GENERAL DESCRIPTION OF STUDY AREA

METHODOLOGY

HIMACHAL PRADESH: The great Himalayan chain of mountain forming the northern boundary of India extends over a length of about 2400 kms. Its width varies from 250 to 400 kms. from North-West to North-East with an elevation of 6000 amsl. of its central axial range. Himachal Pradesh is a mountainous state in North-West Himalaya, which extends from the Shivalik Hills in the South to the Great Himalayan ranges including a slice of trans-Himalayas in the North. (Fig.1)

Fig.: 1. Map of India and Himachal Pradesh showing broad area of Solan district.
**Location:** Himachal Pradesh is situated between 30° 22’ 40” to 33° 12’ 20” north latitudes and 75° 45’ 55” to 79° 04’ 20” East longitudes. The altitude in the state, (a wholly mountainous region in the lap of Himalayas) ranges from 350 meters to 6975 meters above mean sea level. Present study is carried out in Solan district of Himachal Pradesh. It is situated between 30°.53’ and 31°.03’ north latitude and 76°.48’ and 77°.10’ east longitude. (Fig.2)

**Boundaries:** State is surrounded by Jammu and Kashmir in the North, Tibet on North East, Uttaranchal in the East/South east; Haryana in South and Punjab in South West/West.
SOLAN DISTRICT

Solan District came into existence at the time of the reorganization of the districts of the State on 1st September, 1972. The District is bounded by Shimla district in the North and by Ropar District of Punjab and Ambala district of Haryana in the South, by Sirmaur District in the East and by Bilaspur district in the West. Mandi District touches the boundary of Solan district in North-East. It is located between 76.42 and 77.20 degree longitudes and 30.05 and 31.15 degree latitudes. The elevation of the district ranges from 300 to 2900 metres above sea level. The mountain ranges lie in the outer Himalayas and are a part of Shivalik ranges. The total geographical area of the district according to the Surveyor General of India is 1,936 sq. km. which constitutes 3.49 percent of the total area of the State and ranks 9th amongst the district. The Darlaghat Wildlife Sanctuary is located in district Solan. (Fig.3)

Fig.: 3. Detailed Map of Solan district.
Nature has endowed Himachal Pradesh with varied fauna and flora, which are to be preserved for the advantage of present and future generations. The state government is helpful to conserve our natural heritage of flora and fauna and has created a network of protected areas covering all the regions of the state. Darlaghat Wildlife Sanctuary was created to maintain it as a representative sample of measure of biological region of this part of Himalayas in its unaltered state.

The Darlaghat Sanctuary enjoys privilege of being situated in Shimla hill of Western Himalayas.

**Legal Status:** It was first notified as a sanctuary in 1962. Later renotified on 27 March 1974 and then finally notified on April 5, 2002.

**Area and Zoning:** 9226.80 ha. (92.27km²). No zoning has been done.
**Location:** Districts Solan and Bilaspur; Latitudinal range 31°09'12" to 31°17'13"N, Longitudinal range 76°52'40" to 76°59'30"E; nearest town Shimla (35 Km); Nearest Railway Station, Shimla (35 Km); nearest airport Shimla (50 Km). (Fig.4)

**Approach:** There is an entry point on the Shimla- Bilaspur state Highway, 35 km from Shimla.

**Topography and climate:** Altitude 1075 to 2069 m; Temperature ranges from 1 to 30°C; Mean annual rainfall 1040 mm.

**Water Resources:** Bader khad is the major perennial stream. There are three other perennial and several seasonal streams and thirty two springs, along with two seasonal (artificial) water holes.

**Biogeography:** Forms a small portion of the Western Himalayan zone.

**Geomorphology:** The rocks are formed of shale and slate/sand stone etc.

**Forest Types:** The following types of forests are found in Darlaghat Wildlife Sanctuary.
i) Western mixed coniferous and broad leaves forests. ii) Moist temperate deciduous forests and iii) Ban oak forests.

