Depth Wise Studies of Physico-Chemical Properties of Soil Under Different Land Use System at Eastern U.P.

Abstract

The Present Study was undertaken to assess Depth Wise Studies of Physico-Chemical Properties of Soil under Different Land Use System of main campus of university at Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during 2018-2019.

Soil samples were collected under RWCS (Rice-Wheat cropping system), LBCS (Legume based cropping system), and VBCS (Vegetable based cropping System).The land use systems selected for study were Crop land RWCS (Rice-Wheat cropping system), LBCS (Legume based cropping system), and VBCS (Vegetable based cropping System), Plantation land (Mango, Aonla and Bael orchard), Forest land (Shisham, Teak and Eucalyptus) and barren land (NSP-6 farm). Soil samples were taken with GPS system from four depth viz. 0-15cm, 15-30cm, 30-45cm and 45-60cm and analyzed for their physico-chemical properties (soil pH, EC, OC, BD, Available N, P&K). Results revealed that different soil properties varied significantly under different land use system at various soil depths.

Keyword: Land Use System, Soil health, GPS system, Physico-chemical properties of soil, Barren land, cropping system etc.

Introduction

Soil, a part of land, is most important factor for crop production. It is a diversified and complicated system. It is a natural resource used to produce food, fodder, fuel, and fibre for humans and other animals. Due to the ongoing depletion of natural resources, maintaining or improving environmental sustainability and ecological balance has been a major concern in recent years. Soil is a valuable nonrenewable natural resource. It must be kept productive and healthy because it is responsible for a large portion of agricultural yield. **(Mandal*et al*., 2018).**

Soil quality or health is a dynamic interaction of numerous physiochemical and biological variables that are influenced by a variety of factors including land use systems, land management practices, environmental conditions, and socioeconomic properties. **(Ghimire*et al*.,**

2018). Different land uses highly influenced the soil physiochemical properties and also affect the nutrients dynamics and their supply **(Murty*et al.*, 2002; Jiang *et al.*, 2002).** Land use system is defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce change or improve it**(Koellner*et al*., 2013).**Cropping system can influence a range of soil properties depending on the specific crop rotations, nutrients amendments and tillage practices done**(Jokela*et al*., 2011).**Crop rotation with grain legumes have been recognized as an important practice for improving soil fertility for a long term because of their N_2 fixation ability **(Van Kessel, C., & Hartley, C. 2000).**Distribution and availability of phosphorus (P) and other macro-nutrients to a certain extent are also influenced directly by different land–uses, biomass production and level of SOM which is again indirectly affected by land-uses **(Genxu*et al*., 2004).**

Legume-based cropping systems improve soil structure, increase phosphate availability through the secretion of enzymes and acids in the rhizosphere of legumes, and boost VAM colonisation**(Chamkhi*et al*., 2022).**

Soil biological activity assessment is also necessary to ensure the long-term viability of soil ecology. Soil health maintenance and improvement in continuous land use systems are critical to sustaining agricultural output in the future, which not only benefits the farming community by providing guaranteed income but also protects the land from degradation. A greater understanding of the impact of land use systems on soil chemical, physical, and biological properties is required for evaluating soil quality and, as a result, improving cropping system sustainability **(Aparicio and Costa., 2007)**. Therefore, the present study was aimed to assess some selected soil physico-chemical properties and nutrient status in order to evaluate the quality of soil under the effect of different agricultural land uses at ANDUAT, Kumarganj, Ayodhya as eastern part of Uttar Pradesh which might also be able to add value to the documentation of the soil fertility status of the study area and provide future line of work.

