International Journal of Agriculture Innovations and Research
Volume 2, Issue 2, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 04/10/2013 | Accepted on : 21/08/2013 | Published : 25/10/2013

Relationship Between Edaphic Factors and Vertical Ecological Zones of Nepal

Anjali Mainya Shrestha Malla, Ph.D
Associate Professor, Botany Department,
Tri-Chandra College, Tribhuvan University, Kathmandu, Nepal
Email: rajeshanjali_hanoi@yahoo.com

Abstract - **Soil is one of the important factors, which has considerable relationship not only with plant growth but also with the variations in topography. Soil analysis, such as moisture content, water holding capacity and texture was carried out from Kirtipur, Dhunche and Chandanbari in two consecutive years. SPSS/PC + statistical software package was used to carry out one way analysis of variance in soil parameters at 0.05 levels. The comparative study of edaphic factors such as moisture content, water holding capacity and texture of the soil of vertical ecological zones such as Kirtipur, Dhunche and Chandanbari, revealed that percentage of moisture and sand of soil showed a positive correlation and are important edaphic factors, which play an important role in changing "Fine texture soil or Medium type" of soil at Kirtipur during year first into "Coarse textured soil or light type" during year second, whereas it was already found "Light type" at Dhunche and Chandanbari areas. So, moisture and sand content of soil is higher in higher altitude while water holding capacity, clay and silt content of soil are lower. Water holding capacity, clay percentage and silt percentage of soil showed a negative correlation with vertical ecological zones. So, water holding capacity, clay and silt content of soil are higher in lower altitude while moisture and sand content of soil is lower. Therefore, the study showed that there is a relationship between edaphic factors and vertical ecological zones of Nepal.**

Keywords - **Chandanbari, Dhunche, Edaphic Factors, Kirtipur.**

I. INTRODUCTION

Nepal lies on the southern slopes of mid-Himalaya. Nepal's greatest wealth is its natural forests, plains and the mountains. The topography of Nepal varies from low land Tarai, 60 m above the sea level to high land Himalaya, 8848 m the Mt. Everest, which is the highest elevation on the earth. 83 % of the total land areas are high mountains and rolling hills and the remaining 17% is occupied by the flat lands of Tarai. These altitudinal variations produce diverse climatic conditions within a small area. Stainton, 1972 divided Nepal into seven natural zones extending from south to the north. According to him Kirtipur lies in Sub-tropical zone between 1245m to 1350 m elevations. Dhunche lies in Subtropical to Temperate zone between 1900 to 2000m elevations. This zone is represented by Schima-castanopsis and Pinus roxburghii forests type. Chandanbari lies in Temperate to Sub-Alpine Zone (3400 m to 3500 m). Oaks, *Abies*, Birches, *Junipers* and *Rhododendron* forest characterize this region.

Soil is the product of climate and vegetation (Odum, 1971). The vegetation and soil are coexisting in nature. Soil, chemically is a storehouse of nutrients on which the plant exists. Thus, soil is one of the factors that support the growth of the plants by supplying minerals and water (Shrestha Malla, 1981). The soil type is not determining factor of vegetation (Meher-Homji, 1977). Soil poses many characteristic physical and chemical properties that determine its quality and usefulness. Physiochemical characteristics of forest soils vary in space and time due to variations in topography, climate, physical weathering processes, vegetation cover, microbial activities and several other biotic and abiotic variables (Acharya and Shrestha, 2012).