**HUMAN PRESENCE**

**Rights and Leases:** 299.40 ha. of the sanctuary is under cultivation and habitation, which is considered as rights of the local people. These people also enjoy rights in relation to grazing, extraction of fodder and collection of timber; fuelwood and minor forest produce on whole of the sanctuary except the areas closed for plantations. There are also rights in relation to religious monuments and burial grounds. An annual religious fair is held at the Baradeo Temple in April–May every year. Gaddi nomads are issued permits, by the Territorial wing of the Forest Department, for grazing their livestock inside the sanctuary.

**Grazing:** Local people have grazing rights, while Gaddi nomads are issued permits for their livestock inside the sanctuary.
SOCIO-ECONOMIC STRUCTURE

The Darlaghat Wildlife Sanctuary has an area of 628.40 hectare. There are eight human settlement villages with a total population of 1139 human beings. These villages are dependent on the forests of the sanctuary for timber, fuelwood, fodder, and other minor forests produce to a large extent. The society is largely agrarian. *Triticum aestivum*, *Zea mays* and vegetables are the main crops. In many parts trees of stone fruits have also been introduced and are becoming popular. Because of the difficult terrain and harsh climate people have to put in very hard labour to survive. Animal husbandry is main supporting occupation. Sheep and goat are kept to meet the requirement of wool, bullocks are used for ploughing, buffalo and cow are used for milk. Hunting of wild animal was a major past time in the past. However, with the setting of GACL (Gujrat Ambuja Cement Ltd), there has been a large change in the socio-economic condition and life style of the people with emphasis being shifted to secondary sector. (EIA GACL, 1999)

Cropping pattern

The crops like maize and wheat are mainly cultivated in the surrounding villages of study area. The pulses like cowpea, rajmesh, and black gram are also grown. The cultivation is dependent on rain in monsoon which allows only one crop in a year. The lack of adequate irrigation facilities does not give good productive yield of agricultural products. Hence the yield of rice and wheat is very low, maize yield is comparatively higher. The citrus fruits like lemon and vegetables like tomato, kachalu, spinach, cucurbits are cultivated in the region in small scale. Ginger is also cultivated by people in the area. Seeds of wild pomegranate are collected by the locals for their own use was observed during the study period.

LAND USE PATTERN

Studies on land use of any area play an important role in identifying sensitive issues and to take appropriate action to maintain (ecological homeostatis) in the region for sustainable development. However, the data included in this section is collected and incorporated from earlier reports submitted to Gujarat Ambuja Cements by different agencies. (Table.1)
Land use pattern based on remote sensing

In addition to the study of land use pattern based on secondary sources (census records) remote sensing satellite imageries were collected and interpreted for the 10 km radius with existing Kashlog mine as center. The land use/land cover classes of the study area and their respective areas are given in Table-1.

Table: 1. Land use pattern based on IRS-1B data around Kashlog mining of Gujarat Ambuja Cements Ltd.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Class</th>
<th>Area (ha)</th>
<th>% of Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Settlements (Built-up land)</td>
<td>573.72</td>
<td>1.82</td>
</tr>
<tr>
<td>2</td>
<td>Cultivated land (Agriculture land)</td>
<td>8.473.87</td>
<td>26.90</td>
</tr>
<tr>
<td>3</td>
<td>Forest</td>
<td>3.878.96</td>
<td>12.31</td>
</tr>
<tr>
<td>4</td>
<td>Scrub Forest (Open/Dense Scrub)</td>
<td>8.066.61</td>
<td>25.61</td>
</tr>
<tr>
<td>5</td>
<td>Water Bodies (Streams/Rivers)</td>
<td>209.65</td>
<td>0.67</td>
</tr>
<tr>
<td>6</td>
<td>Culturable Waste (Non-Agricultural or waste land)</td>
<td>10.297.75</td>
<td>32.69</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>31,500.56</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>


METEREOLOGICAL DATA

The data pertaining to climate was collected from Gujarat Ambuja Cements and is as follows: (Table.2)

Temperature (°C)

Broadly Himachal experiences three seasons; hot, cold and rainy season. Summer lasts from mid April till the end of June and most parts become very hot (except in alpine zone which experiences mild summer) with the average temperature ranging from 28°C to 32°C. Winter lasts from late November till mid March. Snowfall is common in alpine tracts (generally above 2,200 meters (7,218 ft) i.e. in the Higher and Trans-Himalayan region). The average temperature during winter and summer is 7°C and 28°C respectively.

