CHAPTER-IV

RESULTS
4.1 SOIL ANALYSIS

Soil analysis is a set of various chemical processes that determine the amount of available plant nutrients in the soil but also the chemical, physical and biological soil properties important for plant nutrition, or “soil health”. A soil test can determine fertility, or the expected growth potential of the soil which indicates nutrient deficiencies, potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. Soil chemistry changes over time, as biological and chemical processes break down or combine compounds over time.

The aims of soil analysis are to determine the level of availability of nutrients or the need for its introduction, to predict the increase in yields and profitability of fertilization, to provide the basis for calculating the required fertilizing of each crop, to evaluate the status of each nutrient element and simultaneously determine the compensation plan.

4.1.1 Physico-Chemical Characteristic of Soil at Lower Altitudinal Site

The physico-chemical characteristics of soil of study site during 2013 at lower altitudinal site are given in Table 4.1. The texture of soil at middle and lower depths showed the presence of sandy loam while upper depth was silty loam. Moisture content varied from 11.76 % to 14.36 % in various depths of soil during the study period. At this altitudinal site moisture content was higher in 0 - 10 cm depth than 20 - 30 cm and 10 - 20 cm depths. The water holding capacity was approximately similar in upper and lower depths i.e. 39 % but decreased in middle depth of soil. The values of pH in this altitudinal site showed an increasing pattern with increasing soil depth. The values of pH ranged from 6.80 to 7.00. At lower altitudinal site values of Carbon ranged in the order: upper depth (0.60 %) > middle depth (0.31 %) > lower depth (0.10 %). The values of Phosphorus in lower altitudinal site showed a varied pattern with varied soil depth. The values of Phosphorus across different depths ranged from 12.80 kg/hec to 16.70 kg/hec.
The Potassium content followed a declining pattern with increasing depth of soil. The values of Potassium were reported in the order: upper depth (257.00 kg/hec) > middle depth (164.60 kg/hec) > lower depth (129.90 kg/hec). Sulphur and Iron content was equal in upper and lower depths with slight increase in Sulphur content in middle depth. Contrary to this Iron content showed minor fall in middle depth. The values of Sulphur ranged from 9.60 ppm to 10.00 ppm and that of Iron ranged from 7.50 ppm to 8.00 ppm. Zinc content was considerably higher in the lower depth (1.05 ppm) followed by middle (0.98 ppm) and upper depths (0.88 ppm). The values of Copper were approximately similar in all the depths i.e. 0.35 ppm to 0.38 ppm. Calcium content declined with increasing depth of soil and ranged from 5.12 ppm to 5.23 ppm. The values of Magnesium content increased with increasing soil depth. It was found in the order: 2.01 ppm (upper depth) < 2.12 ppm (middle depth) < 2.60 ppm (lower depth). The amount of Manganese was lowest in lower depth (4.20 ppm) whereas highest (4.60 ppm) in middle depths of soil.

The physico-chemical characteristics of soil of study site during 2014 at lower altitudinal site are given in Table 4.1. The amount of coarse matter varied with depth of soil. At this altitudinal site middle and lower depths showed the presence of sandy loam while upper depth was filled with silty loam. Moisture content varied from 11.98 % to 15.87 % in various depths of soil during the study period. At lower altitudinal site moisture content was highest (15.87 %) in 0 - 10 cm depth and lowest (11.98 %) in 10 - 20 cm depth. The water holding capacity varied from 38 % to 40 %. The values of pH were same in all depths of soil i.e. 6.50. At this altitudinal site values of Phosphorus (22.30 kg/hec) were approximately same in upper and middle depths and lowest (21.80 kg/hec) in lower depth. The values of Carbon and Potassium in lower altitudinal site showed varied pattern with varied soil depths.

The values of Carbon across different depth ranged from 0.31% to 0.43 % and Potassium content ranged from 77.30 kg/hec to 99.70 kg/hec. Sulphur and Iron contents
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<th>Year</th>
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<th>Moisture content (%)</th>
<th>Water holding capacity %</th>
<th>pH</th>
<th>Carbon %</th>
<th>Phosphorus kg/hectare</th>
<th>Potassium kg/hectare</th>
<th>Sulphur ppm</th>
<th>Iron ppm</th>
<th>Zinc ppm</th>
<th>Copper ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Manganese ppm</th>
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<td>164.60</td>
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<td>0.98</td>
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Table 4.1 Physico-Chemical Characteristic of Soil from Different Depths in Lower Altitudinal site at Banri Devi Forest (Almora) during 2013-2014
were highest in middle layer [Sulphur (13.80 ppm) and Iron (9.00 ppm)]. Zinc content was considerably highest in the lower depth (1.50 ppm) followed by middle depth (0.85 ppm) and upper depth (0.75 ppm). The values of Copper ranged from i.e. 0.50 ppm to 0.58 ppm across all depths of soil. The amount of Calcium followed irregular trend 5.60 ppm (middle depth) > 5.55 ppm (lower depth) > 5.05 ppm (upper depth). Magnesium content increased with increasing depth of soil from 2.12 ppm to 2.23 ppm. The values of Manganese were same in upper and middle depths (5.20 ppm) whereas declined in lower depth (5.10 ppm).

### 4.1.2 Physico-Chemical Characteristic of Soil at Middle Altitudinal Site

The physic-chemical characteristics of soil of study site during 2013 at middle altitudinal site are given in Table 4.2. The texture of soil was sandy loam at middle and lower whereas silty loam at upper depth. At this altitudinal site moisture content declined with increasing depth of soil. The values of moisture content ranged from 10.78% to 15.00%. The water holding capacity also decreased with increasing depth of soil. On average water holding capacity ranged from 32.93% to 41.60% at various depths of soil. The value of pH shows a varied pattern with varied soil depths. The values across different depths ranged from 6.60 to 7.40.

Values of Carbon, Phosphorus and Potassium followed a declining pattern with increasing depth of soil. The values of Carbon ranged in the order: upper depth (0.41 %) > middle depth (0.22 %) > lower depth (0.16 %). Phosphorus content was maximum in upper depth (22.00 kg/hect) followed by middle depth (16.90 kg/hect) and lower depth (15.50 kg/hect). Potassium showed a declining trend with depths and values ranged as: 178.10 kg/hect (upper depth) > 85.10 kg/hect (middle depth) > 65.50 kg/hect (lower depth). Sulphur and Iron content showed minor difference at different depths. The values of Sulphur ranged from 9.50 ppm to 9.80 ppm and the values of Iron ranged from 7.50 ppm to 7.90 ppm. Zinc content was considerably highest in the middle depth (1.05 ppm) and approximately same in two depths. The values of Copper were approximately similar in
all the depths and ranged from 0.35 ppm to 0.38 ppm. Calcium content also increased with increasing depth of soil from 5.12 ppm to 5.55 ppm. The values of Magnesium were highest in upper depth (2.55 ppm) whereas approximately same in middle and lower depths of soil (2.22 ppm). The values of Manganese ranged from 4.15 ppm to 4.30 ppm.

The physico-chemical characteristics of soil of study site during 2014 at middle altitudinal site are given in Table 4.2. At this altitudinal site middle and lower depths showed the presence of sandy loam while upper depth was silty loam. The moisture content was highest in 0 - 10 cm depth (16.35 %) and lowest in 10 - 20 cm depth (11.35 %). Water holding capacity declined with increasing depth of soil. The values of water holding capacity ranged from 32.93 % to 41.60% at various depth of soil. The value of pH was same in upper and lower depths (7.00) and lowest (6.50) in middle depth.

At middle altitudinal site values of Carbon, Phosphorus and Potassium followed a decreasing pattern with increasing depths of soil. The values of Carbon ranged in the order upper depth (0.70 %) > middle depth (0.52 %) > lower depth (0.42 %). Phosphorus content was maximum in upper depth (35.0 kg/hec) followed by middle depth (25.0 kg/hec) and lower depth (22.0 kg/hec). Potassium showed a declining trend with depths and values followed the order: 87.40 kg/hec (upper depth) > 75.00 kg/hec (middle depth) > 68.30 kg/hec (lower depth). The highest value of Sulphur content was similar in upper and lower depths. The values of Sulphur ranged from 12.80 ppm to 13.60 ppm. Iron content increased with increasing depth and ranged from 8.50 ppm to 9.10 ppm. Zinc content was considerably highest in the middle depth (0.80 ppm) and approximately same in two depths. The values of Copper ranged from 0.50 ppm to 0.58 ppm. Calcium content varied with depth of soil (4.95 ppm to 5.55 ppm). The values of Magnesium were highest in upper depth (2.34 ppm). The amount of manganese decreased with increasing depth from 5.40 ppm to 4.80 ppm.
<table>
<thead>
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<th>Year</th>
<th>Depth</th>
<th>Textural class</th>
<th>Moisture content (%)</th>
<th>Water holding capacity %</th>
<th>pH</th>
<th>Carbon %</th>
<th>Phosphorus kg/hec</th>
<th>Potassium kg/hec</th>
<th>Sulphur ppm</th>
<th>Iron ppm</th>
<th>Zinc ppm</th>
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<th>Manganese ppm</th>
</tr>
</thead>
<tbody>
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<td>6.60</td>
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<td>75.00</td>
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<td>22.00</td>
<td>68.30</td>
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<td>9.10</td>
<td>0.45</td>
<td>0.58</td>
<td>5.55</td>
<td>2.22</td>
<td>4.80</td>
</tr>
</tbody>
</table>

Table 4.2 Physico-Chemical Characteristic of Soil from Different Depths in Middle Altitudinal site at Banri Devi Forest (Almora) during 2013-2014
4.1.3 Physico-Chemical Characteristic of Soil at Higher Altitudinal Site

The physico-chemical characteristics of soil of study site during 2013 at higher altitudinal site are given in Table 4.3. The amount of coarse matter varied with depth of soil. The texture of the soil was silty loam in upper and lower depths of soil while soil in middle depth was sandy loam. Generally, the moisture content was varied from 18.01 % to 22.61 % in various depths of soil during study period. Moisture content was highest in 10 - 20 cm depth (22.61 %) than 0 - 10 cm and 20 - 30 cm depths. The water holding capacity increased with increasing soil depth. On average water holding capacity ranged from 41.95 % to 45.09 % at various depths of soil. pH value ranged from 5.30 to 5.70 and highest (5.70) in lower depth.

