Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 2645-2648
Received: 07-09-2018
Accepted: 09-10-2018

Varsha Pandey
Department of Soil Science, College of Agriculture, G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Poonam Gautam
Department of Soil Science, College of Agriculture, G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

AP Singh
Department of Soil Science, College of Agriculture, G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Correspondence
Varsha Pandey
Department of Soil Science, College of Agriculture, G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Assessment of physical properties of soil under different land use systems in a Mollisol

Varsha Pandey, Poonam Gautam and AP Singh

Abstract
Present study was undertaken to assess the physical properties of soil under different land use systems in Mollisol at Norman E. Borlaug Crop Research Centre, G. B. Pant University, Pantnagar. Land use systems were rice–wheat–green gram, rice–pea(vegetable)-maize, rice-potato –okra, rice–berseem + oat + mustard(fodder)-maize + cowpea(fodder), maize–wheat–cowpea, sorghum(fodder)-yellow sarson-black gram, guava + lemon, poplar + turmeric, eucalyptus + turmeric and fallow(uncultivated land). Soil samples were taken from 0-20cm depth and analyzed for the various physical properties. Studies revealed that clay content varied from 25.16 to 30.16, silt content ranged from 19.99 to 25.72 and sand content varied from 49.02 to 49.84. Bulk density ranged from 1.29 to 1.43 g cm^{-3}, particle density varied from 2.55 to 2.74 g cm^{-3} whereas porosity ranged from 47.62 to 49.71 percent. Water holding capacity varied from 41.56 to 61.82 percent. Results indicated that soil under agroforestry based systems was found superior with respect to soil physical environment followed by field crops, horticultural crops and the uncultivated land.

Keywords: Land use systems, assessment, physical properties, Mollisol

1. Introduction
Soil is very diverse and complex system consisting of mineral particles, organic matter, water and pore spaces. The mineral particles contain nutrients, which are slowly released in the process of weathering; organic matter and humus vary in quantities, resulting from the decomposition of biomass and minute pores are filled with air or water (IFOAM, 2002) [1]. Soils are characterized by a high degree of variability due to the interplay of physical, chemical, biological and anthropogenic processes that operate with different intensities at different scales (Goovaerts, 1998) [2]. These processes in turn influence the nature and properties of soil hence, knowledge of soil properties is important in determining the best use to which a soil may be put (Amusan *et al*., 2004) [3].
Morphological and physical properties of soil are important indicators of the soil fertility. Soil physical properties provides information related to water and air movement through soil, as well as various conditions affecting germination, root growth and erosion processes. Since, many soil physical properties form the foundation of other chemical and biological processes, which may be further governed by variation in the land use type. Therefore, the present study was undertaken with the objective of assessment of physical properties of soil under different land use systems.

2. Materials and methods
Present study was undertaken at Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University, Pantnagar, District U.S. Nagar in terai region of Uttarakhand. The order of the soil was Mollisol.
Pantnagar falls under sub-humid and sub-tropical climate zone with hot, dry summer and cool winter.
The region has thick vegetation because of prevalence of high moisture in Tarai belt and the forest area is classified as low alluvial savannah (Puri, 1960) [4].
Five composite soil samples (0-20 cm depth) representing the whole area were collected randomly from different land use systems comprising of field crops, horticultural crops, agroforestry crops and fallow (uncultivated land) from the same block during kharif, 2017-18. Each composite soil sample was air dried, processed with the help of pestle and mortar, passed through 2 mm sieve and used for the analysis of physical soil properties.
Soil colour was determined both under moist and dry conditions in the laboratory by Munsell Soil Colour Chart. Texture of soil was determined by by Hydrometer method (Bouyoucos, 1927) [5]. Textural classification was made using USDA textural triangle. Bulk density, particle

density and porosity were determined by procedure given by Baver (1956) [6]. Water holding capacity (WHC) was determined with the help of Hilguard apparatus (Piper, 1950) [7]. The data were analysed statistically by using complete randomized design (C.R.D). The data collected on different soil properties were analysed applying ANOVA technique (Pansa and Sukhatme, 1985) [8]. The overall difference was tested by F test of significance at 5% level of probability. In case of significant F test, C.D. at 5% was calculated for comparing treatment means.

3. Results and Discussion

3.1. Soil colour

Soil colour is one of the morphological indicators of soil fertility status which depends mainly on the amount and state of organic matter and iron oxide as well as the amount of air and water in soil pores.