The yearly average temperature was recorded minimum 11.42°C for the year 2008 and maximum 26.4°C for the year 2009. It was also found that from 2008 to 2012 the
minimum temperature varied between 11.42°C (2008) to 14.36°C (2011) whereas, maximum temperature varied between 23.1°C to 26.4°C.

**Humidity (%)**
The yearly average of percent humidity varied from 53.2% (2008) to 62.6% (2010). However, data for the other years was not available.

**Wind Speed (Km / hr)**
The yearly average for wind speed varied between 3.91 km/hr (2008) to 7.05 km/hr (2010). The direction of the wind was predominating SE-NW. (Table.2)

**Table:2 Meteorological data recorded for Darlaghat area from 2008 to 2012.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Temperature (Deg. C)</th>
<th>Humidity (%)</th>
<th>Wind Speed Km/Hr</th>
<th>Wind Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>11.42</td>
<td>23.1</td>
<td>N.R.</td>
<td>5.42</td>
</tr>
<tr>
<td>2009</td>
<td>12.83</td>
<td>26.4</td>
<td>62.6</td>
<td>5.05</td>
</tr>
<tr>
<td>2010</td>
<td>13.89</td>
<td>24.45</td>
<td>54.59</td>
<td>4.71</td>
</tr>
<tr>
<td>2011</td>
<td>14.36</td>
<td>22.5</td>
<td>57.85</td>
<td>N.R.</td>
</tr>
<tr>
<td>2012</td>
<td>12.9</td>
<td>23.7</td>
<td>53.2</td>
<td>3.91</td>
</tr>
</tbody>
</table>

N.R.: Not Recorded/ Record Not Available


**Rainfall (mm)**

The data on total monthly rainfall is available from 2008-2012 except for few months. On yearly basis it was found that maximum total rainfall was recorded during 2008 (1063 mm) while minimum during 2010 (436.52 mm). On monthly basis maximum rainfall was received during July and August and minimum during April, November and December.

**The study sites:** After a complete survey and in depth study of the sanctuary, three different sites as Hill top (HT), Mid hill (MH) and Hill base (HB) were selected for detailed investigations.

**Hill top:** It lies between altitudes of 1700 to 2160 metre above mean sea level. The site is open and exposed to direct wind. The present site supports grassland and alongside
scattered vegetation of *Euphorbia roylena*, *Bauhinia variegata*, *Berberis aristata* and *Indigofera enneaphylla*. The site is altogether free from any disturbance.

**Mid hill:** It lies between altitudes of 1200 to 1700 metres above mean sea level. It supports grasslands along with *Phoenix humilis*, *Woodfordia floribunda*, *Zizyphus oxyphyla*, *Rhododendron arboreum*.

**Hill base:** It lies between 762 to 1200 meter above mean sea level in hill base. It is exposed to greater biotic disturbance, such as grazing and trampling by animals and scrapping and cutting of vegetation for fodder by the local population. This site supports good vegetation.
EDAPHIC CHARACTERISTICS:

Edaphic characteristics: Broadly soil of the state can be classified into nine groups on the basis of their development and physico-chemical properties. These are: alluvial soil, brown hill soil, brown earth soil, brown forest soil, grey wooded or podzolic soil, grey brown podzolic soil, planosolic soil, humus and iron podzols, alpine humus mountain speletal soils. The soil found in the district of Solan, is generally brown, alluvial and grey brown podzolic soil. The pH of soil is slightly acidic in nature in some parts of the district. Soil is generally sandy loam almost all over the district and soil depth is generally shallow except in areas having good vegetative cover. It is generally dry, shallow and deficient in organic matter. The study area comprises mostly of alluvial deposits of Quaternary age. The geological formations in the study area comprise of sandstone largely micaceous and form major features.

