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Study on soil physico-chemical attributes under *Pinus roxburghii* Sargent along elevational gradient in Solan Forest Division of Himachal Pradesh

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ABSTRACT

The present study was conducted at elevation ranges from 900 m to 2100 m in the year 2012-2013 in Solan Forest Division of Himachal Pradesh. The physico-chemical characteristics of soils along elevational classes showed that the values of bulk density increased with increase in elevation from 900-1200 m to 1800-2100 m. There was a decrease in per cent organic carbon with increase in soil depth at all the elevations. The soil organic carbon decreased with increase in elevation with minimum of 0.24 per cent at 1800-2100 m and maximum of 2.63 per cent at 900-1200 m elevation. Overall pH values varying from 6.00 to 6.90 showed an increasing trend with soil depth. The perusal of data indicates that in general pH varied from 6.00 at 900-1200 m elevation to 6.9 at 1800-2100 m denoting less variation in pH in the study area. Available nitrogen varied from 271.33 kg/ha (20-40 cm) to 533.20 kg/ha (10-20 cm) at 900-1200 m elevation and showed a decreasing trend with increasing depth. Available phosphorus varied from 8.90 (20-40 cm) to 34.5 (10-20 cm) at elevation of 1200-1500 m and showed a decreasing trend from 10-20 cm to 20-40 cm depth as in case of per cent organic carbon and available nitrogen. Available potassium showed an increasing trend with increase in soil depth at all elevations.

Keywords: Elevation ranges; physico-chemical; soil depth

INTRODUCTION

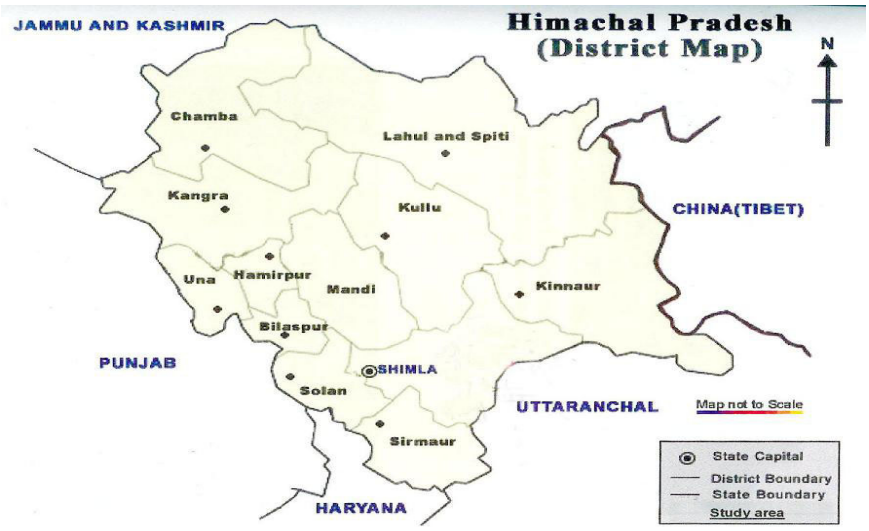
Soil physico-chemical properties are related to field morphology and regulate the qualitative and quantitative aspects of plant growth to a considerable degree. Thus the importance of physico-chemical properties of soil in the domain of system analysis needs to be taken into consideration. The Chir pine (*Pinus roxburghii* Sargent) named after William Roxburgh is a pine native to the Himalaya. The Chir though found between elevations of 600-2200 meters is predominant in lower hills however it grows best between altitudinal range of 600-1800 m. The range extends from northern Pakistan (North-West Frontier Province), across northern India (Jammu and Kashmir, Punjab, Himachal Pradesh, Uttarakhand, Sikkim)

and Nepal to Bhutan. It generally occurs at lower altitudes than other pines in the Himalaya.

To carry out suitable management programmes for the improvement of the degrading forests of Chir pine the knowledge of soil physico-chemical properties is quite essential.