Dry soil - Pale brown colour was noted under rice–wheat–green gram and maize–wheat–cowpea land use systems. Yellowish brown colour was recorded under rice-potato-okra and guava + lemon system. Very pale brown colour was noted under eucalyptus + turmeric and fallow system. Brown colour was noted under rice– berseem + oat + mustard(fodder)-maize + cowpea (fodder) while light greyish brown and brownish yellow colour was observed under sorghum(fodder)-yellow sarson-black gram and poplar + turmeric system respectively. Grayish brown colour of dry soil was noted under rice–pea (vegetable)-maize land use system (Table-1).

Moist soil - Dark brown colour was noted under rice–wheat–green gram, rice–berseem + oat + mustard (fodder)-maize + cowpea(fodder) and maize–wheat–cowpea land use systems. Dark yellowish brown colour was noted under rice-potato-okra and guava + lemon land use systems. Dark grayish brown colour was recorded under sorghum (fodder)- yellow sarson-black gram, poplar + turmeric system and fallow(uncultivated) land while very dark brown colour and very dark grey colour was recorded under rice – pea (vegetable)-maize and eucalyptus + turmeric system respectively (Table-1). Generally, dark soils have high organic matter content, grey soils are waterlogged or anaerobic and brown soils are well-drained and aerated soils. Soil colour recorded in the present study are in conformity with the results obtained by Sarkar *et al.,* (2002) [9] and Yadda (2007) [10].

3.2. Mechanical composition and texture

Clay content in soil varied from 25.16 to 30.16 percent. Highest value of clay percent was observed under eucalyptus + turmeric and the lowest value under fallow land use system. Silt content in soil varied from 19.99 to 25.72 percent. Highest silt content was observed under fallow (uncultivated land) while it was lowest under eucalyptus + turmeric system. Sand content in soil varied from 49.02 to 49.84 percent. Highest sand content was observed under eucalyptus + turmeric and it was lowest under guava + lemon and poplar + turmeric land use system (Table 1). The textural class of soil was sandy clay loam under all the land use system.

3.3. Bulk density

Bulk density differed significantly under different land use systems and varied from 1.29 to 1.43 g cm^{-3} at 0-20 cm depth. Lowest value of bulk density was recorded under eucalyptus + turmeric system which was significantly lower than the bulk density noted under all other systems. Bulk density noted under poplar + turmeric system was significantly lower than that under rice-potato –okra, rice–wheat–green gram, rice–berseem + oat + mustard(fodder)-maize + cowpea(fodder), sorghum(fodder)-yellow sarson- black gram, rice–pea(vegetable)- maize, maize– wheat–cowpea, guava + lemon and fallow(uncultivated) land use system. Bulk density recorded under rice–pea (vegetable) -maize and maize–wheat–cowpea system was significantly lower than the value noted under guava + lemon and fallow land use system. Bulk density recorded under guava + lemon system was significantly lower than that under fallow (uncultivated) land use system (Table-2).

Lowest bulk density under agroforestry based system i.e. eucalyptus + turmeric might be due to high soil organic carbon which lead to decreased soil bulk density. Kumar *et al.*, (2002) [11] and Gupta *et al.*, (2010) [12] were also of similar opinion. Highest bulk density noted under fallow system might be due to low organic carbon and low clay content. Under conditions of reduced tillage soil bulk density is generally greater due to lack of surface soil disruption caused by ploughing (Karamanos *et al.,* 2004) [13]. Highest bulk density in the abandoned land due to soil compaction and organic matter degradation was also observed by Wakene and Heluf (2003) [14]. Variability in bulk density among different land use systems was very low.

Table 1: Dry soil colour, moist soil colour, sand percent, silt percent and clay percent of soil under different land use systems.