Materials and Methods:

Sampling sites:

Geographically, experimental site or sampling site is located at $26^{0}47'$ N latitude and $81^{0}12'$ E longitude and altitude of about 113 meters above from mean sea level in Indo-gangetic regions of Uttar Pradesh. Four land use system were identified for study at main campus of ANDUAT, Kumarganj, Ayodhya (U.P.) which are crop land, plantation land, forest land and barren land. Cropland system is characterized by addition of chemical fertilizer and FYM (farm yard manure). Soil samples were collected under RWCS (Rice-Wheat cropping system), LBCS (Legume based cropping system), and VBCS (Vegetable based cropping System). Plantation land system is characterized by addition of FYM and regular addition of organic matter in the form of falling leaves of Mango, Aonla and Bael orchard whereas Forest land use system is characterized by regular addition of organic matter in the form of falling leaves including those of tree species (Shisham, Eucalyptus and Teak) at forestry farm. On the other hand, Barren land is characterized by some grasses and no tree stands at NSP-6 farm.The details of Land use system is given below:

List 1 :The details of Land use system

S. No.	Land Use System	Location
	Crop Cultivated Land	Agronomy Farm, ANDUAT
1	Rice-Wheat Cropping System	GPB Farm, ANDUAT
2	Legume based cropping system	Vegetable Farm, ANDUAT
3	Vegetable based cropping system	
	Plantation Land	
4	Mango orchard	Horticulture Farm, ANDUAT
5	Aonla orchard	Horticulture Farm, ANDUAT
6	Bael orchard	Horticulture Farm, ANDUAT
	Forest Land	
7	Shisham	Forestry Farm, ANDUAT
8	Eucalyptus	Forestry Farm, ANDUAT
9	Teak	Forestry Farm, ANDUAT
10	**Barren Land**	NSP-6 farm, ANDUAT

Soil sampling and analysis

Three spots were selected from selected sites randomly under each land use system. Soil samples were taken with the help of auger from 0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm depths respectively in each land use system. In all 120 samples, 36 from crop land use, 36 from plantation land use, 36 from forest land use and 12 from barren land use system respectively were taken with GPS system.

Results and Discussion

Effect of different land use systems on Physico-chemical properties of soil at various soil depths:

Soil system was characterized by studying different physico-chemical properties such as pH, EC, organic carbon, bulk density, available N P and K of different land use at different soil depths.

Soil pH:

The data regarding the effect of different land use at various soil depths on pH has been given in table 01. The perusal of the table indicates that the pH has been considerably affected by different land use at various soil depths.

Soil pH varied from 7.94 to 9.72 under different land use system at various soil depths. At 0-15cm soil depth, the highest pH was recorded under NSP-6 farm (8.48) followed by eucalyptus forest land (8.37), shisham forest land (8.35) and RWCS (8.33) etc. and the lowest pH was observed in mango orchard (7.94). The pH ranged from 8.14 to 8.81 at 15-30cm soil depth, the minimum pH was observed in mango orchard (8.14) and maximum pH was observed under NSP-6 farm (8.81) followed by Shisham forest land (8.66), rice- wheat cropping system (8.56) and Eucalyptus forest land (8.51). At 30-45cm soil depth, highest pH value was observed under NSP-6 farm (9.21) followed by shisham forest land (8.84), eucalyptus forest land (8.76) and RWCS (8.62) etc. and the lowest pH recorded under mango plantation (8.39). The pH is significant with the soil depth under all land use system. At 45-60cm soil depth, the maximum pH was recorded under NSP-6 farm (9.72) followed by shisham forest land (9.14), eucalyptus forest land (9.11) and RWCS (8.83) etc. and minimum pH observed under bael orchard (8.65).

Electrical conductivity (d Sm^{-1}):

The data related to electrical conductivity of soil is presented in the table 02. The EC of soil relatively differed under different land use at various soil depths. Among all the land use system, EC ranged from 0.17 to 0.59 dSm^{-1}. At 0-15cm soil depth, the lowest EC was recorded in aonla orchard (0.17 dSm^{-1}) while the highest EC was recorded under NSP-6 farm (0.39dSm^{-1}) followed by VBCS (0.36 dSm^{-1}), shisham forest land (0.35 dSm^{-1}) and RWCS (0.33 dSm^{-1}) etc.

At 15-30cm depth of soil, the minimum EC was observed in aonla orchard (0.23dSm^{-1}) and the maximum EC was recorded in NSP-6 farm (0.45dSm^{-1}) followed by shisham forest land (0.37), RWCS (0.36) and LBCS (0.35) etc. At 30-45cm soil depth, the highest EC was recorded under barren land (NSP-6 farm, 0.51 dSm^{-1}) followed by shisham forest land (0.44), teak forest land (0.43) and RWCS (0.40) etc. whereas the lowest EC was recorded in aonla orchard (0.28dSm^{-1}). At 45-60cm depth of soil, the minimum EC was observed under mango orchard (0.33 dSm^{-1}) and maximum recorded in NSP-6 farm (0.59 dSm^{-1}) followed by teak forest land and RWCS (0.49), LBCS (0.48) and shisham forest land (0.47).

