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Physico-chemical properties of the main soil types of Ranikhet region of Kumaun (Uttarakhand)

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ABSTRACT

Nutrient dynamics in the main soil types of Ranikhet region of Uttarakhand (India) was studied. The data obtained on comparison with the earlier such studies a relatively hot region has been reported.

Key words: Nutrient, Dynamics, Soil, Hill, Physico-Chemical comparison.

INTRODUCTION

Soil is an independent body in nature with a unique morphology from the surface down to the parent materials as expressed by the sample material as expressed by the sample profile [1]. Soil is the product of biochemical weathering of the parent material and its formation is influenced by the soil formation factors like climate, organism, parent material, relief and time [2, 3]. Soil word has been derived from Latin word *solum* which means earthy material in which plants grows. The study of soil is known as *Soil Science or pedology* (pedo means earth). This study is also known as *Edaphalogy* (Edaphos means Soil). Soil may also be defined as the part of the earth crust in which humus is present [4].

The surroundings or conditions in which a person, animal, or plant lives or operates is known as environment. Hydrosphere (i.e. water), lithosphere (i.e. Soil) and atmosphere (i.e. air) are supposed to be the main three components of environment [5-7]. Environment is usually divided into two parts:

(1) Physical environment
(2) Biotic environment
1. The physical environment consists of:
(i) Forces of nature like wind and gravity
(ii)Conditions like temperature and light
(iii) Time
(iv) Materials like soil and water.

2. The biotic environment is made up of all living beings including their reactions, interactions and interrelated actions [5].

It is obvious that no environmental study would be perfect unless all the components of environment are studied in detail. Since all these components are inter-related i.e. one component or factor decisively influences the other, so the environmental study is perhaps the most challenging field where all the factors/components are to be considered.

Moreover all the factors/components responsible for environment are unstable, which makes the job more tedious, difficult and challenging.

Study of the soil of a particular region is one of the important factors which contribute to the environmental study of the region. The nutrient status and the nutrient dynamics are therefore to be studied in detail to categorise the soil of a particular region.

A survey of the literature reveals that the physico-chemical characteristics of the main soil types of Kumaon region of Uttarakhand have not been centre of attraction for the scientists/ researchers working in this field. With the creation of the *new Uttrakhand State* periodic studies on this field have become more important, as this region is one of the major vegetable and pulse producing areas of the new state. A study on the physico-chemical characteristics of the main soil types of the Kumaon region of Uttarakhand have therefore been attempted in the present work with the following major objectives:

1. To study the soil types of Ranikhet region of Kumaun, Uttarakhand.
2. To study the contents of available macro and the micro-nutrients in the soils of the region.
3. To correlate the available soil macro and micro-nutrients with the properties of the soil.
4. To suggest methods/procedures for the maximum yield of the crops from the available agricultural land.
5. To make a guide line for the use of fertilizers to increase productivity.

EXPERIMENTAL SECTION

Three sites namely Bazeena, Bazole and Bamsyun from the Ranikhet Region of Kumaun, Uttrakhand have been selected for the present work. For the present work the urban and rural areas selected for this study have been briefly described below:

RANIKHET (URBAN)

Total Population	12086
Male	5690
Female	6396

RANIKHET (RURAL)

S. No.	Village	Area (in Hectare)	Male	Female	Total population
1	BAMSYUN	**168.856**	165	187	352
2	BAZOLE	**66.678**	62	59	121
3	BAZEENA	**171.356**	209	206	415

SOIL SAMPLING

The true representative soil of the study area was selected and collected vide the following steps/phases:
1. Selection of the sites in a particular study area.
2. Selection of the representative soil of the study area.
3. Collection of the soil samples from the study area.

Selection of the sites and the selection of the representative soil in the study were done by the standard method [1, 8]. Reduction of the sampling sites was done by the quartering method (Fig- 1).

The soil samples were spread uniformly over a sheet of paper which was divided into four equal parts. 2 and 3 parts (portions) were collected and mixed thoroughly and 1 and 4 parts were discarded. This process was repeated several times, till the right size of the sample was obtained.

ANALYSIS OF THE SOIL

Analysis of the soil was done under the following two major categories:
(a) Physical examination
(b) Chemical examination

Under the physical examinations soil temperature, soil clay, soil texture, BD and under the chemical examination, EC, pH, total nitrogen, available phosphorous, available potassium, sulphur, organic carbon, organic matter, and micronutrients were obtained.

