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Effect of different Land-uses Systems on Soil pH, Electrical Conductivity and Micronutrients in Mollisols of Uttarakhand

Basta Ram[1*], Ajeet Pratap Singh[1], Vijay Kant Singh[2], Mamta Shivran[3] and Asha Serawat[4]
[1]Department of Soil Science,
G.B. Pant University of Agriculture and Technology, Pantnagar, (Uttarakhand), India.
[2]Depatment of Soil Science,
Punjab Agricultural University, Ludhiana, (Punjab), India.
[3]Department of Soil Science,
Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, (Madhya Pradesh), India.
[4]Department of Soil Science and Agricultural Chemistry,
Swami Keshwanand Rajasthan Agricultural University, Bikaner, (Rajasthan), India.

(Corresponding author: Basta Ram)*
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ABSTRACT: The variability and status of micronutrients are very important for crop production there for so a sound knowledge of micronutrients is more important. The rapid agricultural change has been reported in South Asian countries.Today change takes place in a single direction from natural ecosystem to artificial ecosystem. Therefore, this study was conducted for the effects of different land-use systems on soil properties,i.e. electrical conductivity (EC), pH, and micronutrients. The study area was located at Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, which lies at 29°N latitude, 79°3′E longitudes, and 243.84 m above the mean sea level altitude. The randomized complete block design, including different treatments with three replications for soil depth (0–20cm), was used in this experiment.The treatment were selected for study micronutrient content in soil that T_1 (rice – potato – okra), T_2 (rice – pea (vegetable) – maize), T_3 (sorghum multi-cut (fodder) – yellow Sarson – black gram), T_4 (rice–wheat – green gram), T_5 (rice – berseem + oat + mustard (fodder) – maize + cowpea (fodder)), T_6 (guava + lemon), S_7 (poplar + turmeric), T_8 (eucalyptus + turmeric), T_9 (fallow (uncultivated land)). The highest value of micronutrients content Zn(2.19mg kg^{-1}), Fe(33.37mg kg^{-1}) Cu(5.77mg kg^{-1})Mn (7.46mg kg^{-1}). Among the different treatmentT_9 fallow (uncultivated) treatment were obtained significantly lowest value of micronutrients content Zn (0.71mg kg^{-1}), Fe (13.45mg kg^{-1}) Cu (3.47mg kg^{-1}) Mn (5.74mg kg^{-1}). According to this finding soil under agro-forestry-based treatment was found better with respect to soil properties followed by crops and the fellow treatment.

India's population is increasing at an increasing rate, due to which the demand for food is also increasing. To meet this demand, we need huge production which we get using chemical fertilizers in crops. Chemical fertilizers were adversely are influenced on the soil health, production potential, water pollution, increase the environmental challenges, land degradation, increase problematic soil areas, and loss of soil biodiversity. These all are the challenges related to monocropping in a particular area. Resultant most fertile soil becomes unproductive, Therefore, the solution to this problems is that we should bring different land uses systems into practice, which will develop in the soil health and the quality of the soil. On the basis of result of the this experiment, we can say that more soil health was found in the crop with forestry base treatments, as well as it was found that with this type of system, we can also generate additional income like different products from different systems. which is sold in different markets It has been concluded from this experiment that the soil EC and micronutrients were observed more in the crop and forestry-based land uses systems because the forestry system increases the amount of organic carbon and organic matter resultant increase the soil micronutrients. The forestry system improves other properties of the soil such as physical, chemical, and biological properties, resultant in increasing the productivity and health of the soil.

Keywords: Micronutrient, lund uses, agroforestry organic matter

INTRODUCTION

The soil quality reduction due to improper land usage is a worldwide issue that has sparked interest in crop production techniques and processes. Land management techniques out of the ordinary can result in a loss of soil nutrients and soil health, hurting agricultural, food security (Perveen *et al*., 2010). The global issue of environmental degradation resulting from poor land use has generated interest in sustainable agriculture production strategies (Ayoubi *et al*., 2011). Soil productivity and long-term viability are dependent on a dynamic balance of Physico-chemical, and bio-chemical qualities (Somasundaram *et al*., 2013). Maintaining soil health is critical for long-term food yield, waste digestion, heat storage, carbon sequestration, and gas exchange. Since 1945, That is been observed that 38% of the global agricultural land has been eroded. nearby 24 billion tonnes of surface soil are lost each year. This equates to around 9.6 million hectares of soil. As a result, land deterioration or variability in the soil properties caused by erosion, salinization, OM and nutrient losses, or soil crust are a significant source of worry in every agricultural area in the world (Liu *et al*., 2006). Soil erosion has resulted from the rapid increase in population, resulting in dwindling cultivable land, reduction in soil nutrients, and loss of soil quality. Land wastage and soil health deterioration due to loss of plant canopy and grasses are the main repercussions of unsuitable land-use changes (Khormali *et al*., 2009). The shift of natural ecosystem and woodland system to agriculture, for example, results in a 30 percent loss of soil properties (Bot and Benites, 2005).