Soil Organic Carbon (g kg^{-1}):

The data regarding the effect of different land use at various depth of soil on soil organic carbon has been given in table 03. The perusal of the table indicates that the organic carbon has been drastically affected by different land use at various soil depths.

At 0-15cm soil depth, lowest OC was recorded in NSP-6 farm (3.2 g kg^{-1}) while the highest OC was recorded under teak forest land (4.8 g kg^{-1}) followed by shisham forest land (4.4 g kg^{-1}), mango orchard (4.3 g kg^{-1}) and LBCS (4.2 g kg^{-1}) etc. At 15-30cm soil depth, the minimum OC observed in NSP-6 farm (2.7 g kg^{-1}) and the maximum EC was recorded in teak forest land (4.5 g kg^{-1}) followed by shisham forest land (4.0 g kg^{-1}), mango orchard (3.8 g kg^{-1}) and bael orchard & eucalyptus forest land (3.7 g kg^{-1}) etc. At 30-45cm soil depth, the highest OC was recorded under teak forest land (3.8 g kg^{-1}) followed by shisham forest land (3.6 g kg^{-1}), LBCS & mango orchard (3.3 g kg^{-1}) etc. whereas the lowest OC was recorded in NSP-6 farm (1.9 g kg^{-1}). At 45-60cm depth of soil, the minimum OC was observed under NSP-6 farm (1.5 g kg^{-1}) and maximum recorded in teak forest land (3.5 g kg^{-1}) followed by shisham forest land (3.1 g kg^{-1}), mango orchard & eucalyptus forest land(2.8 g kg^{-1}) and bael orchard (4.2 g kg^{-1}) .

Table. 01 Effect of different land use systems on pH at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shishum	Eucalyptus	Teak	NSP-6 farm
0-15	8.33	8.22	8.28	7.94	8.2	8.05	8.35	8.37	8.23	8.48
15-30	8.56	8.38	8.47	8.14	8.38	8.21	8.66	8.51	8.24	8.81
30-45	8.62	8.57	8.57	8.39	8.49	8.48	8.84	8.76	8.49	9.21
45-60	8.83	8.79	8.77	8.61	8.74	8.65	9.14	9.11	8.76	9.72
MD	8.59	8.47	8.52	8.26	8.43	8.34	8.75	8.63	8.36	9.01
SD	0.20	0.24	0.20	0.29	0.22	0.26	0.33	0.33	0.25	0.53
CV	0.04	0.06	0.04	0.08	0.05	0.07	0.10	0.10	0.06	0.28

Table. 02 Effect of different land use system on EC (dSm^{-1}) at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eucalyptus	Teak	NSP-6 farm
0-15	0.33	0.28	0.36	0.24	0.17	0.23	0.35	0.31	0.29	0.39
15-30	0.36	0.35	0.31	0.25	0.23	0.25	0.36	0.35	0.32	0.45
30-45	0.42	0.41	0.39	0.31	0.28	0.32	0.44	0.41	0.43	0.51
45-60	0.49	0.48	0.46	0.33	0.34	0.38	0.47	0.46	0.49	0.59
MD	0.39	0.38	0.37	0.28	0.25	0.28	0.4	0.38	0.37	0.48
SD	0.073	0.085	0.062	0.044	0.072	0.068	0.055	0.066	0.092	0.084
CV	0.005467	0.007	0.003	0.001	0.005	0.004	0.003	0.004	0.008	0.007