METHODOLOGY

Edaphic characteristics of the soil of Darlaghat Wildlife Sanctuary were done following Trivedi and Goel (1984) and APHA (1981), the methods are as follows:

Sampling and Processing
Sampling is an important step of any analysis. For cereals, vegetables, grasses and herbs the samples of soil were drawn from 0-15 cm depth. For plantation crops, trees and shrubs, composite sample from soil were collected at depth of 0-30, 30-60 and 60-100 cm from 4 to 5 pits in about 0.5 ha field. The field sample were spread out on a tray for air drying, after drying the samples were, sieved from 2 mm sieve and stored in air tight polythene bag / glass / PVC / porcelain jar. The sampling strategy varied depending upon the shape of the land and intended purpose.

Measurement of pH of soil samples
pH of the soil was measured potentiometrically in a 1:2 soil – water suspensions or in saturate soil paste using measured precaliberated pH meter.

Apparatus
pH meter, mechanical shaker, extraction pump, Buchner funnel.
**Procedure**

25 gm of air dried soil was weighed and sieved with 2 mm sieve and mixed with 50 ml of distilled water in 100 ml flask and shaked for one hour. pH meter was calibrated using pH buffer and after that pH of suspension was measured. Results are presented in table.

**Electrical Conductivity**

The measurement of EC will give the concentration of soluble salts in the soil at any particular temperature. EC measured in 1:2 or 1:5 soil-water suspension with the help of conductivity meter.

**Procedure**

EC meter was calibrated using standard KCl solution and the EC of suspension was determined.

**Organic Carbon**

Organic carbon in the organic matter. The organic carbon in the sample is oxidized with potassium dichromate and sulphuric acid. The excess potassium dichromate is titrated against ferrous ammonium sulphate.

**Procedure**

1 gm of soil was weighed into a 500 ml conical flask. Then 10 ml of 1 N K₂Cr₂O₇ and 20 ml of conc. H₂SO₄ was added and flask was swirled carefully and allowed to stand for 30 minutes. Slowly, 200 ml distilled water and conc. 10 ml H₃PO₄ was added. After which, 1 ml of diphenylamine indicator was added to the solution and titrated against 0.5 N Ferrous ammonium sulphate solution until green colour started appearing, indicating the end point. A blank was also run as a control.

**Calculation**

Organic Carbon (%) = 10(B-S) × 0.39 × mcf

B × W Where

B = ml of ferrous ammonium sulphate solution used for blank.
S = ml of ferrous ammonium sulphate solution used for sample.
mcf = moisture correction factor.
W = sample weight (g).
0.39 = conversion factor (including a correction factor for a supposed 70% oxidation of organic carbon.)
Nitrogen

Nitrogen in soil/sediments is mostly present in the organic form with small quantities of ammonium and nitrate.

**Total Nitrogen by Kjeldhal method**

This method measures only organic and ammoniacal form, therefore nitrate is excluded. The sample is digested in a mixture of $\text{H}_2\text{SO}_4$, $\text{K}_2\text{SO}_4$ and selenium (Se) which converts all N into ammonium sulphate. The distillation of ammonia (librated after sodium hydroxide is added to ammonium sulphate), over boric acid and titrated against standard acid to determine nitrogen.

**Apparatus**

Digestion block, Nitrogen distillation unit.