Values of Carbon ranged in the order: upper depth (0.67 %) > middle depth (0.56 %) > lower depth (0.38 %). Phosphorus content was maximum in upper depth (18.90 kg/hec) followed by lower depth (15.80 kg/hec) and middle layer (15.30 kg/hec). Potassium showed a declining trend with depths and values ranged as 105.00 kg/hec (upper depth) > 63.80 kg/hec (middle depth) > 59.40 kg/hec (lower depth). Sulphur content was highest in middle depth (9.75 ppm). Values of Iron were highest in upper depth (7.80 ppm) and approximately same in middle and lower depths (7.50 ppm). Zinc content was considerably highest in the middle depth (1.05 ppm) and approximately same in two depths (0.78 ppm). Copper (0.42 ppm) and Manganese (4.80 ppm) content were highest in upper depth. Calcium (5.22 ppm) and Magnesium (2.57 ppm) content were highest in lower depth.

The physico-chemical characteristics of soil of study site during 2014 at higher altitudinal site are given in Table 4.3. The amount of coarse matter varied with depth of soil. At higher altitudinal site upper and lower depths showed the presence of silty loam while middle depth was filled with sandy loam. The moisture content varied from 18.62 % to 21.95 % in various depths of soil during study period. At higher altitudinal site moisture content was higher in 0 - 10 cm depth (21.95 %) than 10 - 20 cm and 20 - 30 cm
depths. The water holding capacity increased with increasing soil depths. On average water holding capacity ranged from 41.95 % to 45.09 % at various depth of soil. pH value varied with minor variation ranged from 7.00 to 7.50.

At higher altitudinal site values of Carbon, Phosphorus and Potassium content was maximum in upper depth [Carbon (0.78 %), Phosphorus (26.90 kg/hec) and Potassium (211.00 kg/hec)] followed by lower depth [Carbon (0.61 %), Phosphorus (20.00 kg/hec) and Potassium (171.00 kg/hec)] and middle layer [Carbon (0.58 %), Phosphorus (19.00 kg/hec) and Potassium (144.00 kg/hec)]. Sulphur content was highest in lower depth (14.30 ppm). Values of Iron ranged from 8.00 ppm to 8.60 ppm. The value of Zinc ranged in the order: upper depth (0.98 ppm) > middle depth (0.90 ppm) > lower depth (0.50 ppm). The value of Copper (0.62 ppm) and Calcium (5.44 ppm) were highest in the upper depth. Magnesium content increased from upper to lower depth from 2.50 ppm to 2.65 ppm. Manganese content (5.50 ppm) was considerably highest in the lower depth and approximately same upper and middle depths.

![Fig. 4.1 Moisture content (%) of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014](image-url)
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<thead>
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<th>Year</th>
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<th>Textural class</th>
<th>Moisture content %</th>
<th>Water holding capacity %</th>
<th>pH</th>
<th>Carbon %</th>
<th>Phosphorus kg/hec</th>
<th>Potassium kg/hec</th>
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<tbody>
<tr>
<td>2013</td>
<td>0-10 cm</td>
<td>silty loam</td>
<td>21.00</td>
<td>41.95</td>
<td>5.30</td>
<td>0.67</td>
<td>18.90</td>
<td>105.00</td>
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<td>7.80</td>
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<td>10-20 cm</td>
<td>sandy loam</td>
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<td>63.80</td>
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Table 4.3 Physico-Chemical Characteristic of Soil from Different Depths in Higher Altitudinal Site at Banri Devi Forest (Almora) during 2013-2014
Fig. 4.2 Water Holding Capacity (%) of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014

Fig. 4.3 Carbon Content of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014
Chapter IV

Fig. 4.4 Phosphorus Content of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014

Fig. 4.5 Potassium Content of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014
Fig. 4.6 pH of Soil in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora) during 2013 and 2014

Fig. 4.7 Chemical Constituents of Soil in Lower Altitudinal Site at Banri Devi Forest (Almora) during 2013
Fig. 4.8 Chemical Constituents of Soil in Lower Altitudinal Site at Banri Devi Forest (Almora) during 2014

Fig. 4.9 Chemical Constituents of Soil in Middle Altitudinal Site at Banri Devi Forest (Almora) during 2013
Fig. 4.10 Chemical Constituents of Soil in Middle Altitudinal Site at Banri Devi Forest (Almora) during 2014

Fig. 4.11 Chemical Constituents of Soil in Higher Altitudinal Site at Banri Devi Forest (Almora) during 2013
Fig. 4.12 Chemical Constituents of Soil in Higher Altitudinal Site at Banri Devi Forest (Almora) during 2014
4.2 FLORISTIC ANALYSIS

A total of 77 genera from 88 species of herbaceous vegetation were recorded. Total number of families present in the study site was 35 and the dominating family was Asteraceae (19 genera and 22 species) followed Lamiaceae (8 genera and 8 species), Fabaceae (5 genera and 6 species), Rosaceae (4 genera and 4 species), Acanthaceae (3 genera and 4 species) and Euphorbiaceae (2 genera and 4 species) (Table 4.4).

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<tr>
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<td>Polygonaceae</td>
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<td>2</td>
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<td>14</td>
<td>Scrophulariaceae</td>
<td>2</td>
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<td>15</td>
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<td>Asparagaceae</td>
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<td>19</td>
<td>Brassicaceae</td>
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<td>1</td>
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<td>Campanulaceae</td>
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<td>22</td>
<td>Commelinaceae</td>
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Table 4.4 Total number of Families, Species and Genera of Herb Vegetation Recorded from the Study Area