Table. 03 Effect of different land use system on organic carbon (g kg^{-1}) at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eucalyptus	Teak	NSP-6 farm
0-15	4.1	4.2	3.9	4.3	3.9	4.1	4.4	4.1	4.8	3.2
15-30	3.4	3.6	3.5	3.8	3.6	3.7	4.0	3.7	4.5	2.7
30-45	3.1	3.3	3.1	3.3	3.1	2.6	3.6	3.1	3.8	1.9
45-60	2.4	2.5	2.2	2.8	2.6	2.7	3.1	2.8	3.5	1.5
MD	3.2	3.4	3.3	3.5	3.3	3.2	3.8	3.4	4.1	2.3
SD	0.7	0.7	0.7	0.6	0.5	0.7	0.5	0.5	0.6	0.7
CV	0.04	0.05	0.05	0.04	0.03	0.05	0.03	0.03	0.03	0.05

Bulk Density:

The data on bulk density of soil is given in table 04.The BD of soil were considerably differed under different land use with their soil depth and varied from 1.29 Mg m^{-3} to 1.49 Mg m^{-3}.

At 0-15cm soil depth, the highest BD was recorded under NSP-6 farm (1.39Mg m^{-3}) followed by Shisham forest land (1.38Mg m^{-3}), eucalyptus (1.37Mg m^{-3}) and teak forest land (1.36Mg m^{-3}) etc. and the lowest recorded under aonla orchard (1.29 Mg m^{-3}). At 15-30cm depth of soil, the minimum BD was observed in aonla orchard (1.32 Mg m^{-3}) whereas the maximum recorded in NSP-6 farm (1.42 Mg m^{-3}) followed by shisham forest land (1.41Mg m^{-3}), eucalyptus (1.40Mg m^{-3}) and mango orchard & teak forest land (1.38Mg m^{-3}) etc. At 30-45cm soil depth, the highest BD was recorded under NSP-6 farm (1.47Mg m^{-3}) followed by shisham forest land (1.44Mg m^{-3}), mango orchard (1.43Mg m^{-3}) and teak forest land & RWCS (1.42Mg m^{-3}) etc. and the lowest recorded under aonla orchard (1.35 Mg m^{-3}). At 45-60cm depth of soil, the minimum BD was observed in aonla orchard (1.38 Mg m^{-3}) whereas the maximum recorded in NSP-6 farm (1.49 Mg m^{-3}) followed by shisham forest land (1.47Mg m^{-3}), mango orchard &eucalyptus forest land (1.45Mg m^{-3}) and teak and RWCS (1.44Mg m^{-3}).

Available Nitrogen (kg ha^{-1})

The data regarding the effect of different land use at various depth of soil on available nitrogen have been given in table 05 and depicted in fig. 01. The perusal of the table indicates that the available N has been considerably affected by different land use at various soil depths.

At 0-15cm depth of soil, available N was recorded highest under shisham forest land (210 kg ha^{-1}) followed by teak forest land (208 kg ha^{-1}), eucalyptus forest land (206 kg ha^{-1}) and mango orchard (204 kg ha^{-1}) etc.and lowest under NSP-6 farm (169 kg ha^{-1}). At 15-30cm soil depth, maximum available N recorded in shisham forest land (204 kg ha^{-1})followed by teak forest land (201 kg ha^{-1}), eucalyptus forest land (199 kg ha^{-1}) and bael orchard (204 kg ha^{-1}) etc. and minimum recorded under NSP-6 farm (164 kg ha^{-1}). At 30-45cm soil depth, the highest available N recorded under shisham forest land (198 kg ha^{-1}) followed by teak forest land (194 kg ha^{-1}), LBCS & eucalyptus forest land (189 kg ha^{-1}) and bael orchard (188 kg ha^{-1}) etc. and the lowest recorded in NSP-6 farm (158 kg ha^{-1}). At 45-60cm soil depth, the minimum available N observed in NSP-6 farm (153 kg ha^{-1}) and the maximum recorded under shisham forest land (186 kg ha^{-1}) followed by teak forest land (183 kg ha^{-1}), eucalyptus forest land (181 kg ha^{-1}) and bael orchard (180 kg ha^{-1}).

Available Phosphorus (kg ha^{-1}):

The data on available phosphorus (kg ha^{-1}) of soil is given in table 06 and depicted in fig. 02. The available phosphorus of soil relatively differed under different land use at various depths and ranged from 16.47 to 21.35 kg ha^{-1}.

