CHAPTER - IV

Studies on the Physico-Chemical characteristics of the Soils of Eastern Himalayan Region.

As the nature and mode of different agencies responsible for soil formation and distribution of organic matter in soils are very much governed by the eco-system, the physico-chemical characteristics of the soils vary widely from region to region. In India very little emphasis has so far been given to the study of eco-system of the mountain soils, specially in the Eastern Himalayan Region.

In the present chapter attempts have been made to study some of the physical as well as chemical characteristics of twelve samples of soils collected from foot-hills (Terai and Dooars area) to an altitude of 11200 ft (Sandakphu), above the sea level. Particular attention has been given to study the distribution pattern and the properties of organic matter, clay minerals, free-oxides and minerals as functions of altitude, climatological conditions etc. Relevant information with regard to the organic components of these soils is reported.

Experimental:

Soil samples (0-20 cms) are collected mostly from the virgin soils of different parts of the Eastern Himalayan Region.

Air dried and seived (2 mm seive) soils are first analysed for organic matter (by Walkley and Black method) and available potassium (Using Systronics Digital Flame Photometer). Humus is separated by repeated treatment of the soil with 0.5 (N) NaOH. After first 24 hrs. extraction of the humus, a part of the soils are dried and analysed for organic matter[148] in order to determine the easily extractable humus. The humus is frationate d into humic acid and fulvic acid.

H-form Humic acids are prepared by passing dialysed humic acid through a column of H-form cation exchange resin (Amberlite I.R. 120). Fulvic acid is preserved as Ba-salt. The percentage of Carbon in humic as well as fulvic acids are determined separately.

In Inorganic part i.e. clay fraction ($< 2\mu$) are collected from the soils by usual standard method. It is then freed from the residual organic matter by treatment with hydrogen peroxide in slightly acidic medium on the water bath and the free-oxide is removed from these clays by Oxalic acid-Alluminium reduction method. The cation exchange capacities (C.E.C) for the clays are determined with $Ba(OH)_2$ in presence of $BaCl_2$. In determining C.E.C by potentiometric titrations, a precision pH-Metre (Radelkis-O.P 205) fitted with a combined electrode (O.P 8971-1/A) has been used. Optical densities for 0.02% solutions of sodium humate (pH-8-9) are measured with a Beckmann DU-2 Spectrophotometer.

Results & Discussions:

A study of the following soils samples have been undertaken:

a) Three Terai and Dooars soils from the foothills of the Himalayas viz.,

i) Raja-Rammohanpur soil, ii) Dhupguri soil and iii) Alipurduar soil.

b) Mountain soils collected from the sites of gradual increasing altitude (Table-4-1).

All the soils are acidic in nature (pH - 4.5 to 5.5). In general the acidity of the soil increases with altitude (Table-4-1). This is not unexpected because of higher rate of leaching as a result of heavy rainfall on the mountains.

The percentage of Organic matter increase with increase in altitude of the collection sites. This is probably due to the fact that the gradual change in the temperature and moisture etc. favour the formation of humus like substances (Table-4-1). The presence of comparatively high percentage of organic matter in the Dooars and Terai Soils as compared with the hill soils indicates that these soils act as initial sink to the organic matters from the hills. Moreover, alternate drying and wetting throughout the season favours the increased formation of the humus in these soils. The content of easily extractable organic matter increased almost regularly with height. This suggests that the extent of fixation of humus in these mountain soils is very low. As regards available potassium, no definite corrlation is, however, observed with increase in the altitude of the soils.

Table-4-1

Sl. No.	Soils from	Altitude (feet)	pH	% of Org. matter	% of org. matter after one treatment with caustic Soda	% of clay (<2μ) (w/w)	% of available potassium ppm*
1.	Raja-Rammohanpur	Foothill	5.1	1.41	0.754	13	15.44
2.	Dhupguri	-do-	5.00	1.31	0.204	27	21.15
3.	Alipurduar	-do-	5.25	0.69	0.451	34	7.06
4.	Kalimpong-I	3800	5.25	0.70	0.420	7	20.10
5.	Kalimpong-II	3800	5.20	0.77	0.392	8	6.90
6.	Kalimpong-III	4000	5.20	0.90	0.461	5	18.60
7.	Kalimpong-IV	4000	5.10	0.68	0.401	10	22.00
8.	Sonada	5800	4.85	0.97	0.342	2.9	2.40
9.	Darjeeling	6500	5.05	1.26	0.362	2.00	22.05
10.	Manebhanjan	7800	5.00	1.03	0.315	2.00	28.2
11.	Tanglu	9500	4.65	0.72	0.095	1.2	2.04
12.	Sandakphu	11200	4.60	1.23	0.103	1.3	1.90

* The analysis was done at F.C.I. Soil Testing Laboratory, Siliguri through the courtesy of Shri M.Nandi, Chief Soil Chemist and T.Sinha, Asstt. Soil Chemist.