The water holding capacity of the soil increases to a depth of about 5 cm from the surface and the saturation zone lies at 1.5 cm depth. Silt loam soils have intermediate situation in affecting water holding capacity (Kramer, 1949). According to the proportion of particle size, soil is classified into Clay, Loamy and Sandy i.e., simply heavy, medium and light respectively (Russell, 1988). Zobel and Jha et al. 1987 described different categories of soil mixtures such as Loam (equal amounts of sand and clay i.e 26-40 % clay), Sandy loam (more sand than clay i.e < 25 % clay), Silt Loam (more silt i.e > 50 %) and Clay Loam (more clay i.e < 45% sand). Soils with fine textures are found to have more water absorbing surface when compared with sandy soils. In course-textured soil, there is a range of water contents over which the water potential does not decrease (Miller et al.,1971). The Clay and Silt soils erode more. The steeper the slope, the thinner the soil layer, the higher the difference of the temperature within the soil, the higher the mobility of the soil and therefore the increasing loss of storing water (Kollmannsperger, 1974). The different soil types are responsible for drainage of water through ground covered by a forest (Saito, 1967). The soil type of Kathmandu valley varies from Silt Loam to Clayey Loam (Bhatt, 1970). Soil or edaphic factor increases with elevation (Hanawalt et al., 1976). Soil moisture, sand, silt and clay are important edaphic factors, which plays an important role in the distribution and population attributes of different varieties of *Trifolium repens* (Shrestha Malla, 2005).

II. METHODS

A. Study Areas -

The three study areas were selected for the present work on the basis of vertical ecological zones such as Midhills or Subtropical regions e.g. Kirtipur, Subtropical to Temperate regions e.g. Dhunche and Temperate to Subalpine region e.g. Chandanbari. (See Figure.1)

International Journal of Agriculture Innovations and Research
Volume 2, Issue 2, ISSN (Online) 2319-1473

Kirtipur- Kirtipur lies in south west of Kathmandu district and is 7 km from Kathmandu. It lies in subtropical region with an altitude extending from 1245 m to 1350m. It is located between the latitude 27" 42'N and the longitude 85"20' E. 243 ha of Kirtipur area is occupied by Tribhuvan University territories.

Dhunche- Dhunche lies in Rasuwa district. It is located northeast from Kathmandu valley. Dhunche lies in subtropical to temperate region at an altitude 1900m to 2000m. It is located between the latitude 27" 2' to 27"23'N and the longitude 85"1' to 85" 45'E. Dhunche is 45km far from Bidur, Trishuli. It is colder than Kirtipur area.

Chandanbari- Chandanbari, north from Dhunche also lies in Rasuwa district. There is no motor road from Dhunche to Chandanbari. It takes almost eight hours to reach Chandanbari from Dhunche passing by Deurali (2580m) and Dhimsa (3100m). Chandanbari lies in Temperate to Sub-alpine region at an elevation of 3500m including Himalayas and Inner Himalayas. The forest is dominant with *Abies*, Birches, *Quercus*, *Rhododendron* and *Junipers (Tsuga, cupresus).* Chandanbari forest was burnt 77 years ago, so this area has still remnants of burnt black trunks of *Abies* sp.

Fig.1 Map of Nepal showing study areas at: (K) Kirtipur, (D) Dhunche and (C) Chandanbari

B. Soil Study -

The study of soil was done at Kirtipur, Dhunche and Chandanbari for two consecutive years. Soils from six different aspects including East (1), West (2), North (3), South (4), Centre (5) and High land (6) areas were studied by quadrat method. Six different aspects from Kirtipur, Dhunche and Chandanbari were studied. Three quadrats were studied in each aspect for replications.

Soil sample preparation:

Sampling method- Soil samples were collected from "V "shaped notches, up to 15cm deep dug in the quadrat placed over different areas. The soil excavated while digging "V" notch was discarded. For sample collection, soil scraped from the two sides of the "V" notch was collected. Three quadrats were studied for each aspect. The soil sample from each quadrat was mixed thoroughly and 1 kg of the mixed soil was collected in an air tight polythene bag (F.R.S.R.D, 1980).

Drying and sieving- The soil samples from the field were air dried at room temperature according to their moisture content for seven days. After drying, soil sample was crushed gently with a wooden pastel and mortar discarding pebbles and gravels. It was then sieved through 2mm sieve, (F.R.S.R.D, 1980 and Jackson, 1967).