At 0-15cm depth of soil, available P was recorded highest under teak forest land (21.35 kg ha^{-1}) followed by shisham forest land (19.73 kg ha^{-1}), mango orchard (19.40 kg ha^{-1}) and LBCS (19.36 kg ha^{-1}) etc. and lowest recorded under NSP-6 farm (16.47 kg ha^{-1}). At 15-30cm soil depth, maximum available P recorded under teak forest land (20.88 kg ha^{-1}) followed by shisham forest land (19.45 kg ha^{-1}), mango orchard (19.05 kg ha^{-1}) and LBCS (19.04 kg ha^{-1}) etc. and minimum recorded under NSP-6 farm (16.06 kg ha$^{-1)}$. At 30-45cm soil depth, the highest available P recorded under teak forest land (19.94 kg ha^{-1}) followed by shisham forest land (18.62 kg ha^{-1}), aonla orchard (18.56 kg ha^{-1}) and LBCS (18.51 kg ha^{-1}) etc. and the lowest recorded in NSP-6 farm (15.61 kg ha^{-1}). At 45-60cm soil depth, the minimum available P observed in NSP-6 farm (15.16 kg ha^{-1}) and the maximum recorded under teak forest land (19.12 kg ha^{-1}) followed by shisham forest land (18.24 kg ha^{-1}), mango orchard (18.08 kg ha^{-1}) and aonla orchard (17.72 kg ha^{-1}).

Available Potassium (kg ha^{-1}):

The data regarding the effect of different land use at various depth of soil on available potassium have been given in table 07 and depicted in fig. 03. The inspection of the table indicates that the available K has been drastically affected by different land use at various soil depths.

At 0-15cm depth of soil, available K was recorded highest under shisham forest land (281 kg ha^{-1}) followed by teak forest land (280.67 kg ha^{-1}) and legume based cropping system (260.67 kg ha^{-1}) and eucalyptus forest land (257.67 kg ha^{-1}) etc. whereas lowest available K was found under NSP-6 farm (221 kg ha^{-1}). At 15-30cm soil depth, maximum available K was recorded in shisham forest land (275.67 kg ha^{-1}) followed by teak forest land (272 kg ha^{-1}), eucalyptus forest land (254.33 kg ha^{-1}) and legume based cropping system (254 kg ha^{-1}) etc. while minimum recorded under NSP-6 farm (218 kg ha$^{-1)}$. At 30-45cm soil depth, the minimum available K was recorded in barren land (212.67 kg ha^{-1}) and the maximum recorded under shisham forest land

(265.33 kg ha^{-1}) followed by teak forest land (263 kg ha^{-1}), eucalyptus forest land (247.33 kg ha^{-1}) and legume based cropping system (243.67 kg ha^{-1}) etc. At 45-60cm soil depth maximum available K was recorded in teak (255 kg ha^{-1}) followed by shisham forest land (253.33 kg ha^{-1}), euckalyptus forest land (241.33 kg ha^{-1}) and legume based cropping system (237.33 kg ha^{-1}) etc. whereas minimum available K was found in barren land (207.33 kg ha^{-1}).

Table 0.4. Effect of different land use on BD ($Mg\ m^{-3}$) system at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eucalyptus	Teak	NSP-6 farm
0-15	1.32	1.31	1.32	1.36	1.29	1.33	1.38	1.37	1.36	1.39
15-30	1.36	1.33	1.35	1.38	1.32	1.35	1.41	1.4	1.38	1.42
30-45	1.42	1.36	1.39	1.43	1.35	1.39	1.44	1.42	1.41	1.47
45-60	1.44	1.39	1.41	1.45	1.38	1.42	1.47	1.45	1.43	1.49
MD	1.39	1.34	1.37	1.40	1.33	1.37	1.42	1.41	1.39	1.44
SD	0.055	0.035	0.041	0.042	0.038	0.041	0.038	0.033	0.031	0.045
CV	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.009	0.002

Table 0.5. Effect of different land use system on Available Nitrogen (Kg ha^{-1}) system at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eukalyptus	Teak	NSP-6 farm
0-15	181	201	192	204	201	203	210	206	208	169
15-30	176	195	186	195	191	196	204	199	201	164
30-45	167	189	178	187	184	188	198	189	194	158
45-60	156	174	169	179	175	180	186	181	183	153
MD	171.50	192	182	191	187.50	192	201	194	197.50	161
SD	10.98	11.58	9.97	10.71	10.99	9.94	10.24	10.99	10.66	6.97
CV	120.66	134.25	99.58	114.91	120.91	98.91	105	120.91	113.67	48.67

