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Physical and chemical properties of soils under mid hill humid conditions of North West Himalayas

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Abstract
A total of 50 Global positioning (GPS) surface (0-15cm) soil samples were collected from important sites covering wheat, maize, pea, potato and rajmash growing areas from Ladhbadhol valley District Mandi, Himachal Pradesh (India) lying in North West Himalayas were studied for their morphological, physical and chemical properties. The results show that soils are deep, well drained, silty loam to silty clay loam with dark brown to brownish yellow in colour. No gravels were noticed upto 0.6 m depth and the soil consistency was firm to loose. Few to many black brown concretions were observed only in rice growing soils. Silty loam was the dominant texture of the soils irrespective of soil depth. Coarse sand fraction was more in all sites. In none of the soils except Dharmpur, illuviation of clay had been observed. The values of bulk density, particle density and porosity were variable depending upon organic carbon and other soil characteristics.

Keywords: physico-chemical properties, north westren Himalaya

Introduction
Man is dependent on soil because he obtains all the basic necessities of life like food, fibre, shelter from it, but good soils are also dependent on human civilization. Due to the intimate relationship of man's prosperity with soil, it is very essential that unwise exploitation and misuse of soils be avoided. The knowledge of the soils in respect of its origin and formation, nature and properties and distribution becomes imperative in this connection. Such information's are not only useful in agriculture but are equally important for foresters, geologists and engineers for land use planning and soil management etc. Some piece meal work has been done on the characterization of the soils of Kullu, Kinnaur, Solan and Shimla districts, but information in this respect of Mandi district is still lacking. Keeping in view the importance of such area and inadequate information available, a present study on the characterization of the soils of Mandi district (Himachal Pradesh), lying in North West Himalayas was undertaken which is second largest in population after Kangra and is major grain producing district of Himachal Pradesh. This study will help to realize the full potential of the soil resources of Mandi district, there is a need to characterize the Balh Valley soils lying in North Western Himalayan Region. The mid hill of Mandi district is comprised of rocks mainly of thickly bedded sandstones, boulders, conglomerates and sedimentary rocks. The region as a whole is flat and divided by Suketi River into two parts i.e. eastern and western part. The climate of Mandi Valley is sub-humid to sub-tropical with mean annual rainfall of 1112 to 2001 mm and means annual air temperature varies from 50C to 330C. The study area is rain fed; however, ground water table varies from 8 to 28 m. The eastern part of the Valley is having irrigation facility from the water of Beas River. The main crops grown in the area are maize, paddy and wheat. But now due to the availability of irrigation water, more and more area is coming under vegetables production. Keeping in view the important crops grown in Mandi Valley, the whole studied area has been divided into three subgroups i.e. maize, paddy and vegetable growing areas. The morphological characteristics of soil were recorded in the field by following Standard Techniques as given in the Soil Survey Manual of USDA.

Materials and Method
A preliminary survey of the area was carried out for the collection of basic information regarding vegetation and physiographic locations etc. Surface (0-15 cm) and subsurface (15-30 cm) soil samples were collected randomly from different cropping (Cearal and vegetable) marked with the Global Positioning System co-ordinates. All the samples were collected with stainless steel auger, spade and spatula to avoid any contamination.

The soil samples were air dried, ground, passed through 2 mm sieve and finally stored in cloth bags. Available nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956) [16]. Available phosphorus by 0.5M $NaHCO_3$ (pH 8.5) extraction method Olsen *et al*. (1954) [9], available potassium by neutral normal ammonium acetate extraction method Jackson (1967) [6]. Texture by international pipette method Piper (1950) [10]. Bulk density by weighing bottle method Lutz, J.F. (1947) [7], pH by 1: 2.5 (soil: water) suspension using glass electrode pH meter Jackson (1967) [6]. Electrical conductivity by conductivity bridge method Jackson (1967) [6]. Organic carbon by Rapid titration method (Walkley and Black, 1934) water holding capacity by Keen's box method Piper (1950) [10].

Results and Discussion

Texture

Data revealed that sand fraction varied from 58.5 to 69.5, 57.1 to 71.0 and 56.0 to 68.0 per cent in subsurface horizons of vegetable growing areas, paddy growing areas and soil of maize growing areas whereas, in subsurface soils it ranged from 57.0 to 69.0, 57.1 to71.0 and 56.0 to 68.0 in respective different soil growing areas. Silt content in surface soils of vegetable growing areas, paddy growing areas and soil of maize growing areas varied from 13 to 24, 15.5 to 71.1 and 14.2 to 25.3 per cent respectively whereas, in the Clay content in surface soils of vegetable, paddy and maize growing soils varied from 12.0 to 17.5, 12.5 to 18.5 and 12.0 to 19.20 per cent respectively, whereas, in the sub-surface soils it ranged from 11to 17, 12.1 to 18.2 and 11.2 to 19.0 per cent in respective different soil growing areas. The texture of soils of Mandi district was found to be sandy loam to silty clay loam in texture. According to the work reported by (Verma *et al.* 1976) the dominant parent materials of the soils of mid hill zone were granite, quartzite, gneiss, shale and schist, which might have resulted into coarse texture of the soils.

