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Status of Morphological and Physico-chemical Properties of Balh Valley Soils of Mandi District of Himachal Pradesh in North Western Himalayas India

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ABSTARCT

Background: Himachal Pradesh (India) lying in North West Himalayas were studied for their morphological, physical and chemical properties. Himachal Pradesh, is a mountainous region spread over an area of 55,673 km² with elevation ranging from 350 to 6,500 meters above mean sea level noticeably increased from west to east and south to north. For agricultural planning, development and the sustainable use of natural resources. The state has been categorized into four agro-climatic situations viz. low hills, mid hills sub humid, high hills temperate and high hills dry temperate. However, considerable variations exist within each zone, owing to soil type and local preferences resulting into diversified farming situations.

Methods: A six profile sites of soils were collected randomly from vegetable and cereals growing areas falling under midhill zone. After collecting soil samples, these were air dried and analyzed for physical and chemical properties. The study determined the level of availability of nutrients and know the fertility status of studied areas.

Result: 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 soil profiles. Macro and micronutrients contents were higher under the vegetable growing soils than paddy and maize growing soils. In none of the soils except Dhangu, 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. The soils were slightly acidic to neutral in reaction, medium to high in organic carbon and moderate in available N, P and K status. The DTPA-extractable Fe, Zn, Cu and Mn were also high in these soils. Similarity in the colour and texture in most of the soils indicated the dominant influence of parent material.

Key words: Chemical properties, Physical.

INTRODUCTION

Himachal Pradesh is a state in Northwest Himalayas having diversified climatic conditions. Himachal is known for production of off-season vegetables. Capsicum is one of the important vegetable crops and Himachal is the leading state in the country in terms of area and production only after Karnataka. Its production is 58290 MT covering an area of 2500 hectares in Himachal Pradesh (Anonymous, 2017). The mid-hills zone of Himachal Pradesh extends from 651 to 1800 m above mean sea level with mild temperate climate and it occupies 32 per cent of the total geographical area and about 37% of the cultivated area of the state (Parmar, 2014). With its bestowed climatic conditions, farmers in mountainous areas can produce a variety of off season vegetables and other cash crops, but cultivating the land without best management practices leads to environmental degradation through loss of soil fertility. Limited area under the fertile soils in the mountain landscapes is assuming extra significance because of the decreasing land availability for agriculture caused by the demand for alternate uses. Under these conditions, the high cropping intensity and unscrupulous use of chemical fertilizers adopted by the farmers to reach the higher productivity levels have ultimately rendered the soils in this region with depleted nutritional status (Sharma *et al.,* 2001). A farmer must take into account the requirement of crops and the characteristics of the soil while making decisions on the timing and quantity of fertilizer application. Lack of understanding about soil health is leading to indiscriminate or imbalanced use of chemical fertilizers and exposing farm based livelihoods to soil health related risks. The assay of soil fertility status is essential for judicious use of fertilizers and assurance of better crop yields. Among the diagnostic techniques for

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fertility evaluation such as fertilizer trails, soil test and plant analysis; the soil test provides the most accurate information on the availability of various plant nutrients. Therefore, the present study was envisaged to understand the current soil fertility status of mid Himalayan region. This would help the farmers to make more informed decisions to increase the productivity of their lands and to improve their livelihood.

MATERIALS AND METHODS

The study area in the Mandi district of Himachal Pradesh in the North Western Himalayas is located between 31043′19″ N latitudes and 76058′31″ E longitudes. The elevation of Balh Valley varies from 880 to 950 m above mean sea level, covering an area of about 3500 hectare. A six typical soil profiles representing two each vegetable growing (Gaggal and Kummi), paddy growing (Dhangu and Chhattar) and maize growing areas (Naulakha and Behna) were selected. The morphological characteristics of soil profiles were recorded in the field by following Standard Techniques as given in the Soil Survey Manual of USDA (Soil Survey Staff, 1995).