Fig. 01 Effect of different land use system on Available Nitrogen (Kg ha^{-1}) system at various soil depths

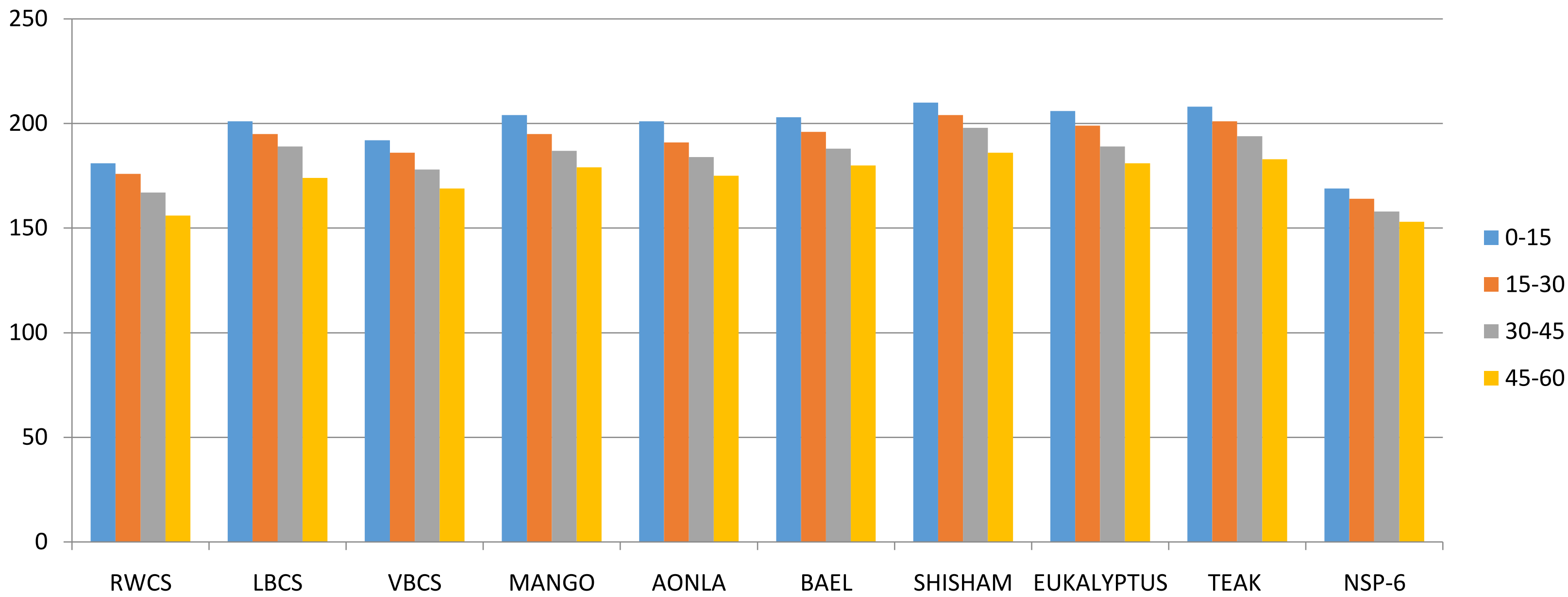


Table 06. Effect of different land use system on Available Phosphorus (Kg ha^{-1}) at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eucalyptus	Teak	NSP-6 farm
0-15	17.17	19.36	17.96	19.4	19.12	17.36	19.73	17.16	21.35	16.47
15-30	16.72	19.04	17.76	19.05	19.02	17.21	19.45	16.58	20.88	16.06
30-45	16.35	18.51	17.23	18.41	18.56	17.07	18.62	16.66	19.94	15.61
45-60	15.93	17.72	16.77	18.08	17.88	16.57	18.24	15.98	19.12	15.16
MD	16.53	18.77	17.49	18.73	18.79	17.14	19.03	16.62	20.41	15.83
SD	0.52	0.71	0.53	0.59	0.56	0.34	0.69	0.48	0.99	0.56
CV	0.27	0.51	0.28	0.35	0.31	0.11	0.48	0.23	0.98	0.31