Physical analysis of soil:

Moisture Content (MC) - Clean and dry crucible was weighed with its lid. 10 gm. of soil sample was kept into the crucible and heated at 105 ◦C for 48 hours in a Hot Air Oven. The crucible was then cooled thoroughly in a desiccator and weighed again. The process was repeated for triplicate samples and calculations of soil moisture are given below (Mishra, 1968 and Zobel, Jha et al., 1987):

Calculations:

$$\text{Soil moisture } (\%) = \frac{\text{Loss of weight on drying}}{\text{Dry weight of soil}} \times 100$$

or

$$\text{Soil moisture } (\%) = \frac{(Y-Z)-(Z-X)}{(Z-X)} \times 100$$

Where, X = Weight of the crucible and lid
Y = Weight of the crucible and lid +Soil
Z = Weight of the crucible and lid +Soil after heating
(Y-X) = Weight of the soil before heating
(Z-X) = Weight of the soil after heating

Water Holding Capacity (WHC) - The filter paper was weighed and soaked in water. It was dried in room temperature for 30 minutes by keeping it in slanting position. When water was completely drained, it was weighed again. 25gm of soil was kept in wet filter paper and kept in the funnel. Water was allowed to pour drop by drop in the soil until the soil became totally saturated. When water drops stopped coming out of the filter paper, it was weighed and dried in oven at 105 ◦C for 48 hours. The dried filter paper with soil was cooled and weighed again. Calculations of WHC are given below (Modified method from Mishra, 1968):

Calculations:

$$W.H.C(\%) = \frac{\text{Wt. of dry soil} - \text{Wt. of wet soil}}{\text{Wt. of actual soil}} \times 100$$

or

$$W.H.C(\%) = \frac{(C - B) - (D - A)}{25\,gm} \times 100$$

Where, A = Weight of dry filter paper
B = Weight of wet filter paper
W = Weight of actual dry soil = 25 gm.
C = Weight of wet filter paper + Weight of wet soil
D = Weight of dry filter paper + Wt. of dry soil after drying
X= (C-B) = Weight of wet soil
Y = (D-A) = Weight of dry soil
Z = (C-B) – (D-A) = Weight of water in soil

Texture- Bouyoucos Hydrometer method (USDA System, Millar et al., 1958) was used for texture analysis. 50 gm. of soil was weighed in a clean beaker of 250 ml. Water was added to it. 10 to 15 ml of sodium hexametaphosphate (NaPO3) was added. Again water was added to make 250 ml by stirring well with a glass rod. It was left overnight. The solution was transferred in a dispersion cup and water was added to fill 2/3 of the cup. It was stirred for 5 to 10 minutes in mechanical stirrer (500 rpm). Then the solution was transferred in the Hydrometer Jar of 1000 ml capacity and the volume was made up to the mark, by adding water. After shaking well for 20 seconds, it was kept on the table and the time was noted immediately. The Hydrometer was immersed in the jar and reading was recorded within 40 seconds. The temperature was noted and it was left for two hours. The second reading was taken after two hours along with the room temperature. The hydrometer reading was corrected by subtracting 0.3 for every ◦C below 20 ◦C or adding 0.3 if the temperature is above 20 ◦C. Percentage of Sand, clay and silt were determined as follows:

$$\text{Silt} + \text{Clay}\,\% = A = \text{Hydrometer reading at 40 seconds} \pm 0.3 \times (t\ 20.C)$$

$$\text{Sand}\,\% = 100 - A$$

$$= 100 - \%\,(\text{clay} + \text{silt})$$

$$\text{Clay}\,\% = B = \text{Hydrometer reading at 2 hours} \pm 0.3 \times (t\ 20.C)$$

$$\text{Silt}\,\% = A - B$$

$$= \%\,(\text{Clay} + \text{silt}) - \%\,\text{clay}$$

The textural class was determined by "Textural Triangle" of USDA System

C. Statistical analysis - SPSS/PC + statistical software package was used to carry out one way analysis of variance at 0.05 levels for soil parameters (Gupta and Kapoor, 1984).

III. Results and Discussion

Moisture content (MC percentage) :

Analysis of variance for moisture in soil collected from six aspects was non-significant in year first and significant in year second at Kirtipur. Variations were significant in both years at Dhunche. Variations were significant in year first and non-significant in year second at Chandanbari (Table 1).