After collecting soil samples, these were air dried and analyzed for physical and chemical properties. Particle size distribution was carried out by International Pipette method as described by Piper (1966). Bulk density and particle density of the soils were determined by Core Sampler method and Pycnometer method as described by Singh (1980) and Black (1965). The physico-chemical properties of the studied soils like pH, organic carbon were determined by standard procedures. Available N was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956); available P by Olsen's method (Olsen *et al.* 1954); available K by 1N NH4OAc (Hanway and Heidal, 1952) and available DTPA-extractable micronutrient cations like Fe, Zn, Cu and Mn by Lindsay and Norvell (1978) on atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

It is observed from the data regarding morphological characteristics (Table 1) that in general all the soils were characterized by brown colour mixed with shades of grey and yellow. Majority of the soils either have silty loam (Balh, Gaggal, Dhangu, Baggi and Behna) or silty clay loam (Dhangu and Chachyot) texture. The variations in the texture of soils obtained here in the present study evinced the general statement of Robinson (1949) that in case the parent material is the dominant factor in soil formation, the most obvious way in which it affects the soils is through similarity in colour and texture. Similar results had already been obtained by Kaistha and Gupta (1992) while studying the soil genesis in Himalayas. However, very dark brown colour in the surface (0.0-0.15 m depth) soils of vegetable growing areas could be attributed to the presence of more content of organic carbon in these soils. Another important morphological characteristic of these soils is the presence of gravels in the lower layers of these soils (Table 1) which might be explained due to the prevailing alluvial conditions earlier in the area as the river Suketi still flows into its eastern and western parts. Black brown concretions were noticed in few of the horizons of paddy growing soils only (Table 1). The presence of very dark brown to dark reddish brown mottles (mostly 10YR 5/6 to 7.5 YR 5/8) was the common phenomenon in the rice growing soils (Table 1).

Silty loam was the dominant texture of the soils irrespective of soil depth. Generally silt was the dominant fraction (25.7 to 49.2%) followed by that of sand (coarse and fine sand). The content of coarse sand fraction was in the range of 12.1 to 48.1 per cent (Table 1). More content of coarse sand in all the soils under study could be explained due to presence of sandy type of rocks *viz.*, sandstones, silt stones, granites etc. prevailed in the area. In none of the profiles except Dhangu, illuviation of clay had been observed indicating, thereby, less development of soil profiles. However, in Dhangu profile, there was an accumulation of clay at 0.60 to 0.75 and 0.75-0.90 m depth. The higher content of organic carbon in these soils which had resulted in bringing about low bulk density from the average value (1.33 mg m^{-3}). The bulk density of surface and sub-surface soils in vegetable, paddy and maize growing soils was found lower as compared to paddy and maize growing soils which might be attributed to the role of intensive management (tillage operations, frequent applications of higher amount of organic manures and fertilizers) and consequently better microbial activities. Particle density increased with depth of the soil in almost all the profiles. Its value in vegetable growing soils was higher in comparison to paddy and maize growing soils. However, this increased trend was not significant which might be due to the dominance of light minerals in these soils as reported by Gupta (1992). The per cent soil porosity in vegetable soils was higher in comparison to paddy and maize soils, which could be due to the presence of higher organic matter in the former groups of soils (Table 1). In general, the per cent soil porosity decreased with the depth (Singh *et al.* 2000).

The overall pH values of the studied soils ranged from 6.4 to 7.1, indicating slightly acidic to neutral in reaction (Table 2). (Kaistha and Gupta, 1993) also found that soils of Central Himalayas of Himachal Pradesh had pH of 6.7-7.7. There is no specific trend in pH values of different crop growing areas except Naulakha paddy soils where pH values were found to increase with depth possibly due to leaching of bases.

EC of soil in vegetable, paddy and maize growing areas varies from 0.31-0.78 dS/ m, electrical conductivity was found almost safe limit in all the growing areas studied, though a decreasing trend was observed in the subsurface. Comparatively a little higher salt accumulation, as evidenced by EC values, under vegetable growing areas was observed, might be the consequence of frequent applications of fertilizers, composted animal manures. Similar findings for soil electrical conductivity under the system of vegetable production were reported by Ammari *et al.* (2015). 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 (Table 2).

The surface horizons of vegetable growing soils had more available N in comparison to paddy and maize growing soils, and their contents decreased with the increase in depth (Table 2). As discussed earlier, the organic carbon content of the soil profile samples also showed a similar distribution. Higher amount of organic carbon in the surface layer of vegetable growing soils was responsible for higher amount of available N. The available N bore a close positive relationship with organic carbon which was also reported by Ramesh *et al*. (1994). The available P content in vegetable growing soils was higher in comparison to paddy and maize growing soils and decreased with increase in depth (Table 2). Among soil properties, organic carbon and DTPA-extractable micronutrients possessed significant positive related with available P. The available K content was higher in vegetable growing soils than paddy and maize growing soils (Table 2). The available K content decreased with the depth in all the soils. The higher available K content in vegetable soils which could be ascribed to more organic matter in these soils. However, addition of potassic fertilizers

Table 1: Morphological characteristics and physical properties of balh valley soils of district Mandi, Himachal Pradesh.