Land use systems	Dry soil colour	Moist soil colour	Sand (%)	Silt (%)	Clay (%)
Rice – wheat – green gram	10YR/6/3 (pale brown)	10YR/2/2 (dark brown)	49.06	20.95	29.98
Rice – pea (vegetable) –maize	10YR/5/2 (grayish brown)	10YR/2/2 (very dark brown)	49.12	20.92	29.96
Rice – potato – okra	10YR/5/4 (yellowish brown)	10YR /4/4 (dark yellowish brown)	49.14	20.84	30.02
Rice – berseem + oat + mustard (fodder) –maize+cowpea(fodder)	10YR/5/3 (brown)	10YR/4/3 (dark brown)	49.06	20.88	30.06
Maize – wheat – cowpea	10YR/6/3 (pale brown)	10YR/3/4 (dark brown)	49.06	20.96	29.98
Sorghum (fodder) – yellow sarson – black gram	10 YR/6/2 (light greyish brown)	10 YR/4/2 (dark greyish brown)	49.12	20.92	29.96
Guava + lemon	10YR/6/4 (yellowish brown)	10YR/4/4 (dark yellowish brown)	49.02	21.06	29.92
Poplar + turmeric	10 YR/6/6 (brownish yellow)	10 YR/4/2 (dark greyish brown)	49.02	20.94	30.04
Eucalyptus + turmeric	10 YR/7/4 (very pale brown)	10 YR/3/1 (very dark grey)	49.84	19.99	30.16
Fallow (uncultivated land)	10YR/7/3 (very pale brown)	10 YR/4/2 (dark greyish brown)	49.12	25.72	25.16

These observations are similar to the findings of Jabro *et al.,* (2008) [15].

3.4. Particle density

Particle density differed significantly under different land use systems and ranged from 2.55 to 2.74 g cm^{-3}. Lowest value of particle density was recorded under eucalyptus + turmeric system which was significantly lower than the value noted under all the land use systems. Particle density under rice–pea (vegetable)-maize, maize–wheat–cowpea and guava +lemon system was significantly lower than that under fallow (uncultivated) land use system (Table-2). Lowest particle density under agroforestry system (i.e. eucalyptus + turmeric) might be due to high organic carbon content. These results are similar to the findings of Kumar and Singh (2007) [16].

3.5. Porosity
Porosity of soil significantly differed under different land use systems and varied from 47.62 to 49.71 percent (Table-2).

Table 2: Bulk density, particle density, porosity and water holding capacity of soil under different land use systems.

Land use systems	Bulk density (g cm^{-3})	Particle density (g cm^{-3})	Porosity (%)	WHC (%)
Rice – wheat – green gram	1.33	2.62	49.27	58.68
Rice – pea (vegetable) –maize	1.36	2.68	49.34	55.97
Rice – potato – okra	1.31	2.61	49.71	59.67
Rice – berseem + oat + mustard (fodder) –maize+cowpea (fodder)	1.34	2.61	48.70	58.38
Maize – wheat – cowpea	1.36	2.68	49.24	54.73
Sorghum (fodder) – yellow sarson – black gram	1.34	2.65	49.31	56.16
Guava + lemon	1.37	2.69	49.04	52.31
Poplar + turmeric	1.30	2.58	49.64	60.02
Eucalyptus + turmeric	1.29	2.55	49.37	61.82
Fallow (uncultivated land)	1.43	2.74	47.62	41.56
SEm±	0.003	0.009	0.23	0.32
CD at 5%	0.01	0.03	0.66	0.92

Highest porosity was recorded under rice-potato-okra land use system. Porosity recorded under rice-potato –okra, poplar + turmeric, eucalyptus + turmeric, rice–pea(vegetable)-maize, sorghum (fodder)-yellow sarson-black gram, rice–wheat–green gram and maize–wheat–cowpea system was significantly higher than the porosity noted under guava + lemon, rice–berseem + oat + mustard (fodder)-maize + cowpea (fodder) and fallow (uncultivated) land use system. Porosity recorded under guava + lemon and rice–berseem + oat + mustard (fodder)-maize + cowpea (fodder) system was significantly higher than fallow (uncultivated) land use system. Higher porosity was observed under rice-potato-okra> poplar + turmeric > eucalyptus + turmeric land use systems. This might be due to high organic carbon content in the soil. Similar observations were also made by Kumar (2015) [17].

3.6. Water holding capacity
Water holding capacity significantly varied under different land use systems (Table-2). Water holding capacity varied from 41.56 to 61.82 percent. Highest water holding capacity was recorded under eucalyptus + turmeric system which was significantly higher than all other land use systems. Water holding capacity noted under poplar + turmeric and rice-potato –okra system was significantly higher than the WHC noted under rice–wheat–green gram, rice–berseem +oat + mustard (fodder)-maize + cowpea (fodder), sorghum(fodder)-yellow sarson-black gram, rice–pea (vegetable)-maize, maize–wheat–cowpea, guava +lemon and fallow (uncultivated) land use system. Water holding capacity noted under guava + lemon system was significantly higher than fallow (uncultivated) land use system.

