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Assessment of Physico-Chemical Parameters of Forest Soil of Hirpora Wildlife Sanctuary, Kashmir

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ABSTRACT

The study was carried out on the forest soil of Hirpora Wildlife Sanctuary, Kashmir from June to November at three sites. Soil samples were collected from 0-15 depth.The following soil characteristics were examined: temperature, pH, soil texture, moisture, bulk density, chloride content, total alkalinity, organic carbon (OC), electrical conductivity (EC) and exchangeablecalcium (Ca) and magnesium (Mg). Soil pH from June to November ranged from 6.21 to 5.56 for site 1, 5.9 to 5.37 for site II and 5.9 to 5.73. Soil texture analysis revealed the soils at all the study sites with major proportion being comprised by the sand fraction and having a loamy sand character. The moisture content was found to be directly related to the herbaceous vegetation cover with the highest value at Site II. The moisture content showed low percentage at Site III, which was more affected by grazing and thus resulted in less cover of grasses and probably more evaporation of soil moisture from the exposed site. The electrical conductivity was highest in June and July months at all sites. Exchangeable Ca and Mg contents showed significant seasonal variation, decreasing from June to November which may be due to high littler decomposition in summer months and uptake by the growing vegetation. Low exchangeable Ca and Mg were found at site II (1.25 meq/100g and 0.30 meq/100g).The amount of organic matter was fairly good except at Site III(non-fenced grazing area/disturbed area) probably due to overgrazing during which much of herbage vegetation was picked up by the grazing animals.The available nitrogen showed a gradual decrease from June to October at all three sites

Key words: Soil Chemistry, Forest, Sanctuary, Anthropogenic activities, Biotic Stress

I.INTRODUCTION

Forest soils play a vital role in determining the sustainable productivity of the forest ecosystems.Forest lands with good physical and chemical characteristics are essential in maintaining productivity in terrestrial ecosystems and driving processes that maintain environmental quality [1].The growth and reproduction of forest cannot be understood without the knowledge of soil. The soil and vegetation have a complex interrelation because they develop together over a long period of time.Soil characteristics are made up of two properties

namely physical and chemical and a soil will usually behave according to the proportion and organization of these properties. Soils are made up of four basic components: minerals, air, water, and organic matter. In most soils, minerals represent around 45% of the total volume, water and air about 25% each, and from 2% to 5% organic matter [2]. Soil properties of terrestrial ecosystems depend upon a variety of abiotic and biotic factors that vary both spatially and seasonally [3]. Among abiotic factors total ion content, acidity, carbon, nitrogen and total phosphorous vary on spatial scale in the topsoil. Some additional factors like climate, land form, topography, soil texture, soil moisture, and plant community composition also affect soil composition [4] [5]. Among these, the total ionic contents and acidity independently influence the soil geochemistry and ultimately the distribution pattern of vegetation in an area. Climate shows no direct influence on the soil composition; however, it can have an indirect effect through plant community composition and/or soil moisture. If the climate turns more arid, then the soil is expected to lose moisture and become less acidic and less fertile [6] [7]. Similarly, the high content of soil carbon, nitrogen, total ion content and acidity strongly correlate with the composition of plant communities. Globally, soils contain more carbon than any other terrestrial carbon pool [8] and the forest floor is the most dynamic part of soil organic matter.Mostly the soil of Jammu and Kashmir is loamy and there is little percentage of clay in them. There is adequate organic matter and nitrogen content in the alluvium of the Kashmir valley as a result of plant residue, crops stubble, natural vegetation and animal excretion. A lot of work has been done on forest soils around the world; there is very little information with respect to soil studies in Jammu and Kashmir State. Keeping this in view a preliminary study on the physico-chemical characteristics was carried out in Hirpora Wildlife Sanctuary (Shopian) which has recently fallen a prey to the anthropogenic pressures vis-a.vis the Mughal road.