The comparative study among Kirtipur, Dhunche and Chandanbari between year first and year second showed highest MC% at Chandanbari (denoted by ↑, in year first) medium at Kirtipur and lowest at Dhunche (denoted by ↓ in year second).

The lowest value at Dhunche is due to low MC % in one of the aspects (dry area), otherwise all other aspects showed high MC%. Soil moisture content at Kirtipur increased in year second than in year first due to higher rainfall while decreased at Dhunche and Chandanbari in second year than in year first due to low rainfall. On an average, moisture content of soil was higher in Chandanbari, which was followed by Dhunche and Kirtipur areas during both years (Table 6, Chart 1and 2). Soil moisture was higher in Chandanbari and Dhunche than in Kirtipur. It is due to moist and humid environment, as it is cool and misty. Moisture of the soil is affected by texture and the amount of available water is low for the plants growing in coarse textured soil type (Olsen and Watanable, 1963; Black, 1968). Soil moisture relatively increased at Kirtipur but it decreased at Dhunche and Chandanbari during year second compared to year first. It is due to change of texture from fine to coarse type as well as higher rainfall in Kirtipur during year second. So, soil moisture content is high in higher altitude whereas it is low in lower altitude. When altitude increases, soil moisture also increases showing a positive correlation between soil moisture and altitude.

Water Holding Capacity (WHC percentage):

Analysis of variance for water holding capacity of soil under six different aspects in Kirtipur, Dhunche and Chandanbari showed non-significant variations in both years (Table, 2).

The comparative study between Kirtipur, Dhunche and Chandanbari during both years revealed that water holding capacity was higher at Dhunche, medium at Kirtipur and lower at Chandanbari When it was compared between these two years, the highest (↑) water holding capacity was found at Dhunche (year second) and lowest (↓) at Chandanbari (year first). On an average, water holding capacity was higher in Kirtipur than in Dhunche and Chandanbari in year first while second year showed almost similar result, which may be due to rainfall and other ecological factors (Table 6, Chart 1and 2). On an average, WHC % was lowest in Chandanbari than in Dhunche and Kirtipur during year first. It is due to highest

% of sand and lowest % of clay in Chandanbari, as shown by Black, 1968 and also due to high organic matter which improves water retention properties that directly helps water holding capacity of soil (Willem, 1990). This result also showed the negative correlation between WHC and altitude i.e. when altitude increases, WHC decreases. High WHC % at Kirtipur is also due to higher silt content, which was higher than in Dhunche and Chandanbari.

Texture: Sand percentage - One way analysis of variance in sand % of soil in different aspects in Kirtipur, Dhunche and Chandanbari showed non-significant in both years (Table 3).

The comparative study between Kritipur, Dhunche and Chandanbari during both years revealed that it was higher at Chandanbari, medium at Dhunche and lower at Kirtipur. When sand % was compared between these two years, it was highest (↑) in Dhunche (year second), Chandanbari (year first) and lowest (↓) in Kirtipur (year first). On an average, sand % was higher in Chandanbari, which was followed by Dhunche and Kirtipur during both years (Table 6, Chart 1and 2). So, Sand % of soil was highest in Chandanbari, medium in Dhunche and lowest in Kirtipur during these two years. The sand % in the soil of Kirtipur as well as Dhunche showed increasing tendencies from year first to year second whereas it was stable at Chandanbari, which might be due to existence of the undisturbed forest. It indicates that the soil in Chandanbari as well as Dhunche was of a lighter type. The coarse textured soil or light soil has high infiltration rate and more or less dry in nature which is much favourable for the plants of the humid tropics (Black, 1968). Higher altitude areas also show the higher sand % in soil. So, when altitude increases, soil sand % also increases showing positive correlation between them.

Clay percentage - The analysis of variance in clay % of soil in different aspects of Kirtipur, Dhunche and Chandanbari was non-significant on both years (Table 4).