Bulk density

Bulk density in the surface soils under vegetable growing areas, paddy growing areas soil of maize growing areas varied from 1.07 to 1.30, 1.09 to 1.32 and 1.09 to 1.29 Mgm^{-3}, respectively. Whereas, in the subsurface layers, it varied from 1.0 to 1.28, 1.07 to 1.29 and 1.1 to 1.34 Mgm^{-3}, respectively. Bulk density increase with increase in soil depth in all the site under study (Table 1,2). This may be attributed to the increase in fraction with depth. The results are in line with the findings of (Sharma and Kanwar, 2010) [15].

Water holding capacity (WHC)

The data on WHC under different crop growing areas have been given in tables 1, 2. A perusal of data in table 1,2 revealed that WHC decreased with increase in soil depth. It may be due to decrease in finer fraction (clay) of soils with depth as WHC of soils is influenced greatly with the amount of clay contents. WHC varied from 15.9 to 27.5, 13.9 to 23.8 and 13.8 to 25.3 in surface layers of cultivated lands vegetable growing areas, paddy growing areas soil of maize growing areas, respectively. Whereas, in the subsurface layers, it varied from 14.8 to 26.2, 13.9 to 23.8 and 12.1 to 23.1 per cent. These results are in line with the findings of (Babhulkar *et al.* 2000, Selvi *et al.* 2005) [2, 12].

Soil pH

A perusal of data in the Table 1,2 indicate that pH of surface soils vegetable growing areas, paddy growing areas soil of maize growing areas varied from 6.3 to 7.2, 5.9 to 7.2 and 5.6 to 6.9 respectively. Whereas, in the subsurface soil it varied from 6.2 to 7.0, 5.8 to 7.1 and 5.5 to 6.7 respectively. The soils of the mid hill zone of Himachal Pradesh were found slightly acidic to neutral in reaction. Paddy soils where pH values were found to increase with depth possibly due to leaching of bases. The organic carbon content in vegetable growing soils was higher in comparison to paddy and maize growing soils, which was due to the addition of FYM in vegetable. These results authenticated the earlier findings of (Sharma and Kanwar, 2012) who have also reported higher pH content at the surface and a decreasing trend with depth.

Electrical conductivity (EC)

The electrical conductivity values for the surface soils of vegetable growing areas, paddy growing areas soil of maize growing areas (Table 1) ranged 0.14 to 0.49 dS m^{-1}, 0.22 to 0.45 dS m^{-1} and 0.25 to 0.44 dS m^{-1} in sub surface layer its value ranged from 0.12 to 0.44,0.22 to 0.44 and 0.22 to 0.43 dS m^{-1} respectively (Table 2). The electrical conductivity was found to be more in the surface 0 – 15 cm soil depth and decreased in the sub surface soil depth. EC values in the study area are in safe limits (<0.8 dS m^{-1}) without any salinity/ alkalinity hazards. Similar results were reported by (Sharma and Singh, 1991) [13].

Organic carbon

Organic carbon content in surface soils under vegetable growing areas, paddy growing areas soil of maize growing areas varied from 0.8 to 1.1, 0.76 to 1.1 and 0.7 to 1.2 per cent, respectively. Whereas, in the subsurface layers it varied from 0.7 to 1.83, 0.76 to 1.1 and 0.71to 1.1 per cent in respective system (Tables 1 and 2). The organic carbon content indicates decreasing values with the soil depth, in general. This may be due to the management practices and more addition of the FYM under protective cultivation systems. The results are in line with the findings of (Liu *et al*. 2010) [5].

Available nitrogen

A look into the data pertaining to available nitrogen content of soils of Mandi district under different cropping system (Table 1) indicated that its content in the surface soils of vegetable growing areas, paddy growing areas soil of maize growing areas ranged from to 180 to 472, 185 to 471 and 189 to 404 kg ha^{-1}, respectively. However, in the sub-surface layers, its values varied from 175 to 470.1, 185 to 471 and 180 to 401 kg ha^{-1} for vegetable growing areas, paddy growing areas soil of maize growing areas. As such available nitrogen was low to medium under all the three cropping systems. The low to medium levels of N may be due to the cultivation of high nutrient requirement crops. Also, despite high organic carbon, the low to medium N levels may be due to the lower decomposition rates of the organic matter under the influence of the prevailing climate. Similar results were also reported by (Verma *et al.* 1976) [17], Mahajan (2001) [8], Chandel (2013) [3].

Available phosphorus

Available phosphorus content ranged from 10.8 to 22.1, 16.9 to 24.1 and 16.4 to 25.3 kg ha^{-1} for the surface soils under vegetable growing areas, paddy growing areas soil of maize growing areas, respectively. In subsurface soils the corresponding values were 10.5 to 22.0, 15.1 to 23.1 and 15.3

to 24.0 kg ha^{-1}. Soils are rated as medium to high in their available P Status (Table 1). The high available P in these soils may be due to higher organic matter and more addition of phosphatic fertilisers for vegetable crop production. Also, the availability of P is highly pH dependent with maximum availability near neutral pH which explains its high contents in these soils. The results are in agreement with the findings of (Zhaohui *et al*. 2007; Quan *et al.* 2011) [11] and Chandel (2013) [3].

