosystem of Bangladesh.

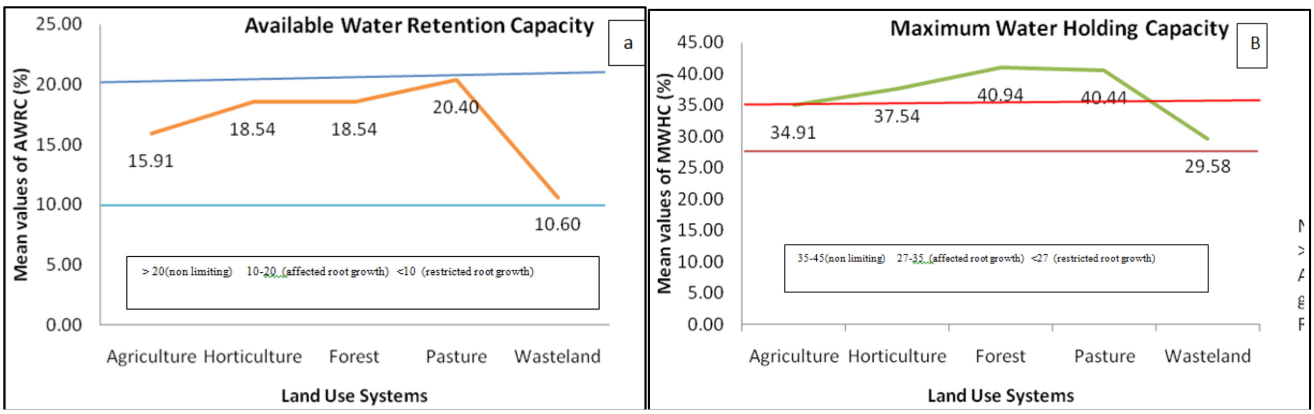

Fig 6: Mean value of Available water holding capacity and maximum water holding capacity under different land use systems

Assessment of Soil Physical Health

To assess the soil physical health in different land use system a linear multiple regression of different soil physical parameters (sand%, silt %, clay%, bulk density, maximum water holding capacity, available water holding capacity and porosity) was done using all the data. In the present study, the differential behaviour of the land use systems in influencing the physical health of soil was very much clear. The data showed that bulk density, AWRC and clay per cent affect the soil organic carbon significantly 64.60% (equations 1-3).

The soils of Udhampur district are sandy loam in texture, mostly neutral in reaction, medium in organic carbon. The porosity, bulk density, water holding capacity and organic carbon were relatively high in soil of forest and pasture than soil of cultivated lands. From the view point of soil physical health, the forest land use system was most superior followed by pasture, horticulture, agriculture and poorest was the wasteland soil.

Regression analysis of soil parameters

OC= 3.595^{**}-1.994^{**} BD,
R^2 (%) =60.40
F-value = 374.58^{**} Eq…1
OC= 3.092^{*}- 1.751^{**} BD +$.009^{**}$ AWRC,
R^2 (%) = 62.0,
F-value = 199.96^{**} Eq…2
OC= 2.330 - 1.758^{**} BD +$.023^{**}$ AWRC +$.009^{**}$ Clay,
R^2 (%) = 64.60 148.23^{**} Eq…3