Table 4.5 present the herbs floristic diversity of Banri Devi forest of Almora in 2013-14. The highest numbers of plant species (50 species) were recorded in the month of July in which at higher altitudinal site maximum (29 species) numbers of species were recorded. Lower altitudinal site was represented by total 62 genera having 68 species belonging to 28 families and Asteraceae (17 genera and 19 species) was the largest family followed by Fabaceae (5 genera and 5 species) and Lamiaceae (5 genera and 5 species). Middle altitudinal site was represented by total 56 genera 62 species belonging to 27 families and Asteraceae (18 genera and 20 species) was the largest family followed by Lamiaceae (6 genera and 6 species), Euphorbiaceae (2 genera and 3 species) and Fabaceae (2 genera and 3 species). Higher altitudinal site was represented by total 56 genera having 63 species belonging to 27 families and Asteraceae (14 genera and 16 genera) was the largest family followed by Lamiaceae (6 genera and 6 species), Fabaceae (4 genera and 4 species) and Rosaceae (4 genera and 4 species).
<table>
<thead>
<tr>
<th>L NO.</th>
<th>NAME OF PLANTS</th>
<th>VERNACULAR NAME</th>
<th>FAMILY</th>
<th>MONTH</th>
<th>SPECIES PRESENT</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Anaphalis margaritacea</strong> (L.) Benth. &amp; Hook.f.</td>
<td>Western pearly everlasting, Pearly everlasting and Bakol</td>
<td><strong>Asteraceae</strong></td>
<td><strong>April</strong></td>
<td>+    +    +</td>
</tr>
<tr>
<td>2</td>
<td><strong>Asparagus filicinus</strong> Buch.-Ham. ex D. Don</td>
<td>Fern Asparagus and chiriya- kanda</td>
<td><strong>Asparagaceae</strong></td>
<td><strong>April</strong></td>
<td>+    -    -</td>
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<td>3</td>
<td><strong>Barleria auriculata</strong> Schumach.</td>
<td>Gokulakanta</td>
<td><strong>Acanthaceae</strong></td>
<td><strong>April</strong></td>
<td>+    -    -</td>
</tr>
<tr>
<td>4</td>
<td><strong>Bidens bitemnata</strong> (Lour.) Merr. &amp; Sherff</td>
<td>Yellow flowered black jack</td>
<td><strong>Asteraceae</strong></td>
<td><strong>April</strong></td>
<td>+    -    -</td>
</tr>
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<td>5</td>
<td><strong>Bidens pilosa</strong> L.</td>
<td>Beggar tick</td>
<td><strong>Asteraceae</strong></td>
<td><strong>April</strong></td>
<td>-    +    -</td>
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<td>6</td>
<td><strong>Boenninghausenia albiflora</strong> (Hook.) Rchb. ex Mein.</td>
<td>White Himalayan rue and Pissumar</td>
<td><strong>Rutaceae</strong></td>
<td><strong>April</strong></td>
<td>-    +    -</td>
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<tr>
<td>7</td>
<td><strong>Buchnera hispida</strong> Buch.-Ham.</td>
<td>Karonji</td>
<td><strong>Scrophulariaceae</strong></td>
<td><strong>April</strong></td>
<td>+    -    -</td>
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<tr>
<td>8</td>
<td><strong>Cannabis sativa</strong> L.</td>
<td>Bhang</td>
<td><strong>Cannabaceae</strong></td>
<td><strong>April</strong></td>
<td>+    +    -</td>
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<td>9</td>
<td><strong>Coryza aegyptiaca</strong> (L.) Aiton</td>
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<td><strong>Asteraceae</strong></td>
<td><strong>April</strong></td>
<td>-    -    +</td>
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<td>10</td>
<td><strong>Coryza japonica</strong> (Thunb.) Less. ex Less.</td>
<td>Japanese fleabane</td>
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<td><strong>April</strong></td>
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<td>11</td>
<td><strong>Crotalaria albida</strong> B. Heyne ex. Roth</td>
<td>Narrowleaf Rattlepod and Ban methi</td>
<td><strong>Fabaceae</strong></td>
<td><strong>April</strong></td>
<td>+    -    +</td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Family</td>
<td>Season</td>
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<td>Dicliptera bupleuroides Nees</td>
<td>Roxburgh’s foldwing</td>
<td>Acanthaceae</td>
<td>April</td>
<td>+</td>
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<tr>
<td>13</td>
<td>Eupatorium adenophorum Spreng.</td>
<td>Crofton weed and Sticky snakeroot</td>
<td>Asteraceae</td>
<td>April</td>
<td>+</td>
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<tr>
<td>14</td>
<td>Euphorbia esula L.</td>
<td>Leafy spurge and Duhila</td>
<td>Euphorbiaceae</td>
<td>April</td>
<td>+</td>
</tr>
<tr>
<td>15</td>
<td>Fragaria indica Andrews</td>
<td>Bhiun kaphal</td>
<td>Rosaceae</td>
<td>April</td>
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<td>Gallant soldier and Potato weed</td>
<td>Asteraceae</td>
<td>April</td>
<td>+</td>
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<tr>
<td>17</td>
<td>Galium aparine L.</td>
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<td>Rubiaceae</td>
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<tr>
<td>18</td>
<td>Geranium nepalense Sweet</td>
<td>Laljari and Syuli</td>
<td>Geraniaceae</td>
<td>April</td>
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<td>19</td>
<td>Gnaphalium luteoalbum L.</td>
<td>Jersey Cudweed</td>
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<tr>
<td>20</td>
<td>Gnaphalium polycaulon Pers.</td>
<td>Tiny Cudweed and Bukhlu</td>
<td>Asteraceae</td>
<td>April</td>
<td>+</td>
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<tr>
<td>21</td>
<td>Indigofera linifolia (L. f.) Retz.</td>
<td>Ratanjot</td>
<td>Fabaceae</td>
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<td>Launaea nudicaulis (L.) Hook. f.</td>
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<td>Lycopodium sp.</td>
<td>Creeping cedar</td>
<td>Lycopodiaceae</td>
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<td>24</td>
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<td>Gorkhapaan and Banajwain</td>
<td>Lamiaceae</td>
<td>April</td>
<td>+</td>
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<tr>
<td>25</td>
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<td>White leaved catmint and Nueet</td>
<td>Lamiaceae</td>
<td>April</td>
<td>+</td>
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<tr>
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<td>India sorrel and Khatti-buti</td>
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<td>April</td>
<td>+</td>
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<td>27</td>
<td><em>Parthenium hysterophorus</em> L.</td>
<td>Congress grass and Gajar ghans</td>
<td>Asteraceae</td>
<td>April</td>
<td>+</td>
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<td><em>Reinwardtia trigyna</em> (Roxb.) Planch.</td>
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<td>Linaceae</td>
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<td><em>Trigonella foenugraecum</em> L.</td>
<td>Methi and Mutti</td>
<td>Fabaceae</td>
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<td>May</td>
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<td>Family</td>
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<td>Japanese fleabane</td>
<td>Asteraceae</td>
<td>May</td>
<td>+</td>
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<td>Boraginaceae</td>
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<td>Lanceleaf and Forget me not</td>
<td>Boraginaceae</td>
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<td>Rosaceae</td>
<td>May</td>
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<td>17</td>
<td><em>Geranium nepalense</em> Sweet</td>
<td>Laljari and Syuli</td>
<td>Geraniaceae</td>
<td>May</td>
<td>-</td>
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<tr>
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<td><em>Gnaphalium polycaulon</em> Pers.</td>
<td>Tiny Cudweed and Bukhlu</td>
<td>Asteraceae</td>
<td>May</td>
<td>+</td>
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<td>Gorkhapaan and Ban ajwain</td>
<td>Lamiaceae</td>
<td>May</td>
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<td>White leaved catmint and Nueet</td>
<td>Lamiaceae</td>
<td>May</td>
<td>+</td>
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<td>22</td>
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<td>India sorrel and Khatti-buti</td>
<td>Oxalidaceae</td>
<td>May</td>
<td>+</td>
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<tr>
<td>23</td>
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<td>Congress grass and Gajar ghans</td>
<td>Asteraceae</td>
<td>May</td>
<td>+</td>
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<td>-</td>
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<td>Bhilmora</td>
<td>Polygonaceae</td>
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<td>Dandelion</td>
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<td>28</td>
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<td>Bichu ghass and Sisna</td>
<td>Urticaceae</td>
<td>May</td>
<td>+</td>
</tr>
<tr>
<td>29</td>
<td><em>Varbascum thapsus</em> L.</td>
<td>Great mullein and Common mullein</td>
<td>Scrophulariaceae</td>
<td>May</td>
<td>+</td>
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<td>Common Name</td>
<td>Family</td>
<td>Month</td>
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<td><em>Ageratum conyzoides</em> L.</td>
<td>Goat weed, Billy goat weed and Jangli pudina</td>
<td>Asteraceae</td>
<td>June</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td><em>Anaphalis margaritacea</em> (L.) Benth. &amp; Hook.f.</td>
<td>Western pearly everlasting, Pearly everlasting and Bakol</td>
<td>Asteraceae</td>
<td>June</td>
<td>+</td>
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<tr>
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<td>Japonise wornwood</td>
<td>Asteraceae</td>
<td>June</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td><em>Bidens biennis</em> (Lour.) Merr. &amp; Sherff</td>
<td>Yellow flowered black jack</td>
<td>Asteraceae</td>
<td>June</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td><em>Bidens pilosa</em> L.</td>
<td>Beggar tick</td>
<td>Asteraceae</td>
<td>June</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td><em>Cannabis sativa</em> L.</td>
<td>Bhang</td>
<td>Cannabaceae</td>
<td>June</td>
<td>+</td>
</tr>
<tr>
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<td>Ladies purse and Shepherd’s purse</td>
<td>Brassicaceae</td>
<td>June</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td><em>Conyza japonica</em> (Thunb.) Less. ex Less.</td>
<td>Japanese fleabane</td>
<td>Asteraceae</td>
<td>June</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td><em>Cynoglossum furcatum</em> Wall.</td>
<td>Indian hound’s tongou</td>
<td>Boraginaceae</td>
<td>June</td>
<td>+</td>
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**Total**

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**Chapter IV**

1. *Acanthospermum hispidium* D.C.
   Starbur and Goat’s head
   Asteraceae
   August
   -

2. *Ageratum conyzoides* L.
   Goat weed, Billy goat weed and Jangli pudina
   Asteraceae
   August
   +

3. *Ajuga bracteosa* Wall
   Neelkhanth and Ratpatia
   Lamiaceae
   August
   +
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<td>August</td>
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<td>Yellow flowered black jack</td>
<td>Asteraceae</td>
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<td>+</td>
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<td>White Himalayan rue and Pissumar</td>
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<td>Jangli jeera</td>
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<td>Pale Bell flower</td>
<td>Campanulaceae</td>
<td>August</td>
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<td>Bhang</td>
<td>Cannabaceae</td>
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<td>Fabaceae</td>
<td>August</td>
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<td>+</td>
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<td>August</td>
<td>+</td>
<td>+</td>
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<tr>
<td>19</td>
<td><em>Euphorbia esula</em> L.</td>
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<td>Lamiaceae</td>
<td>August</td>
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<td>-</td>
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<td>+</td>
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<td>August</td>
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<td>August</td>
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<td><strong>Torenia cordifolia</strong> Roxb.</td>
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<td><strong>Viola serpens</strong> Wall. ex Roxb.</td>
<td>Gul- banafsha</td>
<td>Violaceae</td>
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|   | Total                                           |                                     |                   |        | 22 | 19 | 18 |

<p>|   | <strong>Ageratum conyzoides</strong> L.                      | Goat weed, Billy goat weed and Jangli pudina | Asteraceae       | September | +  | + | + |
|2 | <strong>Ajuga bracteosa</strong> Wall ex. Benth.             | Neelkhanth and Ratpatia              | Lamiaceae        | September | -  | + | - |
|3 | <strong>Anaphalis margaritacea</strong> (L.) Benth. &amp; Hook.f.| Western pearly everlasting, Pearly everlasting and Bakol | Asteraceae       | September | +  | + | + |
|4 | <strong>Argemone mexicana</strong> L.                        | Mexican prickly poppy                | Papaveraceae     | September | +  | + | + |
|5 | <strong>Bidens biternata</strong> (Lour.) Merr. &amp; Sherff     | Yellow flowered black jack           | Asteraceae       | September | +  | + | + |
|6 | <strong>Bidens pilosa</strong> L.                            | Beggar tick                          | Asteraceae       | September | +  | + | + |
|7 | <strong>Campanula colorata</strong> Wall.                    | Pale Bell flower                     | Campanulaceae    | September | -  | + | - |</p>
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<th>Family</th>
<th>Season</th>
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<td>Wandering dew grass</td>
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<td>Lanceleaf and Forget me not</td>
<td>Boraginaceae</td>
<td>September</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<td>Acanthaceae</td>
<td>September</td>
<td>-</td>
<td>-</td>
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<td>Crofton weed and Sticky snakeroot</td>
<td>Asteraceae</td>
<td>September</td>
<td>-</td>
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<td>Euphorbiaceae</td>
<td>September</td>
<td>+</td>
<td>+</td>
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<tr>
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<td><em>Geranium nepalense</em> Sweet</td>
<td>Laljari and Syuli</td>
<td>Geraniaceae</td>
<td>September</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<td>16</td>
<td><em>Gnaphalium polycaulon</em> Pers.</td>
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<td>Bis-kapra</td>
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<td>18</td>
<td><em>Nepeta ciliaris</em> Benth.</td>
<td>White leaved catmint and Nueet</td>
<td>Lamiaceae</td>
<td>September</td>
<td>-</td>
<td>+</td>
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<td>-</td>
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<td>Oxalidaceae</td>
<td>September</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<td><em>Parthenium hysterophorus</em> L.</td>
<td>Congress grass and Gajar ghans</td>
<td>Asteraceae</td>
<td>September</td>
<td>+</td>
<td>+</td>
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<td>Himalayan rose and Ban gulab</td>
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<td>-</td>
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<td>Hisalu</td>
<td>Rosaceae</td>
<td>September</td>
<td>+</td>
<td>-</td>
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<tr>
<td>27</td>
<td><em>Swertia angustifolia</em> Buch.-Ham ex D. Don</td>
<td>Narrow leaved swertia</td>
<td>Gentianaceae</td>
<td>September</td>
<td>-</td>
<td>-</td>
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<td>28</td>
<td><em>Tagetes erecta</em> L.</td>
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<td>Asteraceae</td>
<td>September</td>
<td>-</td>
<td>-</td>
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<td><em>Taraxacum officinale</em> Weber.</td>
<td>Dandelion</td>
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<td>September</td>
<td>+</td>
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<td><em>Urtica dioica</em> L.</td>
<td>Bichu ghass and Sisna</td>
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<td>September</td>
<td>-</td>
<td>-</td>
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<td>31</td>
<td><em>Varbascum thapsus</em> L.</td>
<td>Great mullein and Common mullein</td>
<td>Scrophulariaceae</td>
<td>September</td>
<td>+</td>
<td>+</td>
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**Total**   | 14   | 15   | 23   |
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<td><em>Bidens biternata</em> (Lour.) Merr. &amp; Sherff</td>
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<td>October</td>
<td>+</td>
<td>+</td>
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<td><em>Bidens pilosa</em> L.</td>
<td>Beggar tick</td>
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<td><em>Clematis orientalis</em> L.</td>
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<td><em>Cynoglossum denticulatum</em> A.DC.</td>
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<td><em>Cynoglossum lanceolatum</em> Forssk.</td>
<td>Lanceleaf and Forget me not</td>
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<td>October</td>
<td>+</td>
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<td>11</td>
<td><em>Dicliptera bupleuroides</em> Nees</td>
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<td>Acanthaceae</td>
<td>October</td>
<td>-</td>
<td>+</td>
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<td><em>Eupatorium adenophorum</em> Spreng.</td>
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<td>Asteraceae</td>
<td>October</td>
<td>-</td>
<td>+</td>
<td>+</td>
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<td>Bhiun kaphal</td>
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<td>White leaved catmint and Nueet</td>
<td>Lamiaceae</td>
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<td>-</td>
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<td>Oxalidaceae</td>
<td>10月</td>
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<td>Parthenium hysterophorus L.</td>
<td>国会草和加尔干斯</td>
<td>Asteraceae</td>
<td>10月</td>
<td>+</td>
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<td>Paspalum distichum L.</td>
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<td>Pimpinella diversifolia DC.</td>
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<td>Polygonaceae</td>
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<td>粉头植物</td>
<td>Urticaceae</td>
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<td>Ranunculus sceleratus L.</td>
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<td>Ranunculaceae</td>
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<td>Linaceae</td>
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<td>Tagetes erecta L.</td>
<td>墨西哥万寿菊花和哈拉里</td>
<td>Asteraceae</td>
<td>10月</td>
<td>+</td>
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<td>Taraxacum officinale Weber.</td>
<td>菊花</td>
<td>Asteraceae</td>
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<td>29</td>
<td>Varbascum thapsus L.</td>
<td>大叶洋地黄和普通洋地黄</td>
<td>Scrophulariaceae</td>
<td>10月</td>
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<td>30</td>
<td>Xanthium indicum J. Koenig</td>
<td>苜蓿</td>
<td>Asteraceae</td>
<td>10月</td>
<td>+</td>
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</table>

