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Research Article

ASSESSMENT OF NUTRIENT DISTRIBUTION AS AFFECTED BY LAND USE PATTERN IN ALLAHABAD REGION

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ABSTRACT

An investigation was carried out in the year 2014/2015 to assess the effects of land utilization pattern on nutrient distribution in some soils of Allahabad region of India. Soil samples were collected from three land use patterns that is Agricultural Land, Orchard and Forest land. The data obtained were statistically analyzed for variability using analysis of variance (ANOVA). The results obtained indicated that soil pH does not significantly varied with land use pattern however, Electrical conductivity, soil organic carbon, available nitrogen, available phosphorous, available potassium and available sulphur significantly affected by land use pattern. The mean soil pH ranged from 7.02 to 8.08. Although numerical values showed variability, soil pH was not significantly affected by land use. Forest soil exhibits high EC than the other land use type. Mean Soil OC content was highest (0.92%) under the Orchard land, (0.91%) under the forest and lowest (0.57%) on the cultivated land. The average values of available N were highest (312.27 kg ha^{-1}) on the forest land and lowest (214.83 kg ha^{-1}) under the cultivated land. The content of available P in the forest land appeared to be significantly higher than the rest two land use types. Accordingly, the highest (16.41 P_2O_5 kg ha^{-1}) and the lowest (13.42 P_2O_5 kg ha^{-1}) available P contents were observed under the forest and the cultivated lands, respectively. Available Potassium was also highest (247.0 K_2O kg ha^{-1}) in the forest land and lowest (130.2 K_2O kg ha^{-1}) in the cultivated land. Highest available Sulphur (14.02 Mg kg^{-1}) was observed under forest land. Generally, the higher concentration of nutrients in Forest land and Orchard is associated with high organic matter content owing to litter deposition and decomposition. From the study, it is thus apparent that intensive cultivation has a clear impact on nutrient distribution and availability.

Keywords: *Intensive Cultivation, Forest Land, Nutrient Distribution, Orchard*

INTRODUCTION

Successful agriculture requires the sustainable use of soil resource, because soils can easily lose their quality and quantity within a short period of time for many reasons. Agricultural practice therefore requires basic knowledge of sustainable use of the land (Kiflu and Beyene, 2013). Changes in land use and management practices often modify most soil morphological, physical, chemical and biological properties to the extent reflected in agricultural productivity (Gebrekidan and Wakene, 2006). Assessing land use-induced changes in soil properties is essential for addressing the issue of agro-ecosystem transformation and sustainable land productivity (Yao *et al.*, 2010).

Changes in the land use scenario and greediness of getting high return through intensive cultivation by the resource-rich farmers have resulted in changes in soil quality and leading to declined soil fertility (Singh, and Singh, 2005). Bernoux *et al.*, (1998) indicated that long practices of deforestation and/or replacement of natural forests by agro-ecosystem and uncontrolled overgrazing have been the major causes for soil erosion and climatic change. On the other hand, feeding the ever-increasing human population is most challenging in developing countries because of soil degradation. For instance, in India and Sub-Saharan African countries, soil fertility depletion is the fundamental biophysical cause for declining per capita food production (Sanchez *et al.*, 2003; Katyal, 2012).

Croplands expanded by 50% during the 20th century, from roughly 1200 million ha in 1900 to 1800 million ha in 1990. There are several interacting drivers for land cover change but the exponential growth in human population is important. Currently, 95% of the population growth takes place in tropical regions and soil fertility in tropical regions is affected by rapid land use changes. The effects of deforestation and grass-land conversions as well as agricultural intensification have been fairly well-documented but the spatial and temporal effects of soil fertility change and its interaction with land use change remains to be investigated (Hartemink, 2010). The area of cropland has increased from an estimated 300-400 million ha in 1700, to 1500-1800 million ha in 1990. The area under pasture increased from 500 million ha in 1700 to 3100 million ha in 1990. These increases led to the clearing of forests and the transformation of natural grasslands, steppes, and savannas. Forest area decreased from 5000-6200 million ha in 1700 to 4300-5300 million ha in 1990. The area under steppes, savannas and grasslands declined from around 3200 million ha in 1700 to 1800-2700 million ha in 1990 (Lambin *et al.,* 2003). Lepers *et al.,* (2005) synthesised information on rapid land-cover change for the period 1981-2000 as part of the Millennium Ecosystem Assessment. They produced a series of global maps (10 by 10 km grid) that show how land cover has changed in the past decades.