References

1. Abbasi MK, Rasool G. Effects of different land-use types on soil quality in the hilly area of Rawalakot Azad Jammu and Kashmir. Acta Agriculturae Scandinavica Section B-Soil and Plant 2007;55(3):221-228.
2. Amirinejad AA, Kamble K, Aggarwal P, Chakraborty D, Pradhan S, Mittal RB. Assessment and mapping of spatial variation of soil physical health in a farm. Journal of Geoderma 2011;160:292-303.
3. Aparicio V, Costa JL. Soil quality indicators under continuous cropping systems in the Argentinean Pampas. Soil Tillage Research 2007;96:155-165.
4. Bouyoucos GJ. Hydrometer method improved for making particle size analyses of soils Agronomy Journal 1962;54(5):464-465.
5. Brady NC, Weil RR. The Nature and Properties of Soils. (12th Edn.), Pretence Hall International Inc. Upper Saddle River. New Jersey, USA 1999,634.
6. Chen J, Yu Z, Ouyang J, Van Mensvoort ME. FFactors affecting soil quality changes in the North China Plain: a case study of Quzhou County. Agriculture System 2006;91:171-188.
7. Dexter AR. Soil physical quality: part I. Theory, effects of soil texture, density, and organic matter, and effects on root growth. Geoderma 2004;120(3):201-214.
8. Doran JW, Jones AJ. Methods for Assessing Soil Quality. Soil Science Society of America Special Publication, Soil Science Society of America, Madison, Wisconsin 1996,49.
9. Emadi M, Baghernejad M, Fathi H, Saffari M. Effect of land use change on selected soil physical and chemical properties in North Highlands of Iran. Journal Applied Sciences 2008;8:496-502.
10. Evrendik F, Asher JB, Aydin M. Diurnal photosynthesis, water use efficiency and light use efficiency of wheat under Mediterranean field conditions. Journal of Environmental Biology 2008;29:397-406.
11. Ezeaku PI. Evaluation of agro-ecological approach to soil quality assessment for sustainable land use and management systems. Scientific Research and Essays 2015;10(15):501-512.
12. Gupta RD, Arora S, Gupta GD, Sumberia NM. Soil physical variability in relation to soil erodibility under different land uses in foothills of Siwaliks in NW, India. Tropical ecology 2010;51(2):183.
13. Hajabbasi MA, Jalalian A, Karimzadeh HR. Deforestation effects on soil physical and chemical properties, Lord Egan, Iran. Plant and soil 1997;190(2):301-308.
14. Hassan MM, Majumder AH. Distribution of organic matter in some representative forest soils of Bangladesh. Indian Journal of Forestry 1990;13:281-287.
15. Haynes RJ. Labile organic matter fractions as central components of the quality of agricultural soils: an overview. Advances in Agronomy 2005;85:221-268.
16. Islam KR, Weil RR. Land use effects on soil quality in a tropical forest ecosystem of Bangladesh. Agriculture, Ecosystems and Environment 2000;79(1):9-16.
17. Jackson ML. Soil Chemical Analysis. Asia Publishing House, Bombay 1967.
18. Karlen DL, Ditzler CA, Andrews SS. Soil quality: whyand how? Geoderma 2003;114(3):145-156.
19. Keen BA, Raczkowski H. The relation between the clay content and certain physical properties of a soil. The Journal of Agricultural Science 1921;11(4):441-449.
20. Kong AY, Six J, Bryant DC, Denison RF, Van Kessel C. The relationship between carbon input, aggregation, and soil organic carbon stabilization in sustainable cropping systems. Soil Science Society of America Journal 2005;69(4):1078-1085.
21. Marshman NA, Marshall KC. Bacterial growth on proteins in presence of clay minerals. Soil Biology and Biochemistry 1991;13:127-134.
22. Martinez-Mena M, Rogel JA, Castillo V, Albaladejo J. Organic carbon and nitrogen losses influenced by vegetation removal in a semi-arid Mediterranean soil. Biogeochem 2002;6:309-321.
23. Masto RE, Chhonka PK, Singh D, Patra AK. Soil quality response to long-term nutrient and crop management on a semi-arid Inceptisol. Agriculture, Ecosystems and Environment 2007;118(1):130-142.
24. Quiroga AR. Buschiazzo DE, Peinemann N. Soil organic matter particle size fractions in soils of the semiarid Argentinian pampas. Soil Science 1996;161(2):104-108.
25. Reynolds WD, Drury CF, Yang XM, Tan CS. Optimal soil quality inferred through structural regression and parameter interactions physical. Geoderma 2008;146(3):466-474.
26. Singh GR, Prakash O. Characteristics of erodibility of some hill soil profiles in Uttar Pradesh under varying land use, slope and terracing conditions. Journal of the Indian Society of Soil Science 1985;33:858-864.
27. Voundinkana JC, Tonye J. Assessment of certain soil properties related to different land-use systems in the Kaya watershed of the humid forest zone of Cameroon. Land Degradation Development 2003;14:57-67.
28. Walkley A, Black IA. Determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science 1934;37(1):29-38.
29. Whitmore AP, Whalley WR, Bird NR, Watts CW, Gregory AS. Estimating soil strength in the rooting zone of wheat. Plant and soil 2011;339(1-2):363-375.