|   | 总计 | 12 | 18 | 17 |

<p>|   | Acanthospermum hispidium D.C.          | Starbur and Goat’s head           | Asteraceae      | 11月   |+       |
|2  | Ageratum conyzoides L.                 | goat weed, Billy goat             | Asteraceae      | 11月   |+       |</p>
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<th>Family</th>
<th>Season</th>
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<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
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<td>November</td>
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<td>4</td>
<td>Argemone mexicana L.</td>
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<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
<td>Yellow flowered black jack</td>
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<td>Rosaceae</td>
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1. *Acanthospermum hispidium* D.C. (Starbur and Goat’s head) - Asteraceae - December - - +
2. *Ajuga bracteosa* Wall ex.Benth. (Neelkhanth and Ratpatia) - Lamiaceae - December + - -
3. *Anaphalis margaritacea* (L.) Benth. & Hook.f. (Western pearly everlasting, Pearly everlasting and Bakol) - Asteraceae - December + + +
4. *Argemone mexicana* L. (Mexican prickly poppy) - Papaveraceae - December + + +
5. *Bidens biternata* (Lour.) Merr. & Sherff (Yellow flowered black jack) - Asteraceae - December - - +
6. *Bupleurum hamiltonii* N.P.Balakr (Jangli jeera) - Apiaceae - December + - -
7. *Cynoglossum furcatum* Wall. (Indian hound’s tongou) - Boraginaceae - December - - +
8. *Cynoglossum lanceolatum* Forssk. (Lanceleaf and Forget me not) - Boraginaceae - December - + -
9. *Eupatorium adenophorum* Spreng. (Crofton weed and Sticky snakeroot) - Asteraceae - December - - +
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<td>Leafy spurge and Dudhila</td>
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<td><em>Fragaria indica</em> Andrews</td>
<td>Bhiun kaphal</td>
<td>Rosaceae</td>
<td>December</td>
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<td>Goosegrass and Cleaver</td>
<td>Rubiaceae</td>
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<td>22</td>
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<td>Starbur and Goat’s head</td>
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*Total:* 9, 7, 15
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<tr>
<td>3</td>
<td><em>Bupleurum hamiltonii</em> N.P.Balakr</td>
<td>Jangli jeera</td>
<td>Apiaceae</td>
<td>February</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td><em>Cannabis sativa</em> L.</td>
<td>Bhang</td>
<td>Cannabaceae</td>
<td>February</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>No.</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Family</td>
<td>Season</td>
<td>Flavour 1</td>
<td>Flavour 2</td>
<td>Flavour 3</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------</td>
<td>--------------------------------------------------</td>
<td>--------------</td>
<td>--------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>5</td>
<td><em>Clematis orientalis</em> L.</td>
<td>Chinese clematis and Orange peel</td>
<td>Ranunculaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><em>Crotalaria albida</em> B. Heyne ex. Roth</td>
<td>Narrowleaf Rattlepod and Ban methi</td>
<td>Fabaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Cynoglossum furcatum</em> Wall.</td>
<td>Indian hound’s tongou</td>
<td>Boraginaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><em>Dicliptera bupleuroides</em> Nees</td>
<td>Roxburgh’s foldwing</td>
<td>Acanthaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><em>Erigeron asteroides</em> Roxb.</td>
<td>Bangua</td>
<td>Asteraceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><em>Eupatorium adenophorum</em> Spreng.</td>
<td>Crofton weed and Sticky snakeroot</td>
<td>Asteraceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><em>Euphorbia esula</em> L.</td>
<td>Leafy spurge and Dudhila</td>
<td>Euphorbiaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td><em>Fragaria indica</em> Andrews</td>
<td>Bhiun kaphal</td>
<td>Rosaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td><em>Geranium nepalense</em> Sweet</td>
<td>Laljari and Syuli</td>
<td>Geraniaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td><em>Gypsophila cerastioides</em> D. Don</td>
<td>Bakarchee</td>
<td>Caryophyllaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td><em>Indigofera linifolia</em> (L. f.) Retz.</td>
<td>Ratanjot</td>
<td>Fabaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td><em>Leucas lanata</em> Benth.</td>
<td>Bis- kapra</td>
<td>Lamiaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td><em>Oxalis corniculata</em> L.</td>
<td>India sorrel and Khatti-buti</td>
<td>Oxalidaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td><em>Pimpinella diversifolia</em> DC.</td>
<td>Teroi</td>
<td>Apiaceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td><em>Taraxacum officinale</em> Weber.</td>
<td>Dandelion</td>
<td>Asteraceae</td>
<td>February</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Species</td>
<td>Common Name</td>
<td>Family</td>
<td>Season</td>
<td>Positive</td>
<td>Neutral</td>
<td>Negative</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------</td>
<td>--------------------------------------------</td>
<td>----------------</td>
<td>--------</td>
<td>----------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>20</td>
<td><em>Thalictrum foliolosum</em> DC.</td>
<td>Gold thread root, Leafy meadow rue and Pilijari</td>
<td>Ranunculaceae</td>
<td>February</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td><em>Trigonella foenum-graecum</em> L.</td>
<td>Methi and Mutti</td>
<td>Fabaceae</td>
<td>February</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>22</td>
<td><em>Urtica dioica</em> L.</td>
<td>Bichu ghass and Sisna</td>
<td>Urticaceae</td>
<td>February</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td><em>Varbascum thapsus</em> L.</td>
<td>Great mullein and Common mullein</td>
<td>Scrophulariaceae</td>
<td>February</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**Total** | 17 | 12 | 14 |
<table>
<thead>
<tr>
<th>No.</th>
<th>Scientific Name</th>
<th>Common Name(s)</th>
<th>Family</th>
<th>Month</th>
<th>就能</th>
<th>有益</th>
<th>危险</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td><em>Eupatorium adenophorum</em> Spreng.</td>
<td>Crofton weed and Sticky snakeroot</td>
<td>Asteraceae</td>
<td>March</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td><em>Euphorbia esula</em> L.</td>
<td>Leafy spurge and Dudhila</td>
<td>Euphorbiaceae</td>
<td>March</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td><em>Fragaria indica</em> Andrews</td>
<td>Bhiun kaphal</td>
<td>Rosaceae</td>
<td>March</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>13</td>
<td><em>Geranium nepalense</em> Sweet</td>
<td>Laljari and Syuli</td>
<td>Geraniaceae</td>
<td>March</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>14</td>
<td><em>Ilex sp.</em></td>
<td>Holly</td>
<td>Aquifoliaceae</td>
<td>March</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>15</td>
<td><em>Indigofera linifolia</em> (L. f.) Retz.</td>
<td>Ratanjot</td>
<td>Fabaceae</td>
<td>March</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>16</td>
<td><em>Lactuca dissecta</em> D. Don</td>
<td>Split leaf lettuce</td>
<td>Asteraceae</td>
<td>March</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>17</td>
<td><em>Leibnitzia nepalensis</em> (Kunze) Kitam.</td>
<td>Sunbonnets</td>
<td>Asteraceae</td>
<td>March</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td><em>Micromeria biflora</em> (Buch.-Ham. ex D.Don) Benth.</td>
<td>Gorkhapaan and Ban ajwain</td>
<td>Lamiaceae</td>
<td>March</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>19</td>
<td><em>Nepeta ciliaris</em> Benth.</td>
<td>White leaved catmint and Nueet</td>
<td>Lamiaceae</td>
<td>March</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>20</td>
<td><em>Origanum vulgare</em> L.</td>
<td>Bantulsi</td>
<td>Lamiaceae</td>
<td>March</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>21</td>
<td><em>Oxalis corniculata</em> L.</td>
<td>India sorrel and Khatti-buti</td>
<td>Oxalidaceae</td>
<td>March</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>22</td>
<td><em>Perilla frutescens</em> (L.) Britt.</td>
<td>Beefsteak plant</td>
<td>Lamiaceae</td>
<td>March</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>23</td>
<td><em>Phyllanthus fraternus</em> G. L. Webster</td>
<td>Gulf leaf-flower</td>
<td>Euphorbiaceae</td>
<td>March</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Species</td>
<td>Common Name</td>
<td>Family</td>
<td>Season</td>
<td>Activity Codes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>------------------------------</td>
<td>----------------</td>
<td>--------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td><em>Polygonatum capitatum</em> Hamilt. ex Don.</td>
<td>Pinkhead smartweed</td>
<td>Polygonaceae</td>
<td>March</td>
<td>+   +   +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td><em>Prunella vulgaris</em> L.</td>
<td>Common self-heal</td>
<td>Lamiaceae</td>
<td>March</td>
<td>-   -   +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td><em>Reinwardtia trigyna</em> (Roxb.) Planch.</td>
<td>Basant and Pyuli</td>
<td>Linaceae</td>
<td>March</td>
<td>-   +   -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td><em>Stellaria media</em> (L.) Vill.</td>
<td>Chickweed</td>
<td>Caryophyllaceae</td>
<td>March</td>
<td>-   +   -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td><em>Swertia angustifolia</em> Buch.-Ham ex D. Don</td>
<td>Narrow leaved swertia</td>
<td>Gentianaceae</td>
<td>March</td>
<td>-   -   +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td><em>Torenia cordifolia</em> Roxb.</td>
<td>Indian wish born flower</td>
<td>Linderniaceae</td>
<td>March</td>
<td>-   +   +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td><em>Varbascum thapsus</em> L.</td>
<td>Great mullein and</td>
<td>Scrophulariaceae</td>
<td>March</td>
<td>+   +   -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td><em>Vernonia cinerea</em> Less.</td>
<td>Kalgira and Sahadevi</td>
<td>Asteraceae</td>
<td>March</td>
<td>+   +   -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td><em>Viola serpens</em> Wall. ex Roxb.</td>
<td>Gul- banafsha</td>
<td>Violaceae</td>
<td>March</td>
<td>-   +   -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td><em>Youngia japonica</em> (L.) DC.</td>
<td>Oriental hawksbeard</td>
<td>Asteraceae</td>
<td>March</td>
<td>-   -   +</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|   | Total                                           | 14   | 17   | 22   |