The majority of land use changes are related to agricultural use of the land, including pastures. Agricultural activities change the soil chemical, physical or biological properties. Such activities include cultivation mechanized, by hand, tillage, weeding, terracing, subsoiling, deep ploughing, manure, compost and fertilizer applications, liming, draining, irrigation and empoldering (Bridges and de Bakker 1997). Land use changes influence the fertility of the soil. Land use changes mostly focused on deforestation, cropland expansion, dry land degradation, urbanization, pasture expansion and agricultural intensification. This study was initiated to assess the affect land use on nutrient distribution in Allahabad region.

MATERIALS AND METHODS

District Allahabad is situated in the South-Eastern part of the State Uttar Pradesh. It lies between the parallels of 24° 77' and 25° 47' north latitudes and 81° 19' and 82° 21' east longitudes. Allahabad district has such tropical climate that the average maximum temperature ranges between 43°C- 45°C which may go as high as 46°C during peak summers. The minimum average temperature is 8-9°C which may fall as low as 4°C during peak winter months (Dec. Jan.) The average rainfall of the district is 960 mm and the monsoon season is spread between July-September. Topographically, the district of Allahabad belongs to the central plane zone of Uttar Pradesh. The district Allahabad may be divided in four different agro-ecological situations AES *i.e.*:

(i) Black and Coarse-grey land
(ii) Yamuna khaddar and Alluvial
(iii) Ganga Low land and Sodic
(iv) Ganga plain.

Soil Sampling and Analysis

Soil samples were collected from three different locations (Chaka, Jasra and Handia) under the following land use types: orchard/agroforestry land, forest land, and cultivated land. From each location, nine composite soil samples were obtained from three sampling sites of land use pattern at the depth of 0-20cm, 20-40cm and 40-60cm. Totally, twenty seven soil samples from three locations were collected, air dried and sieved through 2mm sieve.

Soil Colour was determined using Munsell Colour Chart (Munsell, 1971), Bulk Density (Mg m^{-3}), Particle Density (Mg m^{-3}) and Pore Space % were determined using Graduated Measuring Cylinder (Black, 1965).

Organic Carbon % was determined using Wet oxidation method (Walkley and Black, 1947) EC and pH were determined using glass electrode in a 1:2.5 soil/water suspension (Jackson, 1973). Available N was determined following procedure by Subbiah and Asija (1956). Available P was be determined by Sodium bicarbonate extraction Method Olsen *et al.,* (1954).

Available K was determined following Toth and Prince (1949) procedure, while available S was assessed turbid metrically following method of Chesnin and Yien (1950). Measured data were further analyzed using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The soil Colour show varied. The forest soils of Chaka and Jasra appeared light brown, strong brown dark brown to reddish yellow. While that from Handia appeared pinkish white to light gray. However, less variation was observed in agricultural and orchard land the variation in Colour may be due to different in organic matter content. Soil containing high organic matter shows the Colour variation from black to dark brown (Das, 2013). Bulk density value was significantly ($P > 0.05$) affected by land use. Numerically, the highest mean (1.29 Mg m^{-3}) value of bulk density was recorded on the agricultural land and the lowest mean (1.11 Mg m^{-3}) value under the forest land.

The reason for the lowest soil bulk density on the forest land as well as in the subsurface soil depth could be due to the highest organic matter content and less disturbance of the land under forest unlike other land uses and the surface layer (Saha Arun Kumar and Saha Anuradha, 2012).

The highest (2.81 Mg m^{-3}) mean value of particle density was obtained under the orchard land. The particle density under the different land uses increased with increasing soil depth, (Saha Arun Kumar and Saha Anuradha, 2012) reported that particle density of surface soil is generally lower than that of sub surface soils.

Considering the surface and the subsoil depths, the highest particle density values were recorded in the orchard land and the agricultural land. The highest mean value of pore space percentages (67.53%) was obtained in the forest land, decreased from the surface soils to the subsurface soils. Forest soils and surface profile has higher value of pore space % this may be due to higher organic matter content, more aggregation and more root penetration (Saha and Saha, 2012).

The mean soil pH ranged from 7.02 to 8.08 this indicate low variation. Although numerical values showed variability, soil pH was not significantly affected by land use. Similar result obtained by (Saiborne *et al.,* 2012). The soil EC showed significant variation with land use. Forest soil exhibits high EC than the other land use type. This may be as a result of high sodium content and low leaching of forest soil. The high EC value at Handia forest land (4.48 dS m^{-1}) indicated strong salinity as par ratings by (Jaiswal, 2011).