The comparative study between Kirtipur, Dhunche and Chandanbari during year first revealed that it was higher at Kirtipur and lower at Dhunche. The comparative study between these altitudes during year second revealed that it was higher at Kirtipur and lower at Chandanbari. When clay % was compared between these two years, it was highest (↑) at Kirtipur (year first) and lowest (↓) at Dhunche (year first). However, it was increasing in Dhunche and Chandanbari from year first to year second, it was still lowest compared to that of Kirtipur. On an average, clay % was higher at Kirtipur, medium at Dhunche and lower at Chandanbari (Table 6, Chart 1and 2).So, Clay % was highest in Kirtipur indicating the heaviness of the soil but it decreased from year first to year second whereas sand % increased. Clay % was lowest in Dhunche during year first but increased in year second, even though it was lowest than Kirtipur and Chandanbari. Clay % of soil increased from first to year second at Chandanbari. The increase of clay % of soil at Dhunche and Chandanbari influences or induces the decrease of soil moisture and nitrogen content of soil during the year second (Shrestha Malla, 2002). Increase of clay % of soil induces the decrease of moisture and nitrogen content of soil (Black, 1968). The result proved that the increase of altitude brings about decrease of clay % in soil, showing a negative relation between them.

Silt percentage - Similarly analysis of variance in silt % of soil was only significant in Chandanbari in year first under different aspects (Table 5).

Higher silt % was found at Kirtipur and lower at Chandanbari when they were compared between Kirtipur, Dhunche and Chandanbari during both years. When silt % was compared between these two years, it was highest (↑) at Kirtipur (year first) and lowest (↓) at Chandanbari (year second). Silt % showed the decreasing tendency during year second than year first in all these three study areas. On an average, silt % was higher in Kirtipur than in Dhunche and Chandanbari during both these two years (Table 6, Chart 1and 2). When the silt % under different aspects in both years was compared, the decreasing tendency was seen during year second than first in all these three study areas. So, silt % in soil is also decreasing in increasing altitude i.e. when altitude increases, silt in soil decreases. In this way, silt content in soil also showed negative relation with altitude.

In this way the sand % in the soil was increasing while the clay % and silt % were decreasing at Kirtipur during year second as compared to year first. Even though clay and silt proportion in the soil of Kirtipur were greater than that of Dhunche and Chandanbari. Similarly the soil at Dhunche during year second, as compared to first, showed increasing % of sand and clay but the decreasing % of silt. The soil at Chandanbari during year second showed increasing % of clay and decreasing % of sand and silt as compared to year first.

Table 1: M C % of soil at Kirtipur, Dhunche and Chandanbari

Aspect	Year first			Year second		
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
1	14.82 ± 2.5	30.72 ± 3.5	46.4 ± 10.2	19.23±3.8 L	24.64±9.9 H	26.57 ± 4.2
2	14.96±1.1 H	28.73 ± 2.9	24.08 ± 0.7	19.89 ± 1.7	20.37 ± 9.7	26.44 ± 3.4
3	12.99±2.7 L	29.89 ± 2.8	40.31 ± 3.9**H↑**	20.73 ± 3.6	12.63 ± 5.9	32.07 ± 8.3 H
4	14.17 ± 0.8	6.19±2.1 L	19.66 ± 13.8 L	20.52 ± 0.7	14.33 ± 4.5	21.75 ± 1.3
5	14.26 ± 3.0	32.50±1.9 H	25.85 ± 11.5	23.78 ± 3.9	5.99±2.5**L↓**	20.32 ± 2.2 L
6	13.44 ± 2.0	6.40 ± 0.8	23.17 ± 3.8	27.69±1.5 H	9.80 ± 3.1	26.80 ± 3.8
Average	1 4.11	22.41	29.91	21.97	14.63	25.66
P-value	0.859 $	0.000 *	0.014 *	0.025 *	0.045 *	0.076 $

* = Significant value, $= Non-significant, H= High, L= Low,↑ = Highest, ↓ = Lowest

International Journal of Agriculture Innovations and Research
Volume 2, Issue 2, ISSN (Online) 2319-1473