Fig. 02 Effect of different land use system on Available Phosphorus (Kg ha^{-1}) at various soil depths

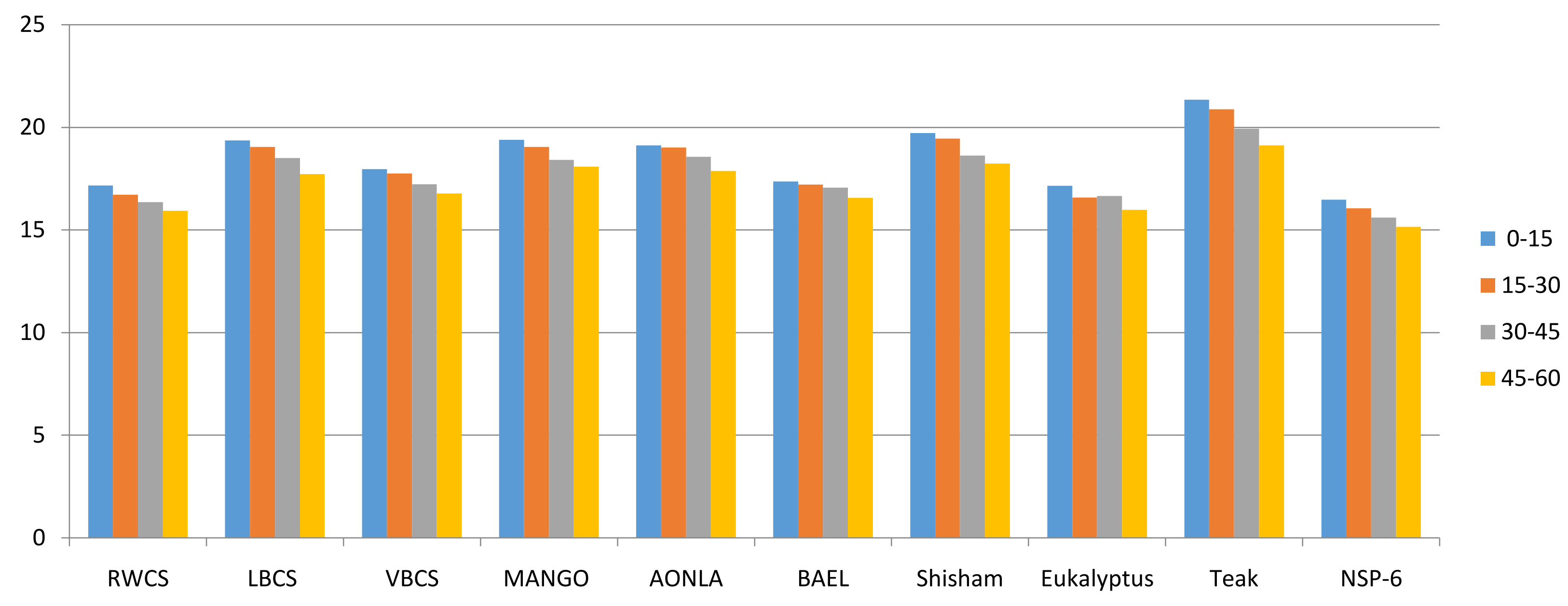
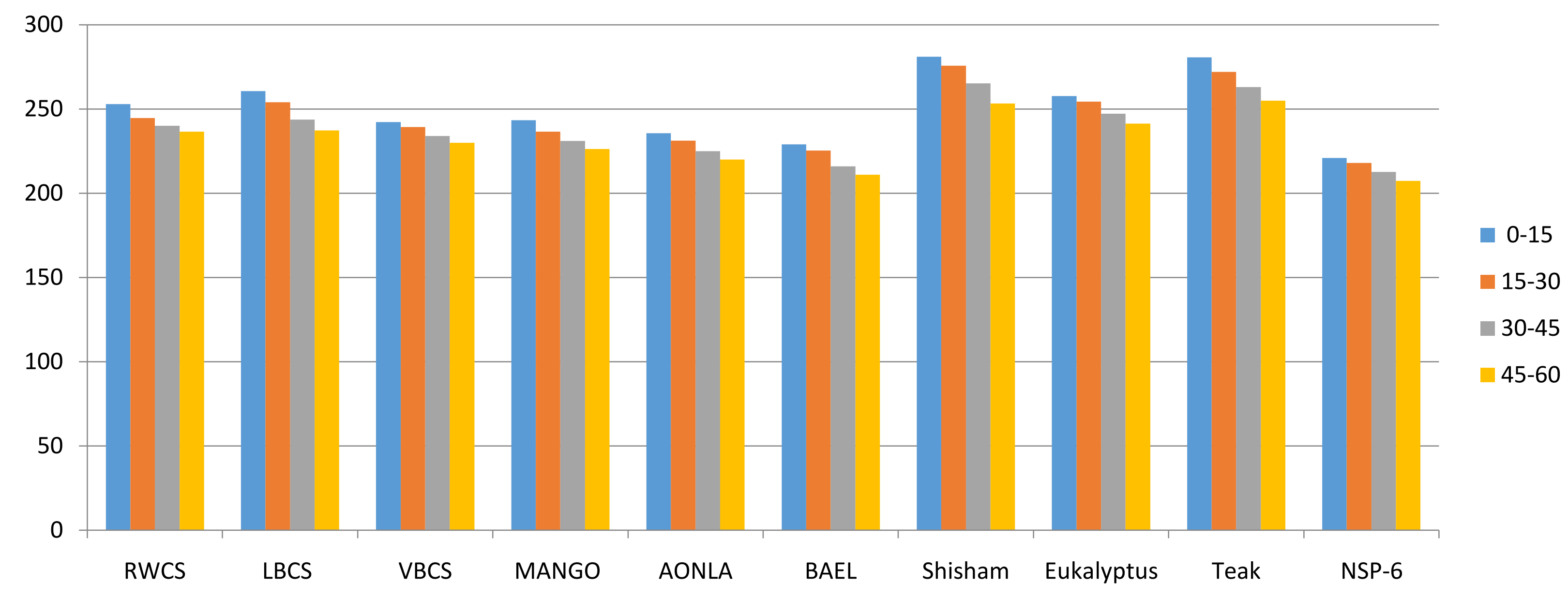