Soil depth (m)	Colour (Moist)	Texture	Bulkdensity mg m^{-3}	Particledensity mg m^{-3}	Porosity %
		Soils of vegetable growing areas			
Profile 1 (Balh)					
0.00-0.15	Very dark brown	SiL	0.95	2.30	51.7
0.15-0.30	Very dark grayish brown	SiL	0.99	2.34	56.7
0.30-0.45	Dark grayish brown	SiL	1.22	2.44	51.2
0.45-0.60	Grayish brown	SiL	1.22	2.53	51.7
0.60-0.75	brown	SiL	1.25	2.56	48.6
Profile 2 (Gagal)					
0.00-0.15	Very dark brown	SiL	0.94	2.31	52.1
0.15-0.30	Very dark grayish brown	SiL	0.98	2.44	51.3
0.30-0.45	Dark grayish brown	SiL	1.23	3.21	52.1
0.45-0.60	Grayish brown	SiL	1.21	2.44	53.7
0.60-0.75	brown	SiL	1.28	2.63	52.4
		Soils of paddy growing areas			
Profile 3 (Dhangu)					
0.00-0.15	Dark brown	SiL	1.20	2.40	50.1
0.15-0.30	Dark yellowish brown	SiL	1.41	2.83	50.7
0.30-0.45	Dark grayish brown	SiL	1.43	2.88	50.1
0.45-0.60	Dark yellowish brown	SiL	1.44	2.91	48.5
0.60-0.75	Dark yellowish brown	SiCL	1.47	2.90	48.1
Profile 4 (Chachyot)					
0.00-0.15	Dark yellowish brown	SiCL	1.46	2.92	48.8
0.15-0.30	SicL	SiCL	1.48	2.98	47.1
0.30-0.45	Dark yellowish	SiCL	1.49	2.99	48.8
0.45-0.60	SicL	SiCL	1.50	3.10	48.1
0.60-0.75	Dark yellowish brown	SiCL	1.50	3.12	47.1
		Soils of maize growing areas			
Profile 5 (Baggi)					
0.00-0.15	Very dark grayish brown	SiL	1.19	2.40	52.5
0.15-0.30	Dark yellowing brown	SiL	1.43	2.86	50.0
0.30-0.45	Dark yellowing brown	SiL	1.46	2.92	49.8
0.45-0.60	Dark brown	SiL	1.24	2.48	46.3
0.60-0.75	Dark yellowish brown	SiL	1.49	5.02	53.2
Profile 6 (Behna)					
0.00-0.15	Dark brown	SiL	1.15	2.46	53.2
0.15-0.30	Dark yellowish brown	SiCL	1.52	5.24	49.1
0.30-0.45	Dark grayish brown	SiCL	1.54	5.00	48.1
0.45-0.60	Dark yellowish brown	SiCL	1.54	4.90	47.1
0.60-0.75	Dark brown	SiL	1.54	1.52	46.1

by the farmers while cultivating vegetables which eventually increased K content in these soils could not be ruled out.

As such, the soils under study were low to medium with respect to available nitrogen, phosphorus and potassium status.

The soils of paddy growing area were high in DTPA-extractable Fe content as compared to vegetable and maize growing areas (Table 2) which might be due to suitable moisture regimes that accelerate the reduction process causing more availability of Fe. DTPA-extractable Fe content decreased with increased depth might be due to regular addition of Fe through plant residues on the surface. These results were in conformity with the findings of Jalali *et al*. (1998). The DTPA-extractable Zn content in vegetable growing soils was slightly more in comparison to paddy and maize growing soils and it also decreased with the depth (Table 2). The higher available Zn content in vegetable soils might be due to the release of organic acids from added FYM and thus converting insoluble Zn into chelating or soluble Zn. Similar results had been reported by Jalali *et al.*

Table 2: Physico-chemical properties of balh valley district Mandi Himachal Pradesh.