MATERIAL and METHODS

The present study was conducted at elevation ranges from 900 m to 2100 m in the year 2012-2013 in Solan Forest Division of Himachal Pradesh which is located between 30°45'00'' to 31°10'00'' N latitude and 76°55'00'' to 77°15'00'' E longitude covering an area of about 57158 ha. The forests in Solan Forest Division have pure crop of Chir and mostly conform to Champion and Seth's Group 9-Sub-Tropical pine forests. The whole area of Solan Forest Division was divided into four altitudes viz 900-1200, 1200-1500, 1500-1800 and 1800-2100 m for conducting the soil study. There were two composite soil samples taken randomly viz



0-20 and 20-40 cm depth in quadrate of size 30 x 20 m.

The following physico-chemical attributes of soil were studied from the basic data:

Soil characteristics

Soil pH: soil/water (1:2.5) suspension method with the help of digital pH meter (Jackson 1973).

Organic carbon: Wet digestion method (Walkley and Black 1934).

Available nitrogen: Alkaline potassium permanganate method (Subbiah and Asija 1956).

Available phosphorus: Method following Olsen et al (1954).
Available potassium: Flame photometer method (Merwin and Peech 1951).

Bulk density: Core tube method.

RESULTS and DISCUSSION

The physico-chemical characteristics of soils recorded during the course of investigation are presented in Table 1.

The soil samples data of Chir forest presented in Table 1 reveal that at all the four elevations per cent organic carbon in soil varied from 0.18 (20-40 cm depth) to 2.63 (0-20 cm depth) at elevation of 900-1200 m amsl. There was a decrease in per cent organic carbon with increase in soil depth at all the elevations. The results are in accordance with the observation of Broquen et al (1999), Malik (2008) and Mahajan (2010). The soil organic carbon decreased with increase in elevation with minimum of 0.24 per cent at 1800-2100 m and maximum of 2.63 per cent at 900-1200 m elevation. The higher organic carbon at lower altitudes might be due to sliding of litter from higher altitudes due to rain, run-off and gravity down the slope and its accumulation at lower altitudes. Similar observations have been recorded by Banerjee and Badola (1980), Gupta et al (1991), Kaushal (1992) and Malik (2008) in forest soils of coniferous forests in Himachal Pradesh.

Overall pH values varying from 6.00 to 6.90 showed an increasing trend with soil depth. In general pH varied from 6.00 at 900-1200 m elevation to 6.9 in elevation class of 1800-2100 m denoting less variation in pH in the study area. Available nitrogen varied from 271.33 kg/ha (20-40 cm depth) to 533.20 kg/ha (10-20 cm depth) at 900-1200 m elevation and showed a decreasing trend with increasing depth. Available phosphorus varied from 8.90 (20-40 cm depth) to 34.5 (10-20 cm depth) at elevation of 1200-1500 m and showed a decreasing trend from 10-20 cm to 20-40 cm depth as in case of per cent organic carbon and available nitrogen. Available potassium values varied between 100.20 (upper depth of 10-20 cm) to 402.5 (lower depth of 20-40 cm) at 1200-1500 m to 1500-1800 m elevation respectively and showed an increasing trend with increase in soil depth at all elevations. The results are in accordance with the observation of Malik (2008) and Mahajan (2010).

The bulk density of soil attained a minimum value of 1.00 g/cm^3 at depth of

Table 1. Physico-chemical attributes of soil under *Pinus roxburghii* Sargent along elevational gradient in Solan Forest Division