**Procedure**

5 gm of sample was weighed into digestion tube and was moist with distilled water. 20 ml of conc. $\text{H}_2\text{SO}_4$ and 5 gm of catalyst was added and tube was placed in digestion unit. In heating equipment the temperature was maintained about 400$^\circ$C and heating was continued till the mixture became transparent and was allowed to cool. 40% NaOH was added in digest till the colour changed to blackish and then it was distilled. The distillate (librated ammonia) was collected in 10 ml of 2% boric acid solution. The distillate was titrated against 0.01N $\text{H}_2\text{SO}_4$ solution until pink colour started appearing. Blank was run without soil for each set of samples.

**Calculation**

Total N in soil (mg/kg) = $(S-B) \times N \times 14 \times 1000$

Sample weight (g)

Where

$S$= Volume of acid used against sample.
$B$= Volume of acid used against blank.
$N$= Normality of acid.

**Calcium carbonate**

Carbonate in the sample is dissolved in the excess of hydrochloric acid. The remainder of the acid is titrated against sodium hydroxide. This method is known as Piper method.
Procedure

5 gm of sample was weighed into a 250 ml conical flask. 100 ml of 1N HCl was added using pipette and swirled gently. This was kept for overnight. It was shaked for two hours and the suspension was allowed to settle down and 5 ml of the supernatant was pipetted to 100 ml conical flask and 10 ml of water was added. 2-3 drops of phenolphthalein indicator was added and titrated with 0.25 M NaOH till colour changed transparent to purple. Blank was run without soil for each set of samples.

Calculation

\[ \text{CaCO}_3 \text{ (\%)} = (B-S) \times N \times 100 \times \text{mcf} \]

Sample weight (g)

Where

\[ B = \text{ml NaOH used for blank.} \]
\[ S = \text{ml NaOH used for sample.} \]
\[ N = \text{Normality of NaOH.} \]
\[ \text{mcf} = \text{moisture correction factor.} \]
\[ 100 = \text{conversion factor.} \]

Phosphorous

Phosphorus in soil and sediments can be determined in the acid digest by Vanadomolybdophosphoric yellow colour method. Ammonium molybdate reacts under acidic conditions to form a heteropoly acid and molybdophosphoric acid. In the presence of vanadium, yellow vanadomolybdophosphoric acid is formed. The intensity of the yellow colour is proportional to phosphate concentration. Concentration ranges for different wavelengths are:

<table>
<thead>
<tr>
<th>P Range (mg/l)</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 5.0</td>
<td>400</td>
</tr>
<tr>
<td>2.0 – 10</td>
<td>420</td>
</tr>
<tr>
<td>4.0 – 18</td>
<td>470</td>
</tr>
</tbody>
</table>

Procedure

10 ml of acid digestsed soil was placed in a 50 ml volumetric flask, and to this 10 ml of the vanadate-molybdate reagent was added and diluted to 50 ml. The contents in the flask were Mixed well and Phosphorus concentrations were read after 10 minutes using spectrophotometer at 420 nm. 0, 1, 2, 3, 4 and 5 ml of the 100 mg/litre of P solution were
taken in 50 ml volumetric flask separately and the colour was developed in identical manner. Spectrophotometer was calibrated with known P concentration and reading of the concentration of sample was taken.

**Potassium**

Potassium in soil exists as water soluble, exchangeable, fixed (lattice-K). The first two forms constitute only small part (not more than 1%) and are considered to be easily available to plant. These forms are determined by Ammonium acetate method of Hanway and Heidel (1952).

**Apparatus**

Flame photometer, Shaker, pH meter.

**Procedure**

5 gm of soil sample was weighed in 100 ml conical flask. 25 ml 1N ammonium acetate solution was added to it and was shaken for 5 minutes. The solution obtained was filtered through Whatman #1 filter paper and K concentration was measured of the filtrate using flame photometer.

**Calculation**

Available K (mg/kg) = C × 25 × mcf

Sample weight (g)

Where

C = Concentration of potassium in filtrate.

mcf = Moisture correction factor.

25 = Volume of Ammonium acetate.