Maximum water holding capacity noted under agroforestry based systems i.e. eucalyptus + turmeric followed by poplar + turmeric. It might be due to more organic carbon content and highest percentage of clay which enhanced the available water. These results are in conformity with those of Khongjee (2012) [18] and Kyndiah (2012) [19]. Lowest water holding capacity was noted under fallow followed by under guava + lemon system. Lowest soil moisture content in guava based land use system was also observed by Ekka *et al*. (2017) [20].

4. Conclusion
It is evident from the study that different land use systems have significant impact on soil physical properties. Soils physical condition under agroforestry based systems was found superior with respect to soil physical environment followed by field crop, horticulture crop and the uncultivated land. The study indicates that dense cover and high litter fall in agroforestry systems led to favourable physical properties of soil for crops. Present study may be helpful in evaluation of soil quality and thereby enhancing cropping system sustainability.

5. References

1. IFOAM. Soil Fertility. The Soil. A living organism Training manual of Organic Agriculture in the Tropics, 2002.
2. Goovaerts P. “Geostatistical tools for characterizing the spatial variability of microbiological and physico-chemical soil properties,” Biology Fertilizers and Soil. 1998; 27(4):315-334.
3. Amusan AA, Shitu AK, Makinde WO, Orewole O. Assessment of changes in selected soil properties under different land use in Obafemi Awolowo University Community, Ile-Ife, Nigeria, Electronic Journal of Environmental Agriculture, Food Chemistry. 2004; 5(1):1178-1184.
4. Puri GS. Indian Forest Ecology, 1. Oxford Book and Stationery Co., New Delhi, 1960.
5. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. Soil Science. 1927; 23:343-352.
6. Baver LD. Practical values from physical analyses of soils. Soil science. 1956; 68:1-14.
7. Piper CS. Soil and Plant Analysis, The University of Adelaide Press, Adelaide, Australia, 1950, 368.
8. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research Publication. 1985, 87-89.
9. Sarkar D, Gangopadhyay SK, Velayutham M. Soil toposequence relationship and classification in lower outlier of Chhotanagpur plateau. Agropedology. 2001; 11:29-36.
10. Yadda TA. Effects of fruit based land use systems on soil physicochemical properties: the case of smallholders farming systems in gamo gofa, southern Ethiopia. Thesis, M.Sc. Hawassa University, Awassa, Ethiopia. 2007, 49.
11. Kumar A, Natarajan VS, Sivasamy R. Characterization and classification of soils of lower Palar-Manimuthar

watershed of Tamil Nadu. Agropedology. 2002; 12:97-103.
12. Gupta RD, Arora S, Gupta GD, Sumberia NM. Soil physical variability in relation to soil erodibility under different land uses in foothills of Shiwalik in North West India. Tropical Ecology. 2010; 51(2):183-190.
13. Karamanos AJ, Bilalis D, Sidiras N. Effect of reduced tillage and fertilizer practices on soil characteristics, plant water status, and growth and yield of upland cotton. J. Agron. Crop Sci. 2004; 190:262-276.
14. Wakene Negassa, Heluf Gebrekidan. The Impact of Different Land use Systems on soil Quality of western Ethiopia Alfisols. A paper presented on an International Research on food Security, national resource Management and Rural Poverty Reduction through research for development and Transformation Trop Entage, 2003, 2004.
15. Jabro JD, Sainju UM, Stevens WB, Lenssen AW, Evans RG. Longterm tillage frequency effects on dryland soil physical and hydraulic properties. International Soil Conservation Organization Conference Proceedings, 15–23 May 2008. Budapest, Hungary, 2008.
16. Kumar S, Singh R. Erodibility studies under different land uses in northwest Himalayas. Journal of Agricultural Physics. 2007; 7:31-37.
17. Khongjee S. Runoff and nutrient losses under different land uses in Ga3a micro watershed of Giri river in Solan district of Himachal Pradesh. M.Sc. Thesis, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, 2012, 1-79.
18. Kumar D. Assessment of soil quality parameters under different land uses in barog-dhillon watershed in Solan district of Himachal Pradesh. Thesis, MSc. College of forestry, Solan, 2015, 47.
19. Kyndiah R. Impact of different land uses on runoff and nutrient losses in Ga3a micro watershed of Giri River in Solan district of Himachal Pradesh. M.Sc. Thesis, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solanpp, 2012, 1-79.
20. Ekka AA, Kumar Dileep Singh, Anand Prakash, Singh Awtar. Variation in physico-chemical properties of soil under different agri-horti system in Vindhyan region. Journal of Applied and Natural Science. 2017; 9(2):1187-1193.