Elevation (m)	pH		% OC		Avail N (kg/ha)		Avail P (kg/ha)		Avail K (kg/ha)		BD (g/cm^3)	
	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
900-1200	6.10	6.50	1.71	0.18	492.31	404.72	17.80	14.40	125.30	133.40	1.00	1.02
	6.10	6.40	2.63	1.92	533.20	496.08	33.10	29.80	391.20	400.10	1.08	1.13
	6.20	6.40	2.22	1.98	492.16	400.87	29.90	25.50	380.30	390.50	1.11	1.13
	6.00	6.10	1.98	0.97	502.11	466.14	24.20	22.10	103.70	111.50	1.14	1.16
	6.00	6.30	2.01	0.66	501.29	473.25	30.20	16.60	228.10	289.70	1.12	1.15
	6.30	6.60	2.00	0.67	420.21	403.13	29.50	26.30	222.50	246.90	1.16	1.18
	6.20	6.80	1.95	0.98	500.13	444.31	31.70	29.20	143.20	151.90	1.16	1.17
	6.00	6.20	1.13	0.77	313.25	271.33	34.70	32.10	102.70	113.60	1.17	1.19
	6.70	6.90	1.11	0.79	392.66	298.56	24.20	22.40	283.40	302.10	1.13	1.15
1200-1500	6.30	6.50	2.22	1.77	528.43	439.66	31.50	29.30	387.20	393.20	1.29	1.33
	6.20	6.70	1.76	0.99	414.56	398.08	29.20	25.20	155.60	178.90	1.23	1.34
	6.70	6.90	1.33	0.88	444.17	401.22	31.80	23.00	212.90	222.80	1.25	1.36
	6.10	6.40	1.63	0.92	514.38	428.03	22.30	13.00	132.20	166.30	1.37	1.39
	6.20	6.50	1.90	0.96	397.44	299.77	28.90	26.10	365.10	377.90	1.27	1.33
	6.10	6.30	1.13	0.78	497.55	408.29	34.50	32.10	117.80	141.30	1.26	1.35
	6.00	6.30	0.72	0.62	500.28	423.14	12.00	8.90	100.20	113.20	1.33	1.38
	6.10	6.60	0.87	0.39	392.17	298.67	15.00	13.40	297.60	303.00	1.22	1.35
	6.30	6.40	1.38	0.81	411.13	403.89	22.10	17.70	333.70	348.20	1.24	1.29
1500-1800	6.20	6.90	1.72	1.52	498.72	402.63	27.33	25.03	388.20	402.50	1.36	1.39
	6.00	6.20	1.56	0.92	402.16	395.89	26.60	24.20	123.90	143.70	1.25	1.33

	6.20	6.70	0.66	0.49	395.67	344.16	15.70	13.30	166.90	198.40	1.36	1.37
	6.40	6.60	0.73	0.52	411.77	398.87	17.50	19.10	144.80	156.10	1.38	1.17
	6.40	6.70	0.33	0.29	513.63	498.77	18.20	16.70	244.50	301.70	1.38	1.39
	6.10	6.50	1.19	0.88	400.92	389.19	11.30	9.20	222.90	245.60	1.39	1.42
	6.00	6.30	0.33	0.23	399.66	317.74	10.60	10.00	111.90	123.10	1.43	1.04
	6.30	6.40	0.45	0.31	503.28	491.10	18.90	16.10	146.90	167.80	1.41	1.42
	6.10	6.50	1.11	0.89	399.31	355.56	21.70	17.60	178.50	209.30	1.43	1.45
1800-2100	6.70	6.80	1.13	0.69	409.03	398.10	24.20	23.10	366.60	370.40	1.53	1.55
	6.60	6.80	1.11	0.77	402.16	385.66	26.80	23.29	223.40	287.90	1.55	1.56
	6.20	6.50	0.99	0.58	498.25	444.17	28.90	24.50	103.80	156.70	1.56	1.57
	6.10	6.70	0.70	0.54	400.08	322.43	13.20	20.30	132.00	211.30	1.48	1.40
	6.20	6.40	0.55	0.43	398.22	273.94	17.70	14.20	360.30	397.90	1.47	1.54
	6.70	6.90	0.73	0.44	402.80	309.88	16.30	13.80	248.70	306.20	1.55	1.57
	6.10	6.90	0.23	0.21	388.11	310.92	9.90	8.80	103.90	145.10	1.55	1.10
	6.20	6.40	0.23	1.92	513.45	493.28	33.10	31.10	391.20	400.90	1.56	1.57
	6.50	6.80	0.24	0.20	400.09	318.48	17.30	13.50	256.60	299.70	1.53	1.55

Depth (D1)= 0-20 cm, Depth (D2)= 20-40 cm, BD= Bulk density, Avail= Available

0-20 cm at 900-1200 m and maximum value of 1.57 g/cm3 at 20-40 cm depth at 1800-2100 m. The bulk density showed an increasing trend with increase in depth at all the elevations. Bulk density varied from 1.00 at 900-1200 m elevation class to 1.56 g/cm^3 at elevation class of 1800-2100 m indicating increasing trend with increase in elevation. The results are supported by Sharma and Qahar (1989), Kaushal (1992), Malik (1992) and Malik (2008) who reported that lower value of bulk density obtained is indicative of increase in clay content and soil compaction with increase in altitude which results in poor organic matter in soils.

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