In general, a thorough knowledge of the effects of treatment and care of soil health is required that allows you to assess the viability of land-use systems land-uses have a constant impact on these features. As reported by Di *et al*. (2013), agricultural conservation approaches have a significant effect on soil health, this is inextricably tied to the long-term viability of agro-ecosystem functions and output. As a result, thriving agriculture necessitates the long-term utilization of soil resources, as quality and quantity can quickly deteriorate (Kiflu and Beyene, 2013).

Micronutrients play a crucial part in completing the life cycle of plants; they are used in small amounts to increase the healthy growth of plants and increase soil quality, increase crop production, and provide balanced nutrition to crops (Lal, 2009). Plants require micronutrients like Zn, Cu, Mn, and Fe to grow. Micronutrients serve an essential part in creating amino acid, genetic material, growth molecule, glucose and lipid degradation, tolerance, chlorophyll, secondary metabolites, and many other physiologically active compounds (Singh and Sharma 2004; Rengel 2007; Gao *et al*. 2008). As a result, soil micronutrients are even more important for healthy nutrition and development. Soil characteristics and the pedogenic process determine the micronutrients content in the soil. Micronutrient availability in soil is influenced by different substitutes like OM, soil pH, biochemical, and Physico-chemical variables in the atmosphere. In addition to soil characterization, land-use patterns contribute an essential role in contolling of the soil nutrient recycling and soil quality **(**Venkatesh *et al*., 2003). The long time cultivation a specific type of system of soils affects physical and chemical soil properties, change in the micronutrient content in soil to make available for plants their growth. Availability of micronutrients and distribution are influenced by different land use through changes in the soil reaction and OM (Doran and Gregorich, 2002). Hargrove *et al*. (1982) reported more Mn and zinc in the soil with no-tillage practice than the plough soil. Human activities, such as various inappropriate agricultural methods, are causing the land-use change in the studied region. Engaging in such activities on undulated terrain impacts current land management systems, exacerbating land-use changes. As a result, it impacts both agricultural productivity and atmospheric quality. Therefore, this study was conducted for the how different treatments affected soil physico-chemical parameters in Pantnagar, Uttarakhand Mollisols soil order. On the basis of the results of this experiment, it has been concluded that adopting agroforestry in future, instead of any one cropping system, which we will be able to conserve soil, soil productivity, and crop production will also increase.

MATERIALS AND METHODS

A. Physiographic description of the study area

The study was conducted at Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University, Pantnagar, and District U.S. Nagar in the tarai region of Uttarakhand (Puri, 1960). Soil samples were collected from the 0-20 cm soil depth.

B. Treatment details

Nive land-use system has been taken as a treatment with three replication. The land-use systems selected for study were T_1 (rice–potato–okra), T_2 (rice–pea (vegetable)–maize), T_3 (sorghum multi-cut (fodder)–yellow sarson–black gram), T_4 (rice-wheat–green gram), T_5 (rice–berseem + oat + mustard (fodder)–maize + cowpea (fodder)), T_6 (guava + lemon), S_7 (poplar + turmeric), T_8 (eucalyptus + turmeric), T_9 (fallow (uncultivated land).

C. pH and Electrical conductivity (EC)

Soil sample pH was determined with soil water suspension (1:2) after half-hour later take pH reading by pH meter (Jackson, 1967). The electrical conductivity of the soil sample was measured by supernatant of soil in water suspension (1:2) by using a digital conductivity meter. The value of EC was expressed as dSm^{-1} at 25-30°C (Bover and Wilcox, 1965).