Soil depth (m)	pH	EC dS/m	OC (%)	Available nutrients, kg ha^{-1}			DTPA-Extractable micronutrients, ppm			
				N	P	K	Fe	Zn	Mn	Cu
Soils of vegetable growing areas										
Profile 1 (Balh)										
0.00-0.15	6.5	0.80	1.07	412.2	18.3	276.1	90.1	2.32	8.22	2.12
0.15-0.30	6.8	0.76	0.81	380.7	15.3	254.2	70.2	2.22	7.21	1.22
0.30-0.45	6.4	0.64	0.87	461.7	16.2	232.2	58.4	2.44	6.88	1.76
0.45-0.60	7.1	0.56	0.82	381.3	12.1	176.1	55.1	2.50	5.65	2.03
0.60-0.75	6.5	0.51	0.71	404.7	15.2	154.4	40.2	1.88	6.12	1.77
Profile 2 (Gagal)										
0.00-0.15	7.0	0.76	0.79	350.1	19.7	170.1	70.1	3.51	2.18	7.15
0.15-0.30	6.8	0.70	0.81	348.1	18.1	231.1	81.1	2.04	2.16	5.20
0.30-0.45	7.1	0.54	0.92	412.1	20.1	170.4	58.1	2.01	1.92	4.44
0.45-0.60	6.7	0.41	0.88	281.2	11.2	151.1	75.1	2.50	1.71	2.85
0.60-0.75	6.9	0.41	0.79	269.1	10.1	143.1	80.1	2.44	1.52	2.77
Soils of paddy growing areas										
Profile 3 (Dhangu)										
0.00-0.15	6.1	0.43	0.51	224.1	17.1	210.1	121.1	1.20	1.74	6.16
0.15-0.30	7.0	0.38	0.44	350.1	14.4	246.1	110.5	1.10	1.48	5.10
0.30-0.45	7.1	0.32	0.75	315.1	11.2	148.1	119.4	0.99	1.52	3.14
0.45-0.60	6.1	0.31	0.64	259.1	10.6	112.2	108.1	0.94	1.31	4.28
0.60-0.75	6.5	0.30	0.48	220.1	12.8	113.1	99.7	0.88	1.13	1.02
Profile 4 (Chachyot)										
0.00-0.15	6.9	0.54	0.70	380.3	16.2	223.1	120.1	1.24	1.60	4.21
0.15-0.30	6.9	0.44	0.66	360.1	13.2	192.1	115.2	1.08	1.01	3.70
0.30-0.45	7.0	0.42	0.64	301.2	12.7	161.2	101.5	0.97	1.20	3.81
0.45-0.60	7.0	0.32	0.60	290.6	12.1	128.5	95.3	0.82	0.93	4.20
0.60-0.75	6.7	0.31	0.57	280.0	10.2	108.1	97.2	0.75	0.85	2.29
Soils of maize growing areas										
Profile 5 (Baggi)										
0.00-0.15	6.8	0.61	0.75	450.1	19.2	254.1	103.1	1.22	1.81	5.49
0.15-0.30	6.9	0.54	0.71	410.2	18.3	241.2	95.2	1.08	1.74	6.03
0.30-0.45	7.0	0.44	0.68	381.2	17.5	197.5	98.1	1.01	1.52	5.25
0.45-0.60	7.0	0.41	0.65	359.0	14.8	146.1	101.2	0.81	1.41	3.94
0.60-0.75	7.2	0.40	0.64	318.1	16.8	128.2	92.2	0.94	1.26	2.97
Profile 6 (Behna)										
0.00-0.15	6.8	0.58	0.74	442.1	18.4	216.2	94.1	1.49	1.71	5.61
0.15-0.30	6.8	0.56	0.70	422.5	16.2	227.3	88.1	1.19	1.52	3.04
0.30-0.45	7.1	0.54	0.65	366.8	15.1	170.2	78.1	1.28	1.31	3.94
0.45-0.60	7.0	0.48	0.59	350.1	12.9	166.2	76.1	0.90	1.16	2.11
0.60-0.75	7.0	0.40	0.50	316.1	10.2	144.1	74.1	0.88	0.94	1.89

(1998). The DTPA-extractable Cu content was found to decrease with the increase in depth, but in the soils of paddy growing area, it did not follow any definite trend which might be due to stratification of soils (Table 2). The DTPA-extractable Fe, Zn, Cu and Mn were also high in these soils. Similar results were by (Vadivelu and Bandyopadhyay, 1995).

CONCLUSION

Thus, the present study clearly showed that Balh Valley soils are deep, having good drainage and put under intensive cultivation without deteriorating its health for growing different cereals and vegetable crops by using recommended doses of balanced use of N, P and K fertilizers.

Conflict of interest: None.

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