Organic Carbon content was significantly affected by land use. Mean Soil OC content was highest (0.92%) under the 0rchard land and lowest (0.57%) on the cultivated land. The OC contents varied greatly with land use and soil depth. However, the higher values of OC in orchard and forest land as well as surface soil are probably because of more rapid recovery of the natural vegetation, less erosion and slower oxidation of organic material (Mandal and Jayaprakash, 2012). Available N content of soils was significantly ($P \leq 0.05$) affected by land use, and soil depth average values of available N was highest (312.27 kg ha^{-1}) on the forest land and lowest (214.83 kg ha^{-1}) under the cultivated land). The mean N content decreased considerably from 275.2 kg ha^{-1} in the surface (0-20 cm) to 236.5 kg ha^{-1} in the subsurface (40-60 cm) soil layers which reveals a reduction compared to its amount in the surface layer. Similar result obtained by (Saiborne *et al.,* 2012).

The available phosphorus (P_2O_5 kg ha^{-1}) was significantly ($P \leq 0.05$) affected by land use. The content of available P in the forest land appeared to be significantly higher than the rest two land use types. Accordingly, the highest (16.41 P_2O_5 kg ha^{-1}) and the lowest (13.42 P_2O_5 kg ha^{-1}) available P contents were observed under the forest and the cultivated lands, respectively. The data also revealed that available P was higher (15.59 P_2O_5 kg ha^{-1}) in the topsoil (0-20 cm) than in the subsurface layer. This result is in agreement with result obtained by (Mandal and Jayaprakash, 2012). Available K content was significantly ($P \leq 0.05$) affected by land use. It was highest (247.0 K_2O kg ha^{-1}) in the forest land and lowest (130.2 K_2O kg ha^{-1}) in the cultivated land.

The highest content in the forest land was related with its high pH value and was in agreement with study results that high K was recorded under high pH tropical soils (Saiborne *et al.,* 2012) reported similar result. The available Sulphur was significantly varied with land use. Highest available Sulphur (14.02 Mg kg^{-1}) was observed under forest land. Effect of soil depth on available sulphur content was also pronounced. Available sulphur generally decline with depth across all land uses which may be associated with decreasing trend of organic matter down soil profile.

Table 1: Soil Physical Properties at Various Locations under Different Land Use and Soil Depth

Block	Land use	Depth (cm)	Bulk density (Mg m^{-3})	Particle density (Mg m^{-3})	Pore space (%)
Chaka	**AGR**	**0 -20**	1.12	2.60	55.60
		20-40	1.33	2.80	55.10
		40-60	1.41	2.86	53.50
		Mean	**1.29**	2.75	54.73
	ORCH	**0 -20**	1.18	2.76	60.10
		20-40	1.25	2.82	58.80
		40-60	1.33	2.85	57.90
		Mean	1.25	**2.81**	58.93
	FOR	**0 -20**	1.05	2.60	69.10
		20-40	1.18	2.62	68.80
		40-60	1.33	2.66	64.70
		Mean	1.19	2.63	**67.53**
Jasra	**AGR**	**0 -20**	1.11	2.55	58.00
		20-40	1.18	2.62	55.50
		40-60	1.25	2.68	54.50
		Mean	**1.18**	2.61	56.00
	ORCH	**0 -20**	1.05	2.50	68.50
		20-40	1.11	2.81	67.40
		40-60	1.11	2.86	63.60
		Mean	1.09	**2.72**	66.50
	FOR	**0 -20**	1.05	2.51	67.80
		20-40	1.11	2.55	67.54
		40-60	1.18	2.62	65.32
		Mean	1.11	2.56	**66.89**
Handia	**AGR**	**0 -20**	1.15	2.54	59.51
		20-40	1.18	2.81	57.32
		40-60	1.25	2.84	52.90
		Mean	**1.19**	**2.73**	56.58
	ORCH	**0 -20**	1.11	2.67	64.50
		20-40	1.18	2.73	63.82
		40-60	1.25	2.84	63.00
		Mean	1.18	**2.73**	63.77
	FOR	**0 -20**	1.11	2.58	67.32
		20-40	1.11	2.65	66.45
		40-60	1.30	2.68	64.21
		Mean	1.17	2.64	**65.99**