(+) present, (-) absent

Table 4.5 Site Wise Distribution of Herbaceous species Reported at Banri Devi Forest (Almora) from April 2013 to March 2014
Table 4.6 shows total number of families, species and genera of tree vegetation found in study site. A total of 18 genera having 18 species belonging to 13 families of tree vegetation were recorded. The highest numbers of plant species were recorded in middle altitudinal sites (13 species) and at higher altitudinal and lower altitudinal sites (7 species) (fig. 4.7). A Total number of families present in the study site were 13 families and the dominating family was Rosaceae (4 geners and 4 species) followed Fabaceae (2 geners and 2 species) and Pinaceae (2 geners and 2 species).

<table>
<thead>
<tr>
<th>Serial no.</th>
<th>Family</th>
<th>Total number of species</th>
<th>Total number of Genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cannabaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Cupressaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ericaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Fabaceae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Meliaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Moraceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Myricaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Pinaceae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Proteaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Rosaceae</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>Salicaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Sapindaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Tiliaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>18</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 Total number of Families, Species and Genera of Tree Vegetation Recorded from the Study Area
<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>NAME OF PLANTS VERNACULAR NAME</th>
<th>FAMILY</th>
<th>SPECIES PRESENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Altitude</td>
</tr>
<tr>
<td>1</td>
<td><em>Aesculus indica</em> Colebr. ex (Cambess) Hook Indian horse chestnut and Ban akhrot</td>
<td>Sapindaceae</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td><em>Cedrus deodara</em> Roxb. Ex D. Don Deodar</td>
<td>Pinaceae</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td><em>Celtis australis</em> L. European nettle tree and Kharik</td>
<td>Cannabaceae</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td><em>Cupressus torulosa</em> D.Don Himalayan cypress and Surai</td>
<td>Cupressaceae</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td><em>Eriobotrya japonica</em> (Thunb.) Lindl. Chinese plum and Loquat</td>
<td>Rosaceae</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td><em>Ficus palmata</em> Forssk. Wild fig and Bedu</td>
<td>Moraceae</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td><em>Grevillea robusta</em> A.Cunn. ex R.Br. Silver oak</td>
<td>Proteaceae</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td><em>Grewia oppositifolia</em> Roxb. ex DC. Bhimal</td>
<td>Tiliaceae</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td><em>Myrica esculenta</em> Buck.-Hem. Bayberry and Kaphal</td>
<td>Myricaceae</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td><em>Pinus roxburghii</em> Sarg. Pine and Chir</td>
<td>Pinaceae</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td><em>Populus ciliate</em> Wall. ex Royle Himalayan poplar</td>
<td>Salicaceae</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td><em>Prunus cerasoides</em> D.Don. Himalayan flowering cherry and Payain</td>
<td>Rosaceae</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td><em>Pyrus pashia</em> Buch.-Ham. ex D.Don Wild Himalayan pear and Mehul</td>
<td>Rosaceae</td>
<td>+</td>
</tr>
<tr>
<td>14</td>
<td><em>Quercus leucotrichophora</em> A. Camus Oak and Banj</td>
<td>Fabaceae</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Species Name</td>
<td>Genus</td>
<td>Family</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>-------</td>
<td>-------------------</td>
</tr>
<tr>
<td>15</td>
<td>Rhododendron arboreum Sm.</td>
<td>Burans</td>
<td>Ericaceae</td>
</tr>
<tr>
<td>16</td>
<td>Stranvaesia nussia Buch.-Hem. ex D. Don</td>
<td>Gudmahal</td>
<td>Rosaceae</td>
</tr>
<tr>
<td>17</td>
<td>Toona hexandra M.Roem.</td>
<td>Toon and Tuni</td>
<td>Meliaceae</td>
</tr>
<tr>
<td>18</td>
<td>Vachellia nilotica (L.) P.J.H.Hurter &amp; Mabb.</td>
<td>Babul and Kikar</td>
<td>Fabaceae</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(+): present, (-): absent

Table 4.7 Site Wise Distribution of Tree Species Reported at Banri Devi Forest (Almora) from April 2013 to March 2014
4.3 PHYTOSOCIOLOGICAL ANALYSIS

Phytosociology is the branch of ecology which concerns especially with the plant communities, their composition and development, and the relationships between the species within them. The term "phytosociology" was coined in 1896 by Józef Paczoski. It is a scientific discipline devoted to the study of vegetation at all levels of complexity spanning populations, plant communities and biomes. It attempts to explain vegetation patterns and the processes governing vegetation assembly and dynamics in all temporal and spatial scales. Phytosociology analysis serves to record anthrpo-zoogenic effects and portrays similarly structured vegetation formations with characteristic vegetation complexes and plant communities. These plant communities consist of recognisable and reproducible associations of plant types which are subject to natural laws under the same ecological conditions. Biodiversity is considered as an important measure for the evaluation of ecosystems. However, the factors that determine species composition remains unknown, unless we identify plant communities, and study their characteristics, dynamics and interactions. Only an evaluation of the heterogeneity of vegetation in time and scale will help us to develop applicable plans for protection and management.

4.3.1 Phytosociological Analysis of Herbaceous Vegetation

4.3.1.1 Phytosociological Analysis of Herbaceous Vegetation in April 2013

At lower altitudinal site 24 species were recorded. Maximum density was recorded for Anaphalis margaritacea (4.40 ind./m²) and minimum value of density (0.10 ind./m²) was recorded for seven species. Maximum frequency values were recorded in three species Anaphalis margaritacea, Conyza japonica and Verbascum thapsus (40%) and lowest is 10% frequency in 13 species. The highest Abundance/Frequency (A/F) ratio was recorded for Galinsoga parviflora (0.90) and the maximum value for total basal area (TBA) was recorded for Verbascum thapsus (1.131 cm²). IVI values showed that
Anaphalis margaritacea (43.96) was dominant species followed by Verbascum thapsus (37.72), Conyza japonica (31.43) and Strobilanthes atropurpurea (26.43).

Total 15 herb species were recorded from site at middle altitude. Highest value of density was recorded for Stellaria media (4.70 ind./m²) and lowest for six species (0.10 ind./m²). Frequency was maximum (50%) in Verbascum thapsus and minimum (10%) in six species. The maximum Abundance/Frequency (A/F) ratio was recorded for Anaphalis margaritacea (0.60) and the maximum value for total basal area (TBA) was recorded for Verbascum thapsus (3.394 cm²). IVI values indicated the dominance of Verbascum thapsus (65.51) followed by Stellaria media (45.04) and Euphorbia esula (34.98).

At higher altitudinal site 17 species were recorded. Maximum density was shown by Anaphalis margaritacea (4.20 ind./m²) and minimum by Pouzolzia hirta (0.40 ind./m²). Maximum frequency (80 %) was reported for Anaphalis margaritacea and minimum (20%) for the 10 species. The highest Abundance/Frequency (A/F) ratio was recorded for Verbascum Thapsus (0.73) and the maximum value for total basal area (TBA) was recorded for Urtica dioica (14.143 cm²). IVI values indicated the dominance of Urtica dioica (65.97). Among codominant species Anaphalis margaritacea (21.62), Pouzolzia hirta (20.72), Conyza japonica (15.99) and Verbascum Thapsus (15.25) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>4.40</td>
<td>40.00</td>
<td>11.00</td>
<td>0.28</td>
<td>23.16</td>
<td>2.11</td>
<td>0.778</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.53</td>
<td>0.53</td>
<td>0.031</td>
<td>0.76</td>
<td>1.81</td>
</tr>
<tr>
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<td>Barleria auriculata Schumach.</td>
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<td>20.00</td>
<td>1.00</td>
<td>0.05</td>
<td>1.05</td>
<td>1.05</td>
<td>0.016</td>
<td>0.38</td>
<td>2.48</td>
</tr>
<tr>
<td>4</td>
<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.53</td>
<td>0.53</td>
<td>0.012</td>
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</tr>
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<td>5</td>
<td>Buchnera hispida Buch.-Ham.</td>
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<td>3.16</td>
<td>0.53</td>
<td>0.023</td>
<td>0.54</td>
<td>2.12</td>
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<tr>
<td>6</td>
<td>Cannabis sativa L.</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.05</td>
<td>0.53</td>
<td>0.023</td>
<td>0.54</td>
<td>2.12</td>
</tr>
<tr>
<td>7</td>
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<td>0.322</td>
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<td>8</td>
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<td>2.00</td>
<td>0.10</td>
<td>2.11</td>
<td>1.05</td>
<td>0.031</td>
<td>0.76</td>
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<td>9</td>
<td>Dicliptera bupleuroides Nees</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.53</td>
<td>0.53</td>
<td>0.031</td>
<td>0.76</td>
<td>1.81</td>
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<tr>
<td>10</td>
<td>Eupatorium adenophorum Spreng.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.53</td>
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<td>0.01</td>
<td>1.06</td>
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<tr>
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<td>0.312</td>
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<td>9.00</td>
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<td>0.53</td>
<td>0.057</td>
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<td>13</td>
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<td>2.11</td>
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<td>0.009</td>
<td>0.21</td>
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<td>14</td>
<td>Gnaphalium luteoalbum L.</td>
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<td>1.00</td>
<td>0.10</td>
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<td>0.028</td>
<td>0.68</td>
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<tr>
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<td>Gnaphalium polycaulon Pers.</td>
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<td>4.00</td>
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<td>4.21</td>
<td>1.05</td>
<td>0.333</td>
<td>7.99</td>
<td>13.26</td>
</tr>
<tr>
<td>16</td>
<td>Micromeria biflora (Buch.-Ham. ex D. Don) Benth.</td>
<td>0.30</td>
<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>1.58</td>
<td>0.53</td>
<td>0.024</td>
<td>0.57</td>
<td>2.67</td>
</tr>
<tr>
<td>17</td>
<td>Nepeta ciliaris Benth.</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.05</td>
<td>0.53</td>
<td>0.016</td>
<td>0.38</td>
<td>1.96</td>
</tr>
<tr>
<td>18</td>
<td>Oxalis corniculata L.</td>
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<td>20.00</td>
<td>6.50</td>
<td>0.33</td>
<td>6.84</td>
<td>1.05</td>
<td>0.102</td>
<td>2.46</td>
<td>10.35</td>
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Table 4.8 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) April 2013