D. Determination of Available, Mn, Cu, Zn, and Fe

Available zinc, Copper, Meganese, and iron were estimated by Lindsay and Norvell (1978) method. By using Diethylenetriamine pentaacetate with atomic absorption spectrophotometer. 10 grams of air-dried soil was weighed and then 20 mL of 0.005 *M* (pH 7.3) DTPA extracting solution was added. Then sample keep on a shaker for 2 hours and zinc, copper, maganese, and iron were analyzed in in filtrated by AAS.

$$\text{DTPA extractable micro-nutrient content (mg kg}^{-1}\text{ soil)} = \frac{\text{Filtrateconc. (ppm)} \times 20}{10}$$

Where, 20 = amount of DTPA extracting solution (ml), 10 = weight of soil (g).

E. Statistical analysis

The complete randomized block design (CRBD) use for the data analysis in this experiment. In this experiment, the data is analyzed by the Analysis of Variance technique (Panse and Suchatme, 1978). The difference in between treatments was measured by applying "F" test of significance at 5 per cent level of significance (0.05 LSD).

RESULT AND DISCUSSION

A. Soil pH

The data of soil pH is tabulated in Table 1. The data indicate to the soil pH significantly varied under different treatments. Soil pH varied from 7.44 to 7.29 under different treatments. The lowest soil pH was recorded under T_8(7.29) treatment which was significantly lower than that under T_1 (7.36), T_2 (7.42), T_3 (7.41), T_4 (7.40), T_5 (7.37), T_6 (7.43), T_7 (7.35) and T_9(7.44) treatment. The highest value of soil pH was recorded with T_9 (7.44) treatment which was higher taen T_1 (7.36), T_2 (7.42), T_3 (7.41), T_4 (7.40), T_5 (7.37), T_6 (7.43), T_7 (7.35) and T_9(7.29) treatment.

The lowest soil pH was observed under the agro-forestry-based treatment *i.e.* Poplar + turmeric which was less than T_8 treatment due to high OM content and break down of OM due to this released organic acids in soil increase, which lowered the soil pH in agroforestry treatment. The same finding was also recorded by Kumar (2015). The reaction a of soil shows of availability of the soil nutrients and leaching requirment of the soil. Fertility characters are determined by pH (Landon, 1991). The change in the coefficient of soil pH is significantly less in the different treatments because pH is mainly governed by parent material, native vegetation, and the climate of a particular place where the soil was formed. A similar result was obtained by Cox *et al*. (2003); Shukla *et al*. (2004). Lower soil pH was observed by Negasa (2020) in the cultivated soil than agroforestry soils.

B. Electrical conductivity (EC)

The data of electrical conductivity for different treatments are given in table 1. The EC of soil significantly differed under different treatments. Among different treatments, EC was varied from 0.249 to 0.326 dSm^{-1} at 0-20cm depth. The lowest value of EC was reported under T_9 (Fallow uncultivated) treatment which was significantly lower than other treatments. The value of EC was recorded higher for T_8(0.326dSm^{-1}) treatment which was significantly higher than T_1 (0.314dSm^{-1}), T_2 (0.269dSm^{-1}), T_3 (0.276dSm^{-1}), T_4 (0.289dSm^{-1}), T_5 (0.300dSm^{-1}), T_6 (0.260dSm^{-1}), T_7 (0.306dSm^{-1}), and T_9 (0.249dSm^{-1}); respectively. The electrical conductivity was obtained lowest under T_9 (0.249dSm^{-1}) treatment, significantly lower than other treatments.

Table 1: Soil pH and electrical conductivity under different land-use systems at 0–20 cm depth.

Treatments	pH	Electrical conductivity (dsm^{-1})
T_1 (Rice – potato – okra)	7.36	0.314
T_2 (Rice – pea vegetable – maize)	7.42	0.269
T_3 (Sorghum multi-cut fodder– yellow Sarson–black gram)	7.41	0.276
T_4 (Rice –wheat–green gram)	7.40	0.289
T_5 (Rice–berseem + oat + mustard – maize+cowpea fodder)	7.37	0.300
T_6 (Guava + lemon)	7.43	0.260
T_7 (Poplar + turmeric)	7.35	0.306
T_8 (Eucalyptus + turmeric)	7.29	0.326
T_9 (Fallow uncultivated land)	7.44	0.249
SEm±	0.010	0.002
CD at 5%	0.031	0.005

The higher value of EC under agroforestry *i.e*. T_8 is followed by T_7 due to high OM and organic carbon content in soil (Larson and Pierce, 1991; Nayak *et al*., 2012). The lower soil EC was observed by Negasa (2020) in plough land soils than agroforestry.