Almost all the soils are characterised by the existence of small clay content and low cation exchange capacity. This is probably due to continuous leaching through heavy rainfall. Sandakphu, Tanglu etc. high altitude soils contain fairly large quantities of free-oxides, although the amount is less than that of foot-hills.

Proceeding from the foot-hills to the higher altitude the proportion of Humic Acid decreases and that of Fulvic Acid increases which is apparent from the decrease in the ratio of Humic Acid/Fulvic Acid (H.A./F.A., Table-4-2). For the soils of the foothills this ratio is found to be greater than Unity.

Table-4-2

No.	Soils from	C.E.C in m.equiv. per 100 gm of Clays: With free Oxides	C.E.C in m.equiv. per 100 gm of Clays: Freed from free Oxides	H.A.	F.A.	H.A/F.A. ratio
1.	Raja-Rammohanpur	27	24	428	560	1.2
2.	Dhupguri	38	33	492	607	1.0
3.	Alipurduar	23	21	470	590	1.02
4.	Kalimpong-I	35	31.4	525	720	0.97
5.	Kalimpong-II	30	29	402	709	0.96
6.	Kalimpong-III	32	29	497	602	0.98
7.	Kalimpong-IV	19	18	370	543	1.01
8.	Sonada	8	7.2	398	993	0.91
9.	Darjeeling	13	12	479	780	0.85
10.	Manebhanjan	18	16	503	693	0.88
11.	Tanglu	12	11	445	841	0.76
12.	Sandakphu	16	15	498	873	0.78

As regards the cation exchange capacity (C.E.C) for H.A. and F.A., it is observed that the C.E.C is in general higher in the hill soils. The increase in C.E.C can be explained by the fact that the acids are of low molecular weight with more aliphatic side chain and there is an intensive formation of new humus[2].

The high mountain soil humic acids have lower optical density as compared to that of the plane i.e. foot-hill soils (e.g. Raja-Rammohanpur, Dhupguri and Alipurduar soils).

Table-4-3

No.	Soils from	Values of Optical Densities at Wave lengths (n.m)					
		400	450	500	600	650	700
1.	Raja-Rammohan-pur	1.75	1.21	0.89	0.45	0.29	0.20
2.	Dhupguri	1.45	0.96	0.61	0.30	0.20	0.15
3.	Alipurduar	1.65	1.14	0.82	0.38	0.25	0.18
4.	Kalimpong-I	1.37	0.83	0.62	0.34	0.25	0.16
5.	Kalimpong-II	1.39	0.84	0.63	0.32	0.25	0.14
6.	Kalimpong-III	1.40	0.84	0.64	0.33	0.24	0.15
7.	Kalimpong-IV	1.40	0.83	0.63	0.32	0.24	0.16
8.	Sonada	1.29	0.81	0.56	0.28	0.22	0.16
9.	Darjeeling	1.10	0.77	0.53	0.25	0.18	0.14
10.	Manebhanjan	1.11	0.75	0.53	0.25	0.17	0.13
11.	Tanglu	1.05	0.65	0.48	0.23	0.16	0.12
12.	Sandakphu	0.99	0.68	0.48	0.22	0.16	0.11

As we go from lower to higher altitude, the optical density showed a gradual decrease (Table-4-3). The result is suggestive. The mountain soil humic acid appear to have less condensed aromatic rings[152]. The ratio of the extinction co-efficients at 465 nm (E_4) and 665 nm (E_6) of the humic acids for the higher mountain soils is higher. The result is in conformity with the views of Campbell et al[89]. They report that the humic material with the lowest mean residence time has the highest E_4 / E_6 ratio and it is of more recent origin. As a consequence the molecular weight is also low. The optical densities of humic acids of foothill soils are high because of the higher age of the H.A. which has presumably well condensed aromatic ring of higher molecular weight.