Available potassium

Data (Table 1) indicated that the values of available potassium in surface horizons under vegetable growing areas, paddy growing areas soil of maize growing areas were 129 to 290, 128 to 260 and 152 to 283 kg ha^{-1}, respectively whereas, in the sub-surface layers these values (Table 2) varied from 128 to 290, 120 to 255 and 150 to 280 kg ha^{-1}. As such, the soils under study were medium available potassium status. The results are in line with the findings of (Zhaohui *et al*. 2007) and Chandel (2013) [3].

Table 1: Range & mean values of physico-chemical properties in surface soils (0-15 cm) under different growing areas in Mandi district

	Sand (%)	Silt (%)	Clay (%)	BD (Mg m^{-3})	WHC (%)	pH	EC (dSm^{-1})	OC (%)	N ($kgha^{-1}$)	P ($kgha^{-1}$)	K ($kgha^{-1}$)
A. Soils of Vegetable Growing Areas											
Range	58.5-69.5	14-25	12.0-17.5	1.07-1.30	15.9-27.5	6.3-7.2	0.14-0.49	0.8-1.1	180-472	10.8-22.1	129-290
Mean	65.94	18.06	15.06	1.19	19.96	6.8	0.31	0.91	313.3	16.8	202.8
SD$\pm$	3.19	2.91	1.55	0.08	3.13	0.271	0.100	0.067	71.26	3.44	49.45
B. Soils of Paddy Growing Areas											
Range	57.1-71.0	15-22.5	12.5-18.50	1.09-1.32	13.9-23.8	5.9-7.2	0.22-0.45	0.76-1.1	185-471	16.9-24.1	128-260
Mean	63.44	19.11	15.95	1.202	18.47	6.59	0.380	0.90	344.0	20.75	180.0
SD$\pm$	3.77	2.25	1.86	0.076	2.74	0.38	0.061	0.10	76.33	2.27	36.50
C. Soils of Maize Growing Areas											
Range	56-68	15-26	12.0-19.20	1.09-1.29	13.8-25.3	5.6-6.9	0.25-0.44	0.7-1.2	189-404	16.4-25.3	152-283
Mean	62.02	20.8	15.21	1.19	19.06	6.40	0.34	0.88	290.86	20.27	201.46
SD$\pm$	4.05	3.34	2.120	0.067	3.30	0.37	0.070	0.36	57.58	2.83	32.75

Table 2: Range & mean values of physico-chemical properties in subsurface soils (15-30 cm) under different growing areas in Mandi district

	Sand (%)	Silt (%)	Clay (%)	BD (Mg m^{-3})	WHC (%)	pH	EC (dSm^{-1})	OC (%)	N ($kgha^{-1}$)	P ($kgha^{-1}$)	K ($kgha^{-1}$)
A. Soils of Vegetable Growing Areas											
Range	57-69	13-24	11-17	1.0-1.28	14.8-26.2	6.2-7.0	0.12-0.44	0.7-1.83	175-470.1	10.5-22.0	128-290
Mean	65.00	17.13	14.36	1.14	18.90	6.7	0.27	0.94	301.34	15.94	198.33
SD$\pm$	3.60	2.84	1.71	0.089	3.10	0.25	0.099	0.26	68.71	3.42	48.62
B. Soils of Paddy Growing Areas											
Range	57.1-71.0	15.5-71.1	12.1-18.2	1.07-1.29	13.9-23.8	5.8-7.1	0.22-0.44	0.76-1.1	185-471	15.1-23.1	120-255
Mean	62.61	22.28	15.48	1.17	17.93	6.38	0.344	0.88	326.46	19.16	180.0
SD$\pm$	3.67	13.61	1.95	0.074	2.68	0.40	0.072	0.10	66.4	2.40	37.11
C. Soils of Maize Growing Areas											
Range	56-68	14.2-25.3	11.2-19.0	1.1-1.34	12.1-23.1	5.5-6.7	0.22-0.43	0.7-1.1	180-401	15.3-24.1	150-280
Mean	61.55	20.23	14.87	1.34	17.54	6.16	0.32	0.85	283.4	19.02	196.53
SD$\pm$	4.16	3.41	2.07	0.067	3.40	0.35	0.080	0.11	56.83	3.02	33.06

Conclusion

The soils of the mid hill zone of Himachal Pradesh were found slightly acidic to neutral in reaction. Organic carbon content in vegetable growing soils was higher in comparison to paddy and maize growing soils, which was due to the addition of FYM in vegetable. Soils are rated as medium to high in their available P Status. The high available P in these soils may be due to higher organic matter and more addition of phosphatic fertilisers for vegetable crop production.

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