C. Available zinc, Copper, iron, and manganese

The data on available zinc, iron, Manganese, and copper content for different land-use systems is illustrated in Table 2, which was significantly differed under different treatments. Available zinc, copper, iron, manganese and copper ranged from 0.71 to 2.19 mg kg^{-1}, 3.47 to 5.77 mg kg^{-1}, 13.45 to 33.47 mg kg^{-1} and 5.74 to 7.46 mg kg^{-1} at 0-20cm depth, respectively. The maximum value of available zinc, copper, iron, and manganese were recorded under T_8 (2.19, 5.77, 33.37, and 7.46 mg kg^{-1}) treatment that was significantly more than the available zinc obtained under all other treatments. T_9 (0.71, 3.47, 13.45 and 5.74 mg kg^{-1}) treatment was obtained significantly the lowest value of available zinc, copper, iron, and manganese than all other treatments. Available zinc, copper, iron and manganese in soil under T_8 treatment was significantly higher than under than T_1 (1.56, 4.79, 26.26, 7.09 mg kg^{-1}), T_2 (0.78, 4.11, 18.20, 6.33 mg kg^{-1}), T_3 (0.84, 4.29, 20.20, 6.43 mg kg^{-1}), T_4 (0.96, 4.54, 21.30, 6.58 mg kg^{-1}), T_5 (1.21, 4.64, 23.27, 6.83 mg kg^{-1}), T_6 (0.75, 3.92, 15.15, 6.28 mg kg^{-1}), T_7 (2.09, 5.28, 30.42, 7.13 mg kg^{-1}), and T_9 (0.71, 3.47, 13.45 and 5.74mg kg^{-1})

treatment, respectively. Available zinc, copper, iron, and manganese content obtained higher under agro-forestry-based treatments compared to agricultural treatment.

This was due to low pH, high cation exchange capacity of the soil, higher organic carbon content. Same observation were also recorded by Singh *et al.* (2006; Singh *et al.,* (2013). Fe availability was higher under the agro-forestry-based system this was due to higher soil OM content in these treatments. The same findings was also obtained by Sarkar *et al*. (2001). Sharma *et al.* (2013) that manganese was positively and significantly increased with the OM content in the soil. That factor is responsible for high maganese content in the eucalyptus + turmeric and poplar + turmeric treatments. Concerning different land-use systems, soils under forest and enset land-use systems had higher levels of iron, manganese, copper, and zinc compared to others. The maximum iron, manganese, zinc, and copper value were in the T_7 eucalyptus + turmeric land-use soils, followed by the popular + turmeric land-use system.

Table 2: Micronutrients content in soil under different land-use systems at 0–20 cm depth.

Treatments	Available Zn (mg kg^{-1})	Available Cu (mg kg^{-1})	Available Fe (mg kg^{-1})	Available Mn (mg kg^{-1})
T_1 (Rice – potato – okra)	1.56	4.79	26.26	7.09
T_2 (Rice – pea – maize)	0.78	4.11	18.20	6.33
T_3 (Sorghum multi-cut fodder– yellow Sarson – black gram)	0.84	4.29	20.20	6.43
T_4 (Rice – wheat – green gram)	0.96	4.54	21.30	6.58
T_5 (Rice– berseem + oat + mustard – maize+cowpea)	1.21	4.64	23.27	6.83
T_6 (Guava + lemon)	0.75	3.92	15.15	6.28
T_7 (Poplar + turmeric)	2.09	5.28	30.42	6.28
T_8 (Eucalyptus + turmeric)	2.19	5.77	33.37	7.46
T_9 (Fallow uncultivated land)	0.71	3.47	13.45	5.74
SEm±	0.024	0.07	0.32	0.069
CD at 5%	0.071	0.22	0.99	0.210

CONCLUSION

Different land-use can influence the properties of soil and the essential nutrient dynamics in the soils. The finding of that experiment was concluded that the significant effect of different treatments on the soil properties seen due to different land-use types in the experiment. Electrical conductivity, soil reaction, zinc, iron, copper, and manganese in soil were varied significantly under different treatments. The highest electrical conductivity, pH, zinc, iron, copper, and manganese were reported under the T_8 (eucalyptus + turmeric) land-use system while the lowest was obtained under T_9 (fallow uncultivated) treatment. The based on of these results, it can be concluded that among different treatments superior electrical conductivity, pH, zinc, iron, copper, and manganese soil were found under agroforestry-based treatment T_8 and T_7 treatments). So, soil researchers should have been promoted the agroforestry land-use system in combination with agricultural systems.

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Conflict of Interest. None.

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