Table 07. Effect of different land use system on Available Potassium (Kg ha^{-1}) at various soil depths

Depth	Crop Land			Plantation Land			Forest Land			Barren Land
	RWCS	LBCS	VBCS	Mango	Aonla	Bael	Shisham	Eukalyptus	Teak	NSP-6 farm
0-15	253	260.67	242.33	243.33	235.67	229	281	257.67	280.67	221
15-30	244.67	254	239.33	236.67	231.33	225.33	275.67	254.33	272	218
30-45	240	243.67	234	231	225	216	265.33	247.33	263	212.67
45-60	236.67	237.33	230	226.33	220	211	253.33	241.33	255	207.33
MD	242.33	248.83	236.66	233.83	228.16	220.66	270.50	250.83	267.50	215.33
SD	7.08	10.42	5.49	7.33	6.90	8.28	12.21	7.29	11.10	6.02
CV	50.16	108.58	30.15	53.85	47.63	68.65	149.13	53.25	123.36	36.33

Fig. 03. Effect of different land use system on Available Potassium (Kg ha^{-1}) at various soil depths



Conclusion:

It may be concluded that the different land use system as well as soil depth affected the soil physico-chemical properties and biological properties.It may also be concluded that plantation land (mango, aonla and bael), forest land (shisham, Eucalyptus and teak) are good for sustainable fertility and soil health whereas crop land use (RWCS, LBCS and VBCS) need the addition of organic matter, FYM and some chemical fertilizers to maintain soil productivity, fertility and soil health.Barren land (NSP-6 farm) need to be reclaimed with Gypsum as per Gypsum Requirement (GR) values and after reclamation, Paddy crop with salt tolerant varieties should be grown with Green manure , addition of FYM and chemical fertilizers as per requirements for better productivity, fertility and soil health.

This study will help for further used for planners and for better use and management of the soils of the main campus of university.

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