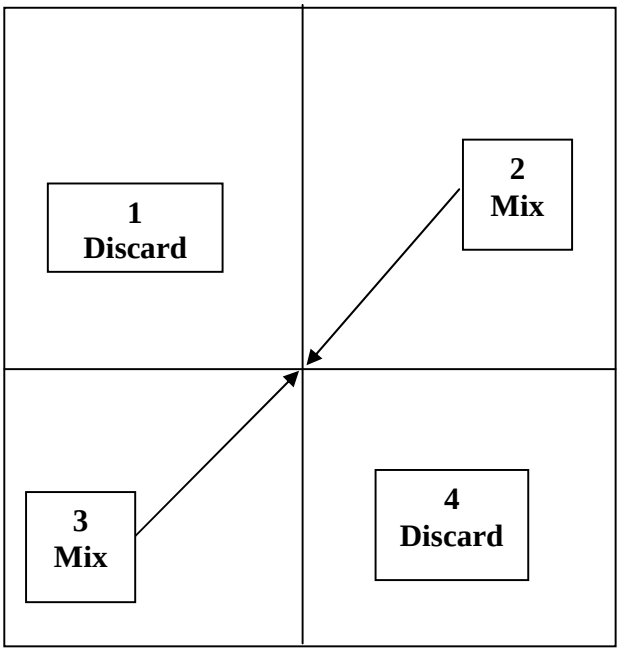

Fig. 1. Reducing sample size by Quartering method

RESULTS AND DISCUSSION

The physical and chemical examination of the soils of the study area was done by the standard methods/procedures. The observations and results of the present work have been reported hereafter vide Tables 1-14.

1. Soil Temperature

The soil temperature was recorded for each of the selected sites of the study area for all the months of the calendar year 2013, i.e. from January 2013 to December 2013. The results have been given in *Table-1*.

Table-1: Temperatures of the Soils of Ranikhet Region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Temperature (^{0}C) Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	11	12	25	27	30	29	29	28	28	27	25	22
2.	Bazole	S_{10}	11	12	24	27	29	28	28	27	27	26	26	20
3.	Bazeena	S_{11}	12	14	23	27	29	27	27	26	25	25	24	22

2. Soil colour

The colour of Soil was noted for each of selected sites of the study area as it was observed. The observations have been reported in Table-2.

Table-2: Colour of the soils of the Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Soil Colour
1.	Bamsyn	S_9	Yellowish brown
2.	Bazole	S_{10}	Yellowish brown
3.	Bazeena	S_{11}	Yellowish brown

3. Soil Texture

The soil texture was determined for each of the sites of the study area by the standard method. The results have been given in Table 1.3.

Table -3: Texture of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Soil Texture
1.	Bamsyn	S_9	Silt loam
2.	Bazole	S_{10}	Silt loam
3.	Bazeena	S_{11}	Silt loam

4. Soil Bulk Density

The soil bulk density was determined for each of the selected sites of the study area for all the months of the Calendar year 2013 i.e., from January 2013 to December 2013. The results have been reported in Table-4.

Table 4: Bulk Density of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Bulk Density (g/cc)											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	1.16	1.17	1.18	1.21	1.26	1.18	1.19	1.14	1.18	1.15	1.12	1.12
2.	Bazole	S_{10}	1.15	1.16	1.14	1.20	1.25	1.22	1.19	1.15	1.16	1.14	1.14	1.13
3.	Bazeena	S_{11}	1.18	1.16	1.18	1.19	1.17	1.02	1.06	1.11	1.18	1.23	1.15	1.13

5. Soil pH

The soil pH was recorded for each of the sites of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 5.

Table-5: The pH of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	pH											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	7.7	6.8	6.9	7.0	7.5	7.6	7.4	7.0	6.8	7.1	7.1	7.0
2.	Bazole	S_{10}	7.2	6.7	7.2	7.1	7.3	7.5	7.0	6.9	7.0	7.1	6.9	6.9
3.	Bazeena	S_{11}	7.6	7.0	7.3	7.0	7.2	7.3	7.1	7.1	6.9	6.8	7.0	6.9

6. Soil Electrical Conductivity (EC)

The soil electrical conductivity (EC) was determined for each of the sites of the study area for all the months of the calendar year 2013, i.e. from January 2013 to December 2013. The results have been reported in Table 6.

Table-6: EC of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	EC (ds/m)											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	0.42	0.38	0.36	0.31	0.29	0.30	0.29	0.30	0.29	0.30	0.28	0.28
2.	Bazole	S_{10}	0.35	0.33	0.31	0.32	0.29	0.40	0.31	0.36	0.38	0.42	0.36	0.33
3.	Bazeena	S_{11}	0.37	0.33	0.31	0.36	0.29	0.40	0.32	0.37	0.36	0.42	0.33	0.33

7. Soil Cation Exchange Capacity (CEC)

The soil cation exchange capacity (CEC) was determined for each of the sites of the study area. The results have been reported in Table 7.

Table-7: CEC of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	CEC (Milli equiv./100 g)
1.	Bamsyn	S_9	12.0
2.	Bazole	S_{10}	11.9
3.	Bazeena	S_{11}	12.5

8. Soil Organic Carbon (OC)

The soil organic carbon was determined for each of the selected sites of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 8.

Table-8: Organic Carbon of the soils of the Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	percentage of Organic Carbon											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	0.91	0.61	0.70	0.71	1.02	0.79	1.00	1.05	0.91	0.92	0.96	0.85
2.	Bazole	S_{10}	0.75	0.58	0.69	0.70	0.82	0.69	0.56	0.71	0.69	0.69	0.82	0.81
3.	Bazeena	S_{11}	0.49	0.39	0.38	0.48	0.67	0.42	0.40	0.51	0.42	0.33	0.36	0.33

9. Soil Organic Matter (OM)

The soil organic Matter was determined for each of the selected sites of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 9.