<table>
<thead>
<tr>
<th></th>
<th>Species</th>
<th>Density</th>
<th>Frequency</th>
<th>Abundance/Freq. Ratio</th>
<th>IVI</th>
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<tbody>
<tr>
<td>19</td>
<td><em>Parthenium hysterophorus</em> L.</td>
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<td>1.33</td>
<td>0.04</td>
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<tr>
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<td>1.00</td>
<td>0.10</td>
</tr>
<tr>
<td>21</td>
<td><em>Stellaria media</em> (L.) Vill.</td>
<td>0.20</td>
<td>20.00</td>
<td>1.00</td>
<td>0.05</td>
</tr>
<tr>
<td>22</td>
<td><em>Strobilanthes atropurpurea</em> Nees</td>
<td>1.20</td>
<td>20.00</td>
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<td>0.30</td>
</tr>
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<td>23</td>
<td><em>Trigonella foenum-graecum</em> L.</td>
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<td>10.00</td>
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<td>0.10</td>
</tr>
<tr>
<td>24</td>
<td><em>Varbascum thapsus</em> L.</td>
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<td>40.00</td>
<td>4.00</td>
<td>0.10</td>
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<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>19.00</strong></td>
<td><strong>420.00</strong></td>
<td><strong>85.58</strong></td>
<td><strong>5.28</strong></td>
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</table>

Table 4.8 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) April 2013
<table>
<thead>
<tr>
<th>SL No.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>2.40</td>
<td>20.00</td>
<td>12.00</td>
<td>0.60</td>
<td>13.26</td>
<td>1.10</td>
<td>0.424</td>
<td>5.98</td>
<td>20.34</td>
</tr>
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<td>2</td>
<td>Bidens pilosa L.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.55</td>
<td>0.55</td>
<td>0.028</td>
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<td>1.50</td>
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<td>3</td>
<td>Boenninghausenia albiflora (Hook.) Rchb. ex Meisn.</td>
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<td>0.55</td>
<td>0.035</td>
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<td>Cannabis sativa L.</td>
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<td>3.31</td>
<td>1.10</td>
<td>0.068</td>
<td>0.96</td>
<td>5.38</td>
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<tr>
<td>5</td>
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<td>20.00</td>
<td>1.50</td>
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<td>1.10</td>
<td>0.024</td>
<td>0.33</td>
<td>3.09</td>
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<tr>
<td>6</td>
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<td>19.34</td>
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<td>0.993</td>
<td>13.99</td>
<td>34.98</td>
</tr>
<tr>
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<td>Fragaria indica Andrews</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.55</td>
<td>0.55</td>
<td>0.008</td>
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<tr>
<td>8</td>
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<td>20.00</td>
<td>6.00</td>
<td>0.30</td>
<td>6.63</td>
<td>1.10</td>
<td>0.416</td>
<td>5.86</td>
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<tr>
<td>9</td>
<td>Micromeria biflora (Buch.-Ham. ex D.Don) Benth.</td>
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<td>20.00</td>
<td>2.50</td>
<td>0.13</td>
<td>2.76</td>
<td>1.10</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.55</td>
<td>0.55</td>
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<td>0.55</td>
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<tr>
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<td>1.196</td>
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<td>14.92</td>
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<td>3.394</td>
<td>47.83</td>
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<td>1.66</td>
<td>0.407</td>
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<tr>
<td></td>
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</table>

Table 4.9 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) April 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>4.20</td>
<td>80.00</td>
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<td>0.743</td>
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<td>14.00</td>
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<tr>
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<td>50.00</td>
<td>7.00</td>
<td>0.14</td>
<td>13.01</td>
<td>1.86</td>
<td>0.74</td>
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<td>15.99</td>
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<td>Crotalaria albida B. Heyne ex Roth</td>
<td>0.50</td>
<td>20.00</td>
<td>2.50</td>
<td>0.13</td>
<td>1.86</td>
<td>0.74</td>
<td>0.372</td>
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<tr>
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<td>Eupatorium adenophorum Spreng.</td>
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<td>0.13</td>
<td>1.86</td>
<td>0.74</td>
<td>0.372</td>
<td>1.52</td>
<td>3.24</td>
</tr>
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<td>Fragaria indica Andrews</td>
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<td>0.20</td>
<td>2.97</td>
<td>0.74</td>
<td>0.372</td>
<td>1.52</td>
<td>3.97</td>
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<td>4.78</td>
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<td>40.00</td>
<td>4.75</td>
<td>0.12</td>
<td>7.06</td>
<td>1.49</td>
<td>0.181</td>
<td>0.74</td>
<td>9.29</td>
</tr>
<tr>
<td>13</td>
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<td>0.13</td>
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<td>0.31</td>
<td>2.92</td>
</tr>
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<td>14</td>
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<td>0.40</td>
<td>20.00</td>
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<td>0.10</td>
<td>1.49</td>
<td>0.74</td>
<td>4.526</td>
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<td>20.72</td>
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<td>2.00</td>
<td>0.05</td>
<td>2.97</td>
<td>1.49</td>
<td>0.141</td>
<td>0.58</td>
<td>5.04</td>
</tr>
<tr>
<td>16</td>
<td>Urtica dioica L.</td>
<td>1.80</td>
<td>40.00</td>
<td>4.50</td>
<td>0.11</td>
<td>6.69</td>
<td>1.49</td>
<td>14.143</td>
<td>57.79</td>
<td>65.97</td>
</tr>
<tr>
<td>17</td>
<td>Varsbassum thapsus L.</td>
<td>2.90</td>
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<td>14.50</td>
<td>0.73</td>
<td>10.78</td>
<td>0.74</td>
<td>0.911</td>
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<td>92.25</td>
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<td>24.472</td>
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Table 4.10 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) April 2013
4.3.1.2 Phytosociological Analysis of Herbaceous Vegetation in May 2013

At lower altitudinal site 10 species were recorded. Density was maximum for *Parthenium hysterophorus* (8.80 ind./m²) and minimum (0.10 ind./m²) for *Ageratum conyzoides*. Frequency values were highest in *Parthenium hysterophorus* (100%) and lowest is (10%) frequency was recorded in *Ageratum conyzoides, Nepeta ciliaris, Oxalis corniculata* and *Urtica dioica*. The highest Abundance/Frequency (A/F) ratio was recorded for two species *Nepeta ciliaris* and *Oxalis corniculata* (0.50) and the maximum value for total basal area (TBA) was reported for *Parthenium hysterophorus* (1.770 cm²). IVI values showed that *Parthenium hysterophorus* (103.31) was dominant species and *Verbascum thapsus* (45.82), *Cynoglossum lanceolatum* (17.7) was codominant species.

At middle altitudinal site 12 species were recorded. Maximum density was shown by *Euphorbia esula* (5.20 ind./m²) and minimum by *Cassia desolata* (0.10 ind./m²). Maximum frequency (40 %) was reported for *Conyza aegyptiaca, Euphorbia esula* and *Verbascum thapsus* and minimum (10%) for *Cassia desolata, Oxalis corniculata* and *Rumex hastatus*. The highest Abundance/Frequency (A/F) ratio was recorded for *Nepeta ciliaris* (0.55) and the maximum value for total basal area (TBA) was recorded for *Euphorbia esula* (0.494 cm²). IVI values indicated the dominance of *Euphorbia esula* (69.62) followed by *Verbascum thapsus* (39.70) and *Conyza japonica* (34.92).