Table 2: WHC% of soil at Kirtipur, Dhunche and Chandanbari

Aspects	Year first			Year second		
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
1	47.97 ± 2.2	46.03 ± 6.2	42.88±12.3 H	44.74±4.8 L	53.91±6.6**H↑**	41.96 ± 5.9
2	46.64 ± 2.1	46.19 ± 6.1	30.35±0.07**L↓**	45.74 ± 2.2	50.12 ± 1.2	38.67 ±5.6 L
3	46.48±1.6L	49.77 ± 7.7	40.4 ± 4.9	45.7 ± 6.2	42.88 ± 11.8	50.44 ± 9.5
4	48.81 ± 3.0	45.69 ± 5.9	40.61 ± 10.7	45.35 ± 5.0	45.75 ± 4.3	50.83 ±3.2 H
5	49.2± 4.1 H	52.43±3.2 H	41.61 ± 3.6	44.43 ± 3.2	43.07 ± 2.6	50.38 ±1.9
6	49.16 ± 4.1	43.77±4 .4 L	37.23 ± 6.2	48.32±4.5 H	42.45± 7.3 L	47.24 ± 12.9
Average	48.04	47.31	38.85	45.71	46.36	46.59
P-value	0.768 $	0.583 $	0.409 $	0.918 $	0.260 $	0.288 $

$= Non-significant, H= High, L= Low, ↑ = Highest, ↓ = Lowest

Table 3: Sand % of soil at Kirtipur, Dhunche and Chandanbari

Aspects	Year first			Year second		
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
1	18.2±3.8**L↓**	65.6± 3.5	75.6 ± 2	49.0 ± 6.7	77.0±1.8**H↑**	75.7 ± 2.8 H
2	23.8 ± 9.3	67.6 ± 6 H	71.8 ± 1.2	56.4±2.7H	71.7 ± 7.2	69.5 ± 3.2 L
3	21.0 ± 9.8	64.9 ± 3.1	76.3 ± 0	48.0±5.9 L	67.6±8.0 L	73.6 ± 5.1
4	24.9 ± 3.3	63.6 ± 3.5	76.2 ± 3.9	50.9 ± 3.9	72.8 ± 6.2	72.8 ± 7.8
5	28.1 ± 8.9	65.6 ± 2	71.5 ± 1.8 L	48.9± 3.9	71.6 ± 2.4	74.2 ± 4.6
6	29.4±6.6 H	59.6±5.3 L	76.5±5.9 **H↑**	50.0 ± 9.6	70.0 ± 7.5	72.4 ± 7.7
Average	24.23	64.48	74.65	50.53	71.78	73.03
P-value	0.475 $	0.32 $	0.23 $	0.58 $	0.57 $	0.83 $

$ = Non-significant, H= High, L= Low, ↑ = Highest, ↓ = Lowest

Table 4: Clay % of soil at Kirtipur, Dhunche and Chandanbari

Aspects	Year first			Year second		
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
1	25.9±6.7H ↑	1.07±1.2 L ↓	2.6± 0.2 L	21.4 ± 5.4	6.07±0.9 L	8.51±3.4 H
2	25.5 ±7.3	1.07±1.2 L↓	4.4 ± 0.0	22.1± 4.8 H	9.82 ± 2.7	6.57 ± 0.7
3	24.4 ±7.9	1.73± 1.2	3.83 ± 1.3	19.2 ± 3.9	8.94 ± 3.5	5.52 ±1.1 L
4	21.7 ±1.7	2.6 ± 2.2	5.47 ± 1.4	17.4 ±1.5 L	10.3 ± 4.1	5.85 ± 1.3
5	20.9 ±1.8	1.07±1.2 L↓	4.5 ± 3.3	20.1 ± 3.1	10.5±3.8H	6.99 ± 0.8
6	19.8±1.9 L	4.7 ±2 H	6.13±1.0 H	19.1± 1.3	9.61 ± 1.9	5.8 ± 1.2
Average	23.03	2.02	4.49	19.88	9.21	6.54
P-value	0.59 $	0.08 $	0.08 $	0.75 $	0.08 $	0.13 $