**Available micronutrients (DTPA Extractable)**

Available micronutrient extracted from soil by DTPA according to Lindsay and Norvell (1978). DTPA is a chelating agent which combines with free metal ions in solution and forms soluble complexes. DTPA offer most favorable combination for the determination of Zn, Fe, Cu and Mn.

**Procedure**

10 gm of soil weighed in 100 ml conical flask. 20 ml of DTPA extractant was added and was shaken for 2 hours on a mechanical shaker. The solution was filtered through
Whatman # 42 filter paper and measured the Zn, Fe, Cu and Mn were in filtrated by Atomic Absorption Spectrophotometer (AAS).

**Calculation**

Element in soil (mg/kg) = $C \times 20 \times mcf$

Sample weight (g)

Where

$C$ = Concentration of element in filtrate.

$mcf$ = Moisture correction factor.

$20$ = Volume of DTPA extractant.
RESULTS

The soil sample at three different sites (Hill top, Mid hill and Hill base) and different directions were excavated at different seasons of the year. The soil samples thus collected were analyzed for the physical and chemical characteristics. (Table 3)

Table: 3. Edaphic characteristics of study area (Darlaghat Wildlife Sanctuary, Solan)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameter</th>
<th>S1(HT)</th>
<th>S2(MH)</th>
<th>S3(HB)</th>
<th>S4(E)</th>
<th>S5(W)</th>
<th>S6(N)</th>
<th>S7(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Texture</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>2.</td>
<td>pH</td>
<td>7.9</td>
<td>7.8</td>
<td>7.6</td>
<td>7.5</td>
<td>7.6</td>
<td>7.7</td>
<td>7.8</td>
</tr>
<tr>
<td>3.</td>
<td>Electrical Conductivity (µms/cm)</td>
<td>228</td>
<td>248</td>
<td>205</td>
<td>245</td>
<td>276</td>
<td>212</td>
<td>265</td>
</tr>
<tr>
<td>4.</td>
<td>Organic Carbon (%)</td>
<td>0.66</td>
<td>0.71</td>
<td>0.59</td>
<td>0.47</td>
<td>0.78</td>
<td>0.43</td>
<td>0.31</td>
</tr>
<tr>
<td>5.</td>
<td>Moisture Retention Capacity (%)</td>
<td>55</td>
<td>48</td>
<td>52</td>
<td>41</td>
<td>36</td>
<td>46</td>
<td>41</td>
</tr>
<tr>
<td>6.</td>
<td>Moisture Content (%)</td>
<td>6.5</td>
<td>7.1</td>
<td>7.6</td>
<td>5.8</td>
<td>6.1</td>
<td>8.4</td>
<td>7.2</td>
</tr>
<tr>
<td>7.</td>
<td>Available Nitrogen N (Kg/Ha)</td>
<td>288</td>
<td>305</td>
<td>322</td>
<td>289</td>
<td>275</td>
<td>361</td>
<td>388</td>
</tr>
<tr>
<td>8.</td>
<td>Available Phosphorus as P2O5 (Kg/Ha)</td>
<td>65</td>
<td>72</td>
<td>80</td>
<td>67</td>
<td>73</td>
<td>85</td>
<td>71</td>
</tr>
<tr>
<td>9.</td>
<td>Available Potassium as K2O (Kg/Ha)</td>
<td>205</td>
<td>212</td>
<td>245</td>
<td>233</td>
<td>278</td>
<td>255</td>
<td>241</td>
</tr>
<tr>
<td>10.</td>
<td>Available Calcium as Ca (Kg/Ha)</td>
<td>20.0</td>
<td>15.4</td>
<td>17.3</td>
<td>19.1</td>
<td>16.4</td>
<td>14.2</td>
<td>16.1</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Available Magnesium as Mg (Kg/Ha)</td>
<td>12.3 16.1 10.5 12.3 10.6 13.6 14.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Available Sodium as Na (%)</td>
<td>0.6 0.4 1.6 1.7 0.8 1.2 1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Chloride as Cl(%)</td>
<td>2.8 3.4 6.6 4.8 5.2 3.8 3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Sulphates as SO₄ (%)</td>
<td>2.6 3.2 4.8 3.2 2.8 4.2 3.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Soil pH:** A suspension of soil and water was obtained by stirring of 10 gm. of soil in 50 ml of distilled water for one hour and pH of this suspension was determined by Philips pH meter after standardizing with standard pH buffers. Range of pH at Hill top, Mid hill and Hill base lies in between 6.07 to 8.35, 5.87 to 8.26 and 7.39 to 8.82 respectively. The soil of study area is neutral soil.