II.MATERIALS AND METHODS

2.1. STUDY AREA

The present study was conducted on the forest soils of Hirpura wildlife sanctuary, which is located in Shopian district, 70 km to south of Srinagar Kashmir. Three study sites were selected viz. Site I (Hirpora village),Site II (Dubjan) and Site III (Sukh Sarai) in order to study the physico-chemical properties of soil (Fig. 1). The study sites were selected at different aspect, topography, vegetation and varied visibly for the purpose of comparison.

Fig. 1 Location of examined sites in the study area.

2.2. METHODS

Soil sampling was performed on monthly basis from June to November. At each site, 3 soil cores were obtained randomly from 0-10cm depth with the help of a soil auger and then mixed to form the composite sample. Three replicates from the composite soil sample were sealed and labeled in the thick polythene bags and used for further analysis. The soil temperature was recorded onsite with the help of soil thermometer (ºC) and the collected soil samples were brought into the laboratory. The soil samples were sieved through 2mm mesh screen and divided into two parts, one part was used in field moist conditions to determine the soil moisture, pH, conductivity and available N and the other part was air dried to determine texture, bulk density (BD), organic carbon (OC), organic matter (OM), exchangeable cat ions (Ca^{2+}, Mg^{2+}). For estimation of chloride, carbonates, bicarbonates, calcium + magnesium and calcium1:2 soil water extract was prepared. Standard methods as given by Jackson (1973) were used for analyzing the soil samples [9]. Available nitrogen was estimated by alkaline permanganate method [10].

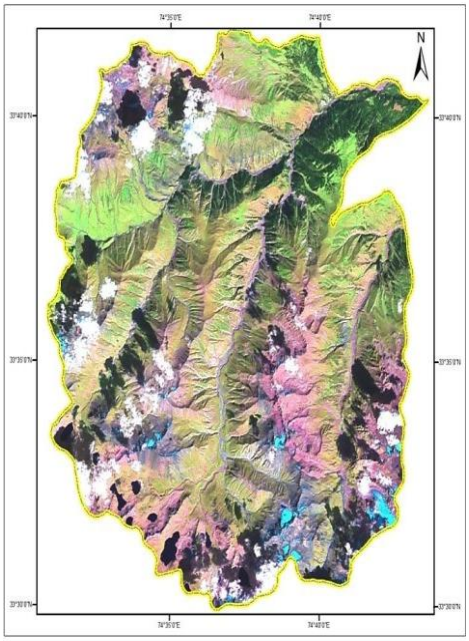

Fig. 2 Satellite image of the study area.

III.RESULT AND DISCUSSION

3.1. PHYSICAL PROPERTIES OF SOILS

3.1.1. AIR TEMPERATURE

The air temperature during the current study at all sites was varying depending on the season and vegetation cover. The maximum temperature of 24ºC was observed at the site III in the month of August and the minimum

of 2.1ºC was observed at the site II in the month of November. The air temperature from June to November ranged from 3.8ºC to 21ºC for site I, 2.1ºC to 20.6ºC for site II and 5.3ºC to 22ºC for site III.

3.1.2. SOIL TEMPERATURE

The soil temperature at all sites followed the same trend as air temperature but was slightly lower. The maximum temperature of 22.3 ºC was observed at the site III in the month of August and the minimum of 1.6 ºC was observed at the site II in the month of November. The soil temperature from June to November ranged from 2.8ºC to 18ºC for site I, 1.6 ºC to 17 ºC for site II and 4 ºC to 19 ºC for site III.

3.1.3. SOIL TEXTURE

The texture at the site II and site III was found to be "loamy sand", showing the dominance of sand at all the sites. The mean percentage of sand, silt and clay of the whole stretch was found as 73% %, 22 % and 4.66 % respectively. Site I had the highest percentage of silt (30%) and lowest percentage of sand (60%). The lowest percentage of clay (2%) was found at site II and site III than the site I.