$ = Non-significant, H= High, L= Low, ↑ = Highest, ↓ = Lowest

Table 5: Silt % of soil at Kirtipur, Dhunche and Chandanbari

Aspects	Year first			Year second		
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
1	55.8±3.5**H↑**	33.3±2.3	21.8 ±2.0 L	29.6±12.0	16.9 ±1.6 L	15.77± 0. **L↓**
2	50.7±2.7 L	31.3± 5.0L	23.8 ±1.2	21.6±5.7L	18.5 ± 4.8	23.91± 2.7 H
3	54.6 ± 7.6	33.3±2.3	19.9 ±2.0	32.8 ± 5.4 H	23.5 ±4.8 H	20.88 ± 4.0
4	53.4 ± 4.7	33.8±4.2	18.4±2.8	30.3 ± 2.3	16.9 ±2.7 L	21.32 ± 6.5
5	51.1 ± 7.5	33.3 ±2.3	24±1.5 H	31.0 ± 3.0	17.9 ± 1.3	18.78 ± 3.8
6	50.8 ± 5.2	35.7±7.2H	17.3 ± 5.0	30.9 ± 8.3	20.4 ± 6.7	21.79 ± 6.8
Average	52.73	33.45	20.87	29.37	19.02	20.41
P-value	0.79 $	0.86 $	0.05 *	0.45 $	0.39 $	0.399 $

* = Significant value, $= Non-significant, H= High, L= Low, ↑ = Highest, ↓ = Lowest

International Journal of Agriculture Innovations and Research
Volume 2, Issue 2, ISSN (Online) 2319-1473

Table 6: Comparative Study Between Edaphic Factors And Vertical Ecological Zones

Average value		Year first			Year second	
	Kirtipur	Dhunche	Chandanbari	Kirtipur	Dhunche	Chandanbari
MC %	14.11	22.41	29.91	21.97	14.63	25.66
WHC%	48.04	47.31	38.85	45.71	46.36	46.59
SAND %	24.23	64.48	74.65	50.53	71.78	73.03
CLAY %	23.03	2.02	4.49	19.88	9.21	6.54
SILT %	52.73	33.45	20.87	29.37	19.02	20.41

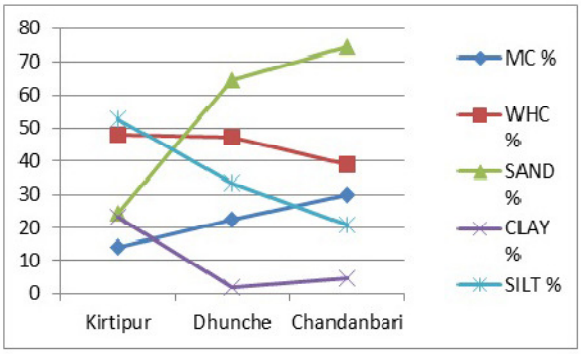

Chart 1- Year first

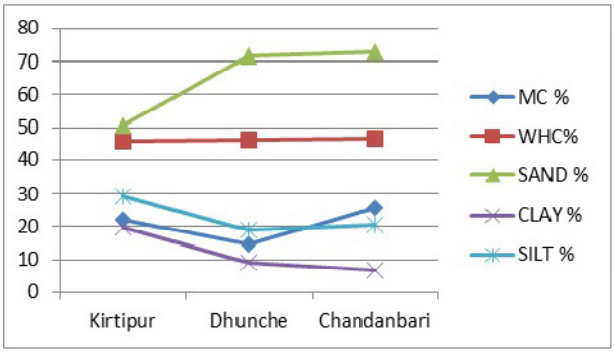

Chart 2- Year second

Chart 1 and 2: Comparative study of Soil Factors and vertical ecological zones

ACKNOWLEDGMENT

My sincere thank goes to Soil division, National Agriculture Research Centre (NARC), Khumaltar for providing laboratory facilities. Many thanks to Swechha Shrestha to formatting and editing the manuscript.

REFERENCES

[1] R. Acharya and B. B. Shrestha. (2012). Physiochemical Characteristics of Soil of A Mixed *Shorea Robusta* Forest In Rupandehi District, Nepal. *J. Nat. Hist. Mus*. 26. pp. 155-162.