AGR = Land under Agriculture, ORCH = Orchard Land and FOR = Forest Land

Table 2: Nutrients Distribution at Various Locations under Different Land Use

Block	Land Use	Depth (cm)	pH	EC (dS m^{-1})	OC %	Available N (kg ha^{-1})	Available P (P_2O_5 kg ha^{-1})	Available K (K_2O kg ha^{-1})	Available S (Mg kg^{-1})
Chaka	**AGR**	**0 -20**	7.32	0.18	0.77	267.0	14.94	134.7	11.52
		20-40	7.01	0.25	0.32	198.1	10.98	121.3	10.65
		40-60	7.14	0.18	0.62	191.8	14.91	134.7	10.21
		Mean	7.16	**0.20**	0.57	218.97	13.61	130.2	10.79
	ORCH	**0 -20**	7.21	0.09	0.77	273.5	16.60	215.7	13.48
		20-40	6.86	0.13	0.74	264.1	15.88	148.2	12.25
		40-60	7.70	0.10	0.54	245.0	15.16	202.1	12.21
		Mean	**7.26**	0.11	0.68	260.87	15.88	188.7	12.65
	FOR	**0 -20**	6.68	0.17	0.92	308.1	17.90	417.7	14.99
		20-40	7.21	0.17	0.99	289.2	16.14	282.7	14.65
		40-60	7.54	0.19	0.57	276.6	14.88	350.3	12.41
		Mean	7.14	0.18	**0.83**	**291.30**	**16.31**	**350.6**	**14.02**
Jasra	**AGR**	**0 -20**	7.81	0.50	0.84	223.2	14.08	134.6	12.40
		20-40	6.65	0.38	0.77	210.6	13.20	161.7	11.33
		40-60	6.63	0.44	0.47	185.5	12.99	121.3	10.50
		Mean	7.03	**0.**44	0.69	206.43	13.42	139.2	11.41
	ORCH	**0 -20**	6.70	0.23	0.89	235.8	14.64	161.8	14.11
		20-40	8.10	0.40	0.60	213.8	13.82	134.7	13.61
		40-60	6.26	0.36	0.47	194.9	12.99	121.5	11.34
		Mean	7.02	0.33	0.65	214.83	13.82	139.3	13.02
	FOR	**0 -20**	8.51	0.15	1.07	317.5	15.55	188.6	14.86
		20-40	6.24	0.35	0.62	295.5	14.14	215.7	13.73
		40-60	6.59	0.30	0.47	276.6	13.52	202.1	12.55
		Mean	**7.11**	0.27	**0.72**	**296.53**	**14.40**	**202.1**	**13.71**
Handia	**AGR**	**0 -20**	7.68	0.71	0.78	270.4	14.88	296.4	11.82
		20-40	8.22	0.45	0.68	226.3	12.99	269.5	11.11
		40-60	8.35	0.45	0.49	216.9	12.90	283.7	10.33
		Mean	8.08	0.54	0.65	237.87	13.59	**283.2**	11.09
	ORCH	**0 -20**	6.30	0.45	0.99	254.6	15.31	202.1	12.19
		20-40	7.58	0.42	0.93	248.4	14.49	188.6	11.98
		40-60	7.55	0.32	0.84	248.4	13.31	188.6	10.54
		Mean	7.14	0.40	**0.92**	250.47	14.37	193.1	11.57
	FOR	**0 -20**	8.80	6.64	1.05	326.9	16.40	309.9	14.23
		20-40	7.21	3.38	0.92	317.5	17.58	269.5	14.19
		40-60	9.30	3.33	0.77	292.4	15.26	161.7	10.69
		Mean	**8.44**	**4.48**	0.91	**312.27**	**16.41**	247.0	**13.04**

AGR = Land under Agriculture, ORCH = Orchard Land and FOR = Forest Land

Conclusion

The study indicated that soil nutrients were significantly affected by land use pattern with forest land having highest nutrient content. Allahabad district was characterized by high population density; forest area is being reduced by pushing the frontier of agriculture. On the other side good agricultural land is being usurped by urban sprawls, industrial establishments and expansion of human settlements and infrastructural facilities. Therefore, strategies to feed the expanding population in the study areas will have to seek a sustainable solution that better addresses integrated soil management. There is also the need to devise the means of increasing crop yield per unit area through soil fertility maintenance rather than bringing more land under cultivation. Generally, governmental and non-governmental rural development programs and strategies should be flexible in responding to the various agro-ecological zones, local resource endowment and farmers' capacity to invest in affordable integrated soil fertility management techniques.

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