3.1.4. MOISTURE CONTENT

The moisture content during the current study at all sites was fairly good. The maximum moisture of 28.50 % was observed at the site II in the month of November and the minimum of 7.4% was observed at site III in the month of July. The moisture content of soils from June to November ranged from, 20.40% to 12.73% for site I, 28.50% to 13.66% for site II and 22.25% to 13.60% for site III. This may be due to the rainfall and snow showers that had occurred then. Thus it showed fixed seasonal trend, i.e., maximum during snowfall and least during summer months showing direct relationship with precipitation [11]. Site II an undisturbed site had higher soil moisture content than disturbed site III. In undisturbed site the vegetation cover is more and less penetration of sunlight and thus results in less loss of moisture through evaporation [12].

3.1.5. BULK DENSITY

The mean bulk density varied from 0.78 g/cm³ at site II to 0.87g/cm³ at site III. The highest bulk density of 0.91 g/cm³ was found at site- III in the month of July and the lowest of 0.75 g/cm³ was found at site II in the month of October and November. This may be due the less grazing impact on site II as compared to other two sites. Bulk density increases with increase in grazing intensity [13] [14].

3.2. Chemical properties of soils.

3.2.1. SOIL pH.

During the current study pH was slightly acidic at all the sites. The maximum pH was recorded in the month of October at all 3 sites, with highest value (6.31) recorded at site I and the minimum pH was recorded in the month of June at all 3 sites, with lowest value (5.37) was recorded at the site- II. The pH of the soils from June to November ranged from 6.21 to 5.56 for site I, 5.9 to 5.37 for site II and 5.9 to 5.73 for site III, with a gradual increase from June to October. Pine needles can be responsible for the lower pH at all the sites which have strong acidifying power [15] [16].On monthly basis, it was found that pH decreased from June to July and then

again increased towards November, this possibly may be due to rise/fall in temperature, resulting increase/decrease in CO2 concentration, increase/decrease in microbial activity and organic matter accumulation /decomposition in soils [17].

3.2.2. ELECTRICAL CONDUCTIVITY

The electrical conductivity during the current study at all sites was low. The maximum electrical conductivity was recorded in the month of June at all three sites, with highest value (240µS/cm) was observed at the site III and the minimum electrical conductivity was recorded in the month of November, with lowest value (155 µS/cm) was observed at site II which indicates that there was a gradual decrease in conductivity from June to November for all three sites and mean Electrical conductivity decreases with decrease in soil temperature at all sites. Electrical conductivity was highest in June and July months at all sites, this could be due to the high organic matter content. Also, an increase in organic materials leads to an increase in the electrical conductivity of the soil [18].

3.2.3. TOTAL ORGANIC CARBON AND ORGANIC MATTER

Organic carbon constitutes a significant fraction of forest soils. During the present study the total organic carbon (%) gradually decreases from June to October and later increases in month of November. The maximum organic carbon (%) was recorded in the month of June at all three sites, with highest value (3.03%) was recorded at the site-II. The organic matter followed the same trend as like organic carbon. Maximum percentage of organic matter (5.22%) was found at site II in the month of June and the minimum percentage of organic matter (2.62%) was found at site III in the month of October.Site II recorded high organic matter content with an average value of 4.66% as compared to the other sites which may be attributed to the rich litter deposition, less grazing impacts and due to the low mineralization caused by relatively lower temperature under the shade of dense trees and therefore due to the slow rate of decomposition of organic matter [19] [20].

3.2.4. CHLORIDE CONTENT

Chloride content of soil during the present study was found low at site II and site III other than site I. The maximum value (2.16meq/l) of chloride content was recorded in month of June at site I and minimum value (0.7meq/l) was recorded in the month of November at site II. During the present study the lowest chloride content was found in site II, this may be due to the high uptake of Cl^- ions by trees as nutrient and leaching effect by rainfall. Higher concentration of trees and moisture causes decrease in chloride-content [21] [22].