Table-9: Organic matters of the soils of the Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	% Organic Matter											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	1.57	1.05	1.39	1.22	1.76	1.36	1.72	1.81	1.57	1.59	1.66	1.47
2.	Bazole	S_{10}	1.29	0.99	1.19	1.39	1.41	1.19	0.96	1.22	1.19	1.19	1.41	1.49
3.	Bazeena	S_{11}	0.84	0.67	0.66	0.83	1.16	0.72	0.69	0.88	0.72	0.57	0.62	0.57

10. Soil Nitrogen

The soil nitrogen was determined for each of the selected site of the study area for all the months of the calendar year 2013, i.e. from January 2013 to December 2013. The results have been reported in Table 10.

Table-10: Nitrogen of the soils of the Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	% of Nitrogen											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	Bamsyn	S_9	0.61	0.60	0.65	0.70	0.75	0.60	0.68	0.70	0.63	0.59	0.55	0.48
2.	Bazole	S_{10}	0.58	0.71	0.70	0.72	0.70	0.61	0.59	0.69	0.70	0.71	0.59	0.55
3.	Bazeena	S_{11}	0.71	0.76	0.72	0.76	0.73	0.69	0.71	0.68	0.60	0.59	0.55	0.54

11. Soil Phosphorous

The soil phosphorous was determined for each of the selected site of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 11.

Table-11: Phosphorous of the soils of Ranikhet region of Kumaon (Uttarakhand). Year: 2013

S. No.	Site Name	Site No.	Phosphorous (Kg ha^{-1})											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Bamsyn	S_9	9.0	17.0	15.5	11.5	20.5	14.5	11.5	8.5	11.5	12.5	14.5	9.5
2.	Bazole	S_{10}	9.0	12.5	10.0	11.0	18.5	14.5	13.5	12.0	11.0	9.0	8.5	9.5
3.	Bazeena	S_{11}	9.0	4.5	9.5	11.5	18.5	14.5	14.0	12.5	11.5	8.5	9.5	8.0

12. Soil Potassium

The soil potassium was determined for each of the selected sites of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 12.

Table-12: Potassium of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Potassium (Kg ha^{-1})											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	Bamsyn	S_9	150	154	135	121	100	175	164	188	135	150	172	199
2.	Bazole	S_{10}	150	118	110	125	130	169	140	152	161	179	152	177
3.	Bazeena	S_{11}	117	126	122	135	150	169	140	160	135	145	170	175

13. Soil Sulphur

The soil sulphur was determined for each of the selected sites of the study area for all the months of the calendar year 2013, i.e., from January 2013 to December 2013. The results have been reported in Table 13.

Table-13: Sulphur of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Site Name	Site No.	Sulphur (Kg ha^{-1})											
			Months											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	Bamsyn	S_9	25	29	26	31	32	26	24	27	33	30	23	21
2.	Bazole	S_{10}	30	39	34	36	32	37	31	35	38	35	33	28
3.	Bazeena	S_{11}	19	17	15	18	16	16	12	14	17	15	13	17

14. Micronutrients

Micronutrients in the soils of the study area were determined by the standard methods on atomic absorption spectroscopy. The results have been reported in the Table 14.

Table 14: Available Metallic Ions (Zn, Cu, Fe, Mn and Mo) of the soils of Ranikhet region of Kumaon (Uttarakhand), Year: 2013

S. No.	Metals/Site No.	S_9	S_{10}	S_{11}
1.	Zinc (ppm)	3.15	1.36	1.25
2.	Manganese (ppm)	9.13	6.23	14.4
3.	Ferrous (ppm)	10.5	11.0	10.2
4.	Copper (ppm)	1.35	0.51	0.51
5.	Molybdenum (ppm)	0.23	0.32	0.22

A comparison of the results of the present work on the properties of the soils of the hill region of Ranikhet of Kumaon (Uttarakhand) state with the earlier studies by Pande and Trilochan in the Tarai/Bhabar regions was also attempted [9,10]. It was surprising to note that except a slight variation in the soil texture, soil temperature, soil colour and the bulk density of the soils, all other soil properties like pH, EC, CEC, OC, OM, P, K, S and the micronutrients like Zn, Cu, Fe, Mn were almost in the same range. It is probably due to the heavy rains in the hill region which in the form of rivers/streams takes away the soils of the hill region in bulk and these soils coming from the hills of the Kumaon region have ultimately spread over the Tarai and Bhabar regions of the Uttarakhand state. It is important to mention here that this process of the flow/transfer of soils has been a regular and inevitable natural phenomenon since the creation of these regions by nature. The minor changes in the soil of the hills and the Tarai/Bhabar regions is perhaps due to the change in the climate and the different types of fertilizers used by the farmers of these regions. The results of present study area in accordance with the work reported earlier from other regions [11-17].

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