Total 21 herb species were recorded from site at higher altitude. Highest value of density was recorded for *Anaphalis margaritacea* (2.00 ind./m²) and minimum for six species (0.10 ind./m²). Frequency was maximum (50%) in *Anaphalis margaritacea* and minimum (10%) in 10 species. The maximum Abundance/Frequency (A/F) ratio was recorded for *Verbascum thapsus* (0.60) and the maximum value for total basal area (TBA) was recorded for *Urtica dioica* (1.179 cm²). IVI values showed the dominance of *Anaphalis margaritacea* (42.68). Among codominant species *Urtica dioica* (36.02) and *Conyza japonica* (23.72) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>RELATIVE ABUNDANCE</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Ageratum conyzoides</em> L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.55</td>
<td>0.55</td>
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<td>0.22</td>
<td>1.32</td>
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<td>2</td>
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<td>4.00</td>
<td>0.20</td>
<td>4.42</td>
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<td>7.64</td>
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<tr>
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<td><em>Coryza japonica</em> (Thunb.) Less. ex Less.</td>
<td>1.70</td>
<td>50.00</td>
<td>3.40</td>
<td>0.07</td>
<td>9.39</td>
<td>2.76</td>
<td>0.065</td>
<td>1.82</td>
<td>13.97</td>
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</tr>
<tr>
<td>4</td>
<td><em>Cynoglossum lanceolatum</em> Forssk.</td>
<td>2.20</td>
<td>30.00</td>
<td>7.33</td>
<td>0.24</td>
<td>12.15</td>
<td>1.66</td>
<td>0.140</td>
<td>3.89</td>
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<td>50.00</td>
<td>3.80</td>
<td>0.08</td>
<td>10.50</td>
<td>2.76</td>
<td>0.037</td>
<td>1.04</td>
<td>14.30</td>
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<tr>
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<td><em>Nepeta ciliaris</em> Benth.</td>
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<td>10.00</td>
<td>5.00</td>
<td>0.50</td>
<td>2.76</td>
<td>0.55</td>
<td>0.025</td>
<td>0.70</td>
<td>4.01</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Oxalis corniculata</em> L.</td>
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<td>10.00</td>
<td>5.00</td>
<td>0.50</td>
<td>2.76</td>
<td>0.55</td>
<td>0.025</td>
<td>0.70</td>
<td>4.01</td>
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<td>8</td>
<td><em>Parthenium hysterophorus</em> L.</td>
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<td>8.80</td>
<td>0.09</td>
<td>48.62</td>
<td>5.52</td>
<td>1.770</td>
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<td>9</td>
<td><em>Urtica dioica</em> L.</td>
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<td>2.00</td>
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<td>0.182</td>
<td>5.05</td>
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<td>50.00</td>
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<td>7.73</td>
<td>2.76</td>
<td>1.272</td>
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<td>45.82</td>
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Table 4.11  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) May 2013
<table>
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<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.60</td>
<td>30.00</td>
<td>2.00</td>
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<td>2.01</td>
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<td>1.00</td>
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<td>1.34</td>
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<tr>
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<td>1.00</td>
<td>0.10</td>
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<td>0.67</td>
<td>0.008</td>
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<td>40.00</td>
<td>1.50</td>
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<td>2.68</td>
<td>0.038</td>
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<td>0.067</td>
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<td>0.457</td>
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Table 4.12 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) May 2013
<table>
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<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>ABUNDANCE RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Ageratum conyzoides L.</td>
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<td>0.93</td>
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<td>0.28</td>
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<td>0.086</td>
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<td>14.07</td>
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<td>10.00</td>
<td>1.00</td>
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<td>0.93</td>
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<td>2.08</td>
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<tr>
<td>15</td>
<td>Nepeta ciliaris Benth.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
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<td>16</td>
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<td>0.28</td>
<td>10.19</td>
<td>1.85</td>
<td>0.086</td>
<td>2.03</td>
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<td>Abundance/Frequency Ratio</td>
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<td>18</td>
<td><em>Rosa macrophylla</em> Lindl.</td>
<td>0.10</td>
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<td>1.00</td>
<td>0.10 0.93 0.126 2.95 4.80</td>
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</tr>
<tr>
<td>20</td>
<td><em>Urtica dioica</em> L.</td>
<td>0.60</td>
<td>30.00</td>
<td>2.00</td>
<td>0.07 5.56 2.78 1.179 27.68 36.02</td>
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<td>21</td>
<td><em>Varbascum thapsus</em> L.</td>
<td>0.60</td>
<td>10.00</td>
<td>6.00</td>
<td>0.60 5.56 0.93 0.483 11.34 17.82</td>
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<tr>
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<td><strong>TOTAL</strong></td>
<td><strong>10.80</strong></td>
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<td><strong>54.25</strong></td>
<td><strong>3.49 100.00 35.19 4.257 100.00 235.19</strong></td>
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Table 4.13 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) May 2013
4.3.1.3 Phytosociological Analysis of Herbaceous Vegetation in June 2013

At lower altitudinal site 18 species were recorded. Density was maximum for *Anaphalis margaritacea* (4.50 ind./m²) and minimum (0.10 ind./m²) for *Reinwardtia indica*. Frequency values were highest in *Cynoglossum furcatum* (70%) and lowest (10%) for twelve species. The maximum Abundance/Frequency (A/F) ratio was recorded for species *Ranunculus sceleratus* (1.50) and the maximum value for total basal area (TBA) was reported for *Anaphalis margaritacea* (3.621 cm²). IVI values showed that *Anaphalis margaritacea* (69.27) was dominant species followed by *Urtica dioica* (37.15) and *Cannabis sativa* (20.32).

At middle altitudinal site 14 species were recorded. Maximum density was shown by *Euphorbia esula* (4.70 ind./m²) and minimum by *Eupatorium adenophorum* (0.20 ind./m²). Maximum frequency (70%) was reported for *Cynoglossum lanceolatum* and minimum (10%) for the six species. The maximum Abundance/Frequency (A/F) ratio was recorded for species *Conyza japonica* (0.60) and the maximum value for total basal area (TBA) was reported for *Cynoglossum lanceolatum* (2.546 cm²). IVI values indicated the dominance of *Cynoglossum lanceolatum* (61.19) followed by *Anaphalis margaritacea* (35.70) and *Euphorbia esula* (33.88).

During June a total 17 herbs species were recorded at higher altitudinal site. Highest value of density were recorded for *Parthenium hysterophorus* (4.90 ind./m²) and lowest density was recorded for *Micromeria biflora* and *Oxalis acetosella* (0.10 ind./m²). *Parthenium hysterophorus* showed maximum value of frequency (70%) while nine species showed minimum value of frequency (10%). The highest Abundance/Frequency (A/F) ratio was recorded for species *Phyllanthus fraternus* (0.90) and the maximum value for total basal area (TBA) was reported for *Verbascum thapsus* (0.665 cm²). On the basis of IVI *Parthenium hysterophorus* (60.77) was the most dominant species and the codominated species were *Verbascum thapsus* (41.67) and *Bidens biternata* (23.70).
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.60</td>
<td>10.00</td>
<td>6.00</td>
<td>0.60</td>
<td>3.37</td>
<td>0.56</td>
<td>0.038</td>
<td>0.43</td>
<td>4.37</td>
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<tr>
<td>2</td>
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<td>50.00</td>
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<td>3.621</td>
<td>41.18</td>
<td>69.27</td>
</tr>
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<td>3.00</td>
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<td>0.56</td>
<td>0.024</td>
<td>0.27</td>
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</tr>
<tr>
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<td>1.046</td>
<td>11.90</td>
<td>20.32</td>
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<td>7.00</td>
<td>0.70</td>
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<td>0.56</td>
<td>0.005</td>
<td>0.06</td>
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<td>6</td>
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<td>4.00</td>
<td>0.20</td>
<td>4.49</td>
<td>1.12</td>
<td>0.051</td>
<td>0.58</td>
<td>6.20</td>
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<tr>
<td>7</td>
<td>Cynoglossum furcatum Wall.</td>
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<td>70.00</td>
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<td>3.93</td>
<td>0.190</td>
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<td>0.20</td>
<td>1.12</td>
<td>0.56</td>
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<td>1.86</td>
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<td>9</td>
<td>Nepeta ciliaris Benth.</td>
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<td>10.00</td>
<td>4.00</td>
<td>0.40</td>
<td>2.25</td>
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<td>0.045</td>
<td>0.51</td>
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<td>5.00</td>
<td>0.50</td>
<td>2.81</td>
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<td>0.039</td>
<td>0.45</td>
<td>3.82</td>
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<td>0.14</td>
<td>7.30</td>
<td>1.69</td>
<td>0.016</td>
<td>0.19</td>
<td>9.17</td>
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<tr>
<td>12</td>
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<td>10.00</td>
<td>5.00</td>
<td>0.50</td>
<td>2.81</td>
<td>0.56</td>
<td>0.173</td>
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<td>5.34</td>
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<tr>
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<td>8.00</td>
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<td>0.56</td>
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<td>1.00</td>
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<td>0.56</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.12</td>
<td>0.56</td>
<td>0.016</td>
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<td>1.86</td>
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<tr>
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<td>Urtica dioica L.</td>
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<td>8.00</td>
<td>0.80</td>
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<td>1.69</td>
<td>0.638</td>
<td>7.26</td>
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Table 4.14: Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) June 2013
<table>
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<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>2.29</td>
<td>1.14</td>
<td>0.038</td>
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<td>3.98</td>
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<tr>
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<td>1.529</td>
<td>21.99</td>
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<tr>
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<td>10.00</td>
<td>5.00</td>
<td>0.50</td>
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<td>6.00</td>
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<td>2.546</td>
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<td>0.30</td>
<td>1.71</td>
<td>0.57</td>
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<td>0.57</td>
<td>0.039</td>
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<td>0.693</td>
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<td>100.00</td>
<td>18.29</td>
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Table 4.15 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) June 2013
<table>
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<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELETIVE DENSITY</th>
<th>RELETIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELETIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
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<td>10.00</td>
<td>2.00</td>
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<td>2.00</td>
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<td>4.17</td>
<td>2.08</td>
<td>0.063</td>
<td>3.05</td>
<td>9.30</td>
</tr>
<tr>
<td>4</td>
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<td>30.00</td>
<td>4.00</td>
<td>0.13</td>
<td>6.25</td>
<td>1.56</td>
<td>0.136</td>
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<td>0.012</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.04</td>
<td>0.52</td>
<td>0.016</td>
<td>0.76</td>
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Table 4.16 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) in June 2013
4.3.1.4 Phytosociological Analysis of Herbaceous Vegetation in July 2013

At lower altitudinal site 28 species were recorded. Density was maximum for *Ageratum conyzoides* (4.10 ind./m²) and minimum (0.10 ind./m²) for four species. Frequency values were highest in *Euphorbia esula* (50%) and lowest is (10%) frequency was recorded for sixteen species. The highest Abundance/Frequency (A/F) ratio was recorded for *Parthenium hysterophorus* (1.60) and the maximum value for total basal area (TBA) was reported for *Verbascum thapsus* (5.813 cm²). IVI values showed that *Verbascum thapsus* (51.22) was dominant species and *Ageratum conyzoides* (19.74) and *Anaphalis margaritacea* (19.25) was codominant species.

At middle altitudinal site 28 species were recorded. Maximum density was shown by *Anaphalis margaritacea* (5.60 ind/m²) and minimum by *Acanthospermum hispidium, Artemisia parviflora* and *Geranium nepalense* (0.10 ind./m²). Maximum frequency (70 %) was reported for *Euphorbia esula* and minimum (10%) for fifteen species. The highest Abundance/Frequency (A/F) ratio was recorded for *Swertia angustifolia* (1.80) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (7.217 cm²). IVI values indicated the dominance of *Verbascum thapsus* (46.98) followed by *Anaphalis margaritacea* (37.64) and *Taraxacum officinale* (19.96).