3.2.5.EXCHANGEABLE CALCIUM AND EXCHANGEABLE MAGNESIUM

During the present study the exchangeable calcium content was found to vary between a minimum of 0.75 meq/100g of soil at site I in the month of November to a maximum of 1.83 meq/100g of soil at site III in the month of June. The recorded calcium content decreased from June to November at all the sites. The highest value of exchangeable calcium was found at site III and lowest at site II. The highest value of exchangeable magnesium at 3 sites was recorded in the month of June and the lowest was recorded in the month of

November.It has been noticed that increase in calcium and magnesium may be due to decomposition of litter; subsequent decreasing may be due to leaching and uptake by plants [23].

3.2.6.TOTAL ALKALINITY (BICARBONATES)

During the present study the total alkalinity was mainly found as bicarbonate alkalinity. The maximum bicarbonates of 2.91meq/l was found at site I in the month of November and minimum of 1.50 meq/l found at site III in the month of July. The highest values of bicarbonates were found in the month of November at all 3 sites and minimum in the month of July at all 3 sites. The bicarbonates decreased from the June to July, and then the values showed a gradual increase in bicarbonates at all 3 sites from July to November. Bicarbonate alkalinity was recorded at all sites and showed an increasing trend with increase in soil moisture which was found to be the fact in the study area. Lower values of insolation parameter might favour greater moisture in the soil, causing an increase in bi-carbonate concentration [24].

3.2.7. AVAILABLE NITROGEN

The maximum value (210ppm) was recorded in the month of June at site III and minimum value (126ppm) was recorded in the month of September at site II. The available nitrogen was recorded highest in the month of June and July at site I and site III which could be due to higher amount ofavailable organic material [25].while as lowest value recorded at the site II. The available nitrogen showed a gradual decrease from June to October at all three sites. As per the study the soil nutrients are most available in the spring and early summer when summer temperature and moisture are favorable, and mineralization, is rapid [26] [27].

Table.1 Physico-Chemical Characteristics of Soil Samples.

Parameters	Sites	June	July	August	September	October	November	Mean ±S.D
Air temperature (ºC)	I	21	23	22	22.8	14.6	3.8	17.86±7.56
	II	20.6	22.4	21.2	20.2	12.2	2.1	16.45±9.91
	III	22	22.8	24	21	13.8	5.3	18.15±7.25
	Mean ±S.D	21.2±0.72	22.73±0.30	22.4±1.44	21.33±1.33	13.53±1.22	3.73±1.60	
Soil temperature	I	18	20	19	16	11.8	2.8	14.6±6.46
	II	17	19	18.4	14	10.7	1.6	13.4±6.57

(ºC)	III	19	21.8	22.3	17.1	12	4	16±6.97
	Mean ±S.D	18±1.00	20.26±1.41	19.9±2.1	15.7±1.57	11.5±0.7	2.8±1.2	
Soil moisture (%)	I	12.73	15.60	15.68	17.10	19.50	20.40	16.8±2.81
	II	13.66	12.6	18.7	20.66	23.25	28.5	19.5±5.97
	III	13.6	7.40	8.60	15.4	15.48	22.25	13.8±5.38
	Mean ±S.D	13.33±0.52	11.86±4.14	14.32±5.18	17.72±2.68	19.41±3.88	23.7±4.24	
Bulk density(g/cm³)	I	0.86	0.87	0.86	0.83	0.80	0.79	0.84±0.02
	II	0.83	0.81	0.78	0.77	0.75	0.75	0.78±0.03
	III	0.86	0.91	0.88	0.87	0.86	0.84	0.87±0.02
	Mean ±S.D	0.85±0.01	0.86±0.05	0.84±0.05	0.82±0.05	0.80±0.05	0.79±0.04	
pH	I	5.56	5.64	6.23	6.12	6.31	6.21	6.01±0.32
	II	5.37	5.68	5.91	6.10	6.12	5.90	5.84±0.28
	III	5.73	5.96	6.01	6.10	6.14	5.90	5.97±0.14
	Mean ±S.D	5.55±0.18	5.76±0.17	6.05±0.16	6.10±0.01	6.19±0.10	6.00±0.17	
Electrical conductivity (µS/cm)	I	215	207	191	179	173	162	187.8±20.4
	II	203	205	173	167	163	155	177.6±21
	III	240	232	220	184	178	165	203±31.3
	Mean	19.33±18.8	14.66±15.0	94.66±23.7	176.66±8.73	171.33±7.63	160.66±5.13	