[2] D. D. Bhatt. (1970). *Natural History and Economic Botany of Nepal.* Orient Longman, Calcutta (2nd ed.).

[3] Black. C. A. (1968). *Soil Plant relationships*. Willey Eastern Private Limited, New Delhi, India (2nd ed.).

[4] F.R.S.R.D. (1980). *Standard Methods of Analysis for Soil, Plant tissue, Water and Fertilizer*. Philippine Council for Agriculture and Resources research, Los Banõs, Laguna.

[5] S. C. Gupta and V. K. Kapoor. (1984). *Fundamentals of Applied Statistics*. Sultan Chand and Sons Publishers, 23, Daryaganj, New Delhi- 110002.

[6] R. B. Hanawalt and R. H. Whittaker. (1976). Altitudinally Co-ordinated Patterns Of Soils And Vegetation In The San Jacin To Mountains, California, USA, Soil Sci. 121 (8).pp. 114-124.

[7] M. L. Jackson. (1967). *Soil Chemical analysis*. Prentice Hall of India Private Limited, New Delhi.

[8] F. Kollmannsperger. (1974). *Agricultural Advisora In Gandaki Zone, Erosion and Erosion Control in Pokhara area (Kaski District),* Selfhelp Programme with the development project(F.E.1304), pp. 32-34.

[9] P. J. Kramer. (1949). *Plant and Soil-water Rlationships*. Mc Graw-Hill Book, Co.Inc., New York.

[10] V. Meher-Homji. (1977). Vegetation Climate Parallelism Along Pondicherry – My sore Murkal Transect, South India, Phyto Oosno Logya, 4 (2). pp. 206-217.

[11] C. E. Millar, L. M. Turk and H. D. Foth. (1958). USDA System in Fundamentals of Soil Science. 3 rd. ed., New York, John Willey and Sons, Inc. London. Toppan Company, Ltd. Tokyo, Japan. pp. 42-50.

[12] F. P. Miller, N. Holowaychuck and L. P. Wild ind. (1971). Soil Sci. Soc. Amer. Proc, 35.

[13] R. Mishra. (1968). Ecology Workbook. Oxford and IBH Publishing Co., Calcutta, Bombay, New Delhi.

[14] E. P. Odum. (1971). Fundamentals Of Ecolo gy , 3rd ed., W. B. Sanders Co. London. pp. 374.

[15] S. R. Olsen and F. S. Watanable. (1963). Diffusion of Phosphorous related to soil texture and plant uptake. Soil Sci. Soc. Amer. Proc, 27. pp. 648-653.

[16] E. W. Russel. (1988). Soil condition and Plant growth. Longmans Green and Co. London.

[17] K. Saito. (1967). Relation Between Distribu tion of Plant Communities and Soil on Mt. Hakkado, North-east japan. Ecol. Rev., 17 (1). pp.11-17.

[18] A. M. Shrestha Malla. (1981). Distributional Analysis of Plant species from Suryabinayak Forest Area (Kathmandu valley). A Disserta tion thesis submitted for the partial fulfilment of Degree in Science (Botany), Tribhuvan University.

[19] A. M. Shrestha Malla. (2002). The study On The Diversity Of Trifolium repens L. (white clover) In Nepal. Ph.D. Dissertation, submitted to central department of Botany, Tribhuvan University. Krtipur, Kathmandu, Nepal.

[20] A. M. Shrestha Malla. (2005). Effect of Eco logical Factors In The Distribution Of Trifolium repens L. In Nepal. J. Nat. Hist. Mus., 22. pp. 140-147.

[21] J. D. A. Stainton. (1972). Forests of Nepal. John Murray Ltd.

[22] C. B.Willem. (1990). Raising and Sustaining Productivity of Small holder Farming System in the Tropics, Natural Resources and Technical Aspects.pp. 205-215.

[23] D. B. Zobel, P. K. Jha, M. J. Behan and U. K. Yadav. (1987). A Practical Manual for Ecology. Nepal Printing Press (P) Ltd., BID, Balaju, Kathmandu.