**Soil conductivity:** Electric conductivity range in between 0.109 to 0.208 d/Sm at Hill top, 0.051 to 0.223 d/Sm at Mid hill and 0.055 to 0.259 d/Sm at Hill base. It means all the samples of soil from different area have electric conductivity value in safe limits.

**Organic carbon:** Availability of organic carbon were found low to very high organic carbon at Hill top lies in between 0.45% to 4.5%, at Mid hill lies in between 0.22% to 4.5% and at Hill base lies in between 0.3% to 2.1%.

**Chemical characteristic:** The bulk of soil consists of mineral particle that are composed of array of silicates ions combined with various positively charged metal ions. It is the number and type metal ions present that determine particular mineral.

**Macronutrients:** Macronutrient such as nitrogen, phosphorus and potassium are studied. Available nitrogen and phosphorus is low, medium and high in different sample. Potassium found low to medium.

**Nitrogen:** Nitrogen quantity at Hill top, Mid hill and Hill base range in between 137.9 to 639.7 ppm., 101.4 to 357.5 ppm. and 62.72 to 269.60 ppm. respectively. Hill top soil has higher amount of nitrogen than Mid hill and Hill base.
Phosphorus: Availability of phosphorus at Hill top lies in between 11.2 to 103.04 ppm, at Mid hill between 11.2 to 208.32 ppm and in Hill base 11.2 to 89.6 ppm. Soil rich of high phosphorus at Mid hill followed by Hill base and Hill top.

Potassium: At Hill top soil had high amount of potassium which was between 144.4 to 556.6 ppm. At Mid hill and Hill base potassium amount ranged between 96.3 to 288.9 ppm and 106.4 to 398.7 ppm.

Micronutrients: Availability of Micronutrient copper; zinc, ferrous and manganese are studied at different sites. It is found that soil contain micronutrients in sufficient amount.

The range of copper was between 0.22 to 2.38 ppm, 0.12 to 1.93 ppm and 0.15 to 1.62 ppm at Hill top, Mid hill and Hill base. It has high contents at Hill top as compare to Hill base and Mid hill. Zinc ranged between 0.81 to 1.55 ppm at Hill top, 0.58 to 2.09 ppm at Mid hill and 0.67 to 2.23 ppm at Hill base. Soil has high zinc contents at Hill base followed by Hill top and Mid hill.

Ferrous ranged between 2.8 to 19.3 ppm., 1.0 to 24.0 ppm. and 2.0 to 16.5 ppm. at three different sites (Hill top, Mid hill and Hill base). It was found that Hill top soil was rich in ferrous and manganese ranged between 2.80 to 19.3, 3.20 to 23.20 and 1.90 to 18.80 ppm. at Hill top, Mid hill and Hill base respectively. Hill top soil has high amount of manganese followed by Mid hill and Hill base.

The soil system comprises of mineral fraction, organic matter, soil moisture and soil atmosphere, all these factors collectively determine the nature of plant species growing in the area. Further, the amount of each element contained within a plant varies with type of plant, stage of maturity and environmental conditions. A part of the variation is dependent on the supply of each element alongwith presence of moisture and organic matter available in the soil. Available nutrient supply varying within limits may also change plant composition. Since, there are several interactions between soil and other components of the environment. Therefore, for the long-term conservation and regeneration of biodiversity maintenance of the soil fertility is critical.