	±S.D	7	4	1				
Total organic carbon (%)	I	2.14	1.89	1.86	1.83	1.76	1.89	1.89±0.12
	II	3.03	2.90	2.67	2.53	2.14	2.99	2.71±0.33
	III	2.28	2.19	2.06	1.76	1.52	2.02	1.97±0.28
	Mean ±S.D	2.48±0.47	2.32±0.51	2.19±0.42	2.04±0.42	1.80±0.31	2.3±0.60	
Total organic matter (%)	I	3.68	3.25	3.20	3.15	3.03	3.25	3.26±0.22
	II	5.22	4.99	4.60	4.36	3.68	5.15	4.66±.058
	III	3.93	3.77	3.55	3.03	2.62	3.48	3.39±.048
	Mean ±S.D	4.28±.008	4.00±0.008	3.78±0.007	3.51±0.007	3.11±0.005	3.96±0.01	
Chloride content (meq/l)	I	2.16	2.15	2.15	2	1.66	1.50	2.02±041
	II	1.50	1.33	1.16	1.1	0.96	0.7	1.12±0.28
	III	1.66	1.50	1.33	1	0.83	0.79	1.18±0.36
	Mean ±S.D	1.77±0.34	1.66±0.43	1.54±.052	1.36±0.55	1.15±0.44	0.99±0.43	
Exchangeable calcium (meq/100g)	I	1.75	1.70	1.45	1.35	1	0.75	1.33±0.39
	II	1.65	1.35	1.31	1.20	1.12	0.90	1.25±0.25
	III	1.83	1.75	1.45	1.20	1.15	0.87	1.37±0.37
	Mean ±S.D	1.74±0.09	1.6±0.21	1.40±0.08	1.25±0.08	1.09±0.07	0.84±0.07	
Exchangeable	I	0.63	0.48	0.43	0.36	0.31	0.24	0.40±0.13

magnesium (meq/100g)	II	0.38	0.33	0.32	0.30	0.27	0.23	0.30±0.05
	III	0.61	0.55	0.45	0.38	0.33	0.29	0.43±0.12
	Mean ±S.D	0.54±0.13	0.45±0.11	0.4±0.07	0.34±.004	0.30±0.03	0.25±0.03	
Total alkalinity (bicarbonates) (meq/l)	I	2.16	2.33	2.50	2.66	2.83	2.91	2.56±0.29
	II	1.87	1.66	1.70	1.83	2	2.16	1.87±0.87
	III	1.65	1.50	1.52	2.16	2.33	2.41	1.92±0.41
	Mean ±S.D	1.89±0.25	1.83±0.44	1.90±0.52	2.21±0.41	2.38±0.41	2.49±0.38	
Avalaible Nitrogen (ppm)	I	196	182	168	154	140	152	165.33±20.80
	II	184	140	140	126	154	168	152±21.20
	III	210	196	183	168	154	154	177.5±22.90
	Mean ±S.D	196.66±13.01	172.66±29.14	163.66±21.82	149.33±21.38	149.33±8.08	158±8.71	

IV.CONCLUSION

From the present investigation, it can be inferred that seasons have great influence on soil characteristics. Grazing pressure not only brought about a reduction in the plant density and vegetation cover, but also caused a significant change in plant growth pattern. By higher animal trampling the availability of mineral nutrients in the soil was significantly affected. High nutrient levels at the forest site is also due to nutrient regeneration from fallen leaves, twigs, buds, flowers, animal excretal, decaying roots etc. The results of the present study indicate that a magnitude of ecological stresses have disturbed the forest ecosystem as reflected by variability in soil characteristics. On the other hand, the reduction in vegetation cover due to various factors such as grazing pressure and construction of Mughal road not only makes the soils prone to erosion but also lead to loss of major plant nutrients due to leaching.

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