At higher altitudinal site 29 species were recorded. The higher altitudinal site showed the highest density of *Anaphalis margaritacea* (6.80 ind./m²) and lowest density (0.10 ind./m²) was recorded for *Cassia tora* and *Dracunculus vulgaris* and the maximum frequency was recorded for *Anaphalis margaritacea* (70%) and minimum value of frequency was recorded for eleven species (10%). The maximum Abundance/Frequency (A/F) ratio was recorded for species *Stellaria media* (0.80) and the maximum value for total basal area (TBA) was reported for *Verbascum thapsus* (16.731cm²). IVI values indicated the dominance of *Verbascum thapsus* (65.34) followed by *Anaphalis margaritacea* (41.23) and *Bidens biternata* (16.75).
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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<td>0.544</td>
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<td>0.30</td>
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Table 4.17  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) July 2013
<table>
<thead>
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<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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<td>17.89</td>
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<td>3.208</td>
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Table 4.18 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) July 2013
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<th>RELATIVE DENSITY</th>
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<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
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Table 4.19 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) July 2013
4.3.1.5 Phytosociological Analysis of Herbaceous Vegetation in August 2013

At lower altitudinal site 22 species were recorded. Density was maximum for *Parthenium hysterophorus* (3.60 ind./m²) and minimum (0.10 ind./m²) for four species. Maximum frequency values were recorded in *Ageratum conyzoides* (80%) and lowest is 10% frequency in ten species. The highest Abundance/Frequency (A/F) ratio was recorded for *Tagetes erecta* (0.80) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (6.653 cm²). IVI values showed that *Verbascum thapsus* (65.28) was dominant species. Among codominant species *Parthenium hysterophorus* (30.73) and *Ageratum conyzoides* (23.97) were important.

Total 19 herb species were recorded from site at middle altitude. Highest value of density was recorded for *Eupatorium adenophorum* (2.70 ind./m²) and lowest for *Indigefera linifolia* and *Swertia angustifolia* (0.10 ind./m²). Frequency was maximum (70%) in *Eupatorium adenophorum* and minimum (10%) in *Acanthospermum hispidium*, *Indigefera linifolia*, *Origanum vulgare* and *Swertia angustifolia*. The maximum Abundance/Frequency (A/F) ratio was recorded for *Acanthospermum hispidium* (1.50) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (2.735 cm²). IVI values indicated the dominance of *Eupatorium adenophorum* (41.65) followed by *Verbascum thapsus* (33.93) and *Acanthospermum hispidium* (21.56).

At higher altitudinal site 18 species were recorded. Maximum density was shown by *Bidens biternata* (5.00 ind./m²) and minimum by *Rubus ellipticus* and *Rumex hastatus* (0.10 ind./m²). Maximum frequency (80%) was reported for *Bidens biternata* and minimum (10%) for the six species. The highest Abundance/Frequency (A/F) ratio was recorded for *Cassia tora* (0.30) and the maximum value for total basal area (TBA) was recorded for *Anaphalis margaritacea* (4.068 cm²). IVI values indicated the dominance of *Anaphalis margaritacea* (47.08). Among codominant species *Bidens biternata* (29.94), *Clematis orientalis* (24.63) and *Parthenium hysterophorus* (23.02) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
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Table 4.20  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) August 2013
### Table 4.21

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<th>NAME OF PLANTS</th>
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<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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<td>12</td>
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<td>2.10</td>
<td>30.00</td>
<td>7.00</td>
<td>0.23</td>
<td>11.48</td>
<td>1.64</td>
<td>0.165</td>
<td>1.55</td>
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</tr>
<tr>
<td>13</td>
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<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.55</td>
<td>0.55</td>
<td>0.008</td>
<td>0.07</td>
<td>1.17</td>
</tr>
<tr>
<td>14</td>
<td>Origanum vulgare L.</td>
<td>0.20</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.09</td>
<td>0.55</td>
<td>0.031</td>
<td>0.29</td>
<td>1.93</td>
</tr>
<tr>
<td>15</td>
<td>Parthenium hysterophorus L.</td>
<td>1.30</td>
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<td>3.25</td>
<td>0.08</td>
<td>7.10</td>
<td>2.19</td>
<td>1.181</td>
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<td>16</td>
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<td>7.00</td>
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<td>1.09</td>
<td>0.110</td>
<td>1.04</td>
<td>9.78</td>
</tr>
<tr>
<td>17</td>
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<td>1.00</td>
<td>0.10</td>
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</tr>
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<td>1.80</td>
<td>50.00</td>
<td>3.60</td>
<td>0.07</td>
<td>9.84</td>
<td>2.73</td>
<td>0.362</td>
<td>3.41</td>
<td>15.98</td>
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<td>19</td>
<td>Varbascum thapsus L.</td>
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<td>2.00</td>
<td>0.04</td>
<td>5.46</td>
<td>2.73</td>
<td>2.735</td>
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<td>530.00</td>
<td>67.37</td>
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<td>100.00</td>
<td>28.96</td>
<td>10.628</td>
<td>100.00</td>
<td>228.96</td>
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Table 4.21  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) August 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>1.40</td>
<td>50.00</td>
<td>2.80</td>
<td>0.06</td>
<td>5.17</td>
<td>1.85</td>
<td>0.133</td>
<td>1.13</td>
<td>8.14</td>
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<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>2.80</td>
<td>60.00</td>
<td>4.67</td>
<td>0.08</td>
<td>10.33</td>
<td>2.21</td>
<td>4.068</td>
<td>34.54</td>
<td>47.08</td>
</tr>
<tr>
<td>3</td>
<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
<td>5.00</td>
<td>80.00</td>
<td>6.25</td>
<td>0.08</td>
<td>18.45</td>
<td>2.95</td>
<td>0.37</td>
<td>34.54</td>
<td>29.94</td>
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<td>30.00</td>
<td>4.67</td>
<td>0.16</td>
<td>5.17</td>
<td>1.11</td>
<td>0.159</td>
<td>1.35</td>
<td>8.41</td>
</tr>
<tr>
<td>5</td>
<td>Cannabis sativa L.</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.08</td>
<td>2.00</td>
<td>0.74</td>
<td>0.37</td>
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<tr>
<td>6</td>
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<td>3.32</td>
<td>1.11</td>
<td>0.159</td>
<td>2.40</td>
<td>6.83</td>
</tr>
<tr>
<td>7</td>
<td>Clematis orientalis L.</td>
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<td>50.00</td>
<td>9.80</td>
<td>0.20</td>
<td>18.08</td>
<td>1.85</td>
<td>0.554</td>
<td>4.71</td>
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<td>3.00</td>
<td>0.10</td>
<td>3.32</td>
<td>1.11</td>
<td>0.283</td>
<td>2.40</td>
<td>6.83</td>
</tr>
<tr>
<td>9</td>
<td>Dracunculus vulgaris Schott</td>
<td>1.00</td>
<td>30.00</td>
<td>3.33</td>
<td>0.11</td>
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<td>1.11</td>
<td>0.113</td>
<td>0.96</td>
<td>5.76</td>
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<td>40.00</td>
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<td>0.07</td>
<td>4.06</td>
<td>1.48</td>
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<td>7.51</td>
<td>13.05</td>
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<tr>
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<td>2.67</td>
<td>0.09</td>
<td>2.95</td>
<td>1.11</td>
<td>0.063</td>
<td>0.53</td>
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<td>2.00</td>
<td>0.02</td>
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<td>0.37</td>
<td>0.035</td>
<td>0.30</td>
<td>1.41</td>
</tr>
<tr>
<td>13</td>
<td>Parthenium hysterophorus L.</td>
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<td>40.00</td>
<td>3.75</td>
<td>0.09</td>
<td>5.54</td>
<td>1.48</td>
<td>1.886</td>
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<td>23.02</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.37</td>
<td>0.37</td>
<td>0.145</td>
<td>1.23</td>
<td>1.97</td>
</tr>
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<td>Rumex hastatus D. Don.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.37</td>
<td>0.37</td>
<td>0.008</td>
<td>0.07</td>
<td>0.80</td>
</tr>
<tr>
<td>16</td>
<td>Stellaria media (L.) Vill.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>0.74</td>
<td>0.37</td>
<td>0.091</td>
<td>0.77</td>
<td>1.88</td>
</tr>
<tr>
<td>17</td>
<td>Swertia angustifolia Buch.-Ham ex D. Don</td>
<td>3.90</td>
<td>50.00</td>
<td>7.80</td>
<td>0.16</td>
<td>14.39</td>
<td>1.85</td>
<td>0.441</td>
<td>3.75</td>
<td>19.98</td>
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<tr>
<td>18</td>
<td>Taraxacum officinale Weber.</td>
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<td>1.86</td>
<td>0.03</td>
<td>4.80</td>
<td>2.58</td>
<td>0.540</td>
<td>4.59</td>
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<td>620.00</td>
<td>64.34</td>
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<td>22.88</td>
<td>11.778</td>
<td>100.00</td>
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</table>

Table 4.22 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) August 2013
4.3.1.6 Phytosociological Analysis of Herbaceous Vegetation in September 2013

At lower altitudinal site 14 species were recorded. Density was maximum for *Anaphalis margaritacea* (4.40 ind./m²) and minimum (0.10 ind./m²) for *Argemone maxicana* and *Rubus ellipticus*. Frequency values were highest in *Anaphalis margaritacea* (80%) and lowest (10%) frequency was recorded in *Argemone maxicana, Leucas lanata* and *Rubus ellipticus*. The highest Abundance/Frequency (A/F) ratio was recorded for *Verbascum thapsus* (0.60) and the maximum value for total basal area (TBA) was reported for *Verbascum thapsus* (1.591 cm²). IVI values showed that *Anaphalis margaritacea* (44.72) was dominant species and *Verbascum thapsus* (39.99) and *Rubus ellipticus* (27.17) was codominant species.

At middle altitudinal site 15 species were recorded. Maximum density was shown by *Ageratum conyzoides* (14.00 ind./m²) and minimum by *Nepeta ciliaris* and *Plantago major* (0.10 ind./m²). Maximum frequency (60%) was reported for two species *Ageratum conyzoides* and *Bidens biternata* and minimum (10%) for six species. The highest Abundance/Frequency (A/F) ratio was recorded for *Anaphalis margaritacea* (2.40) and the maximum value for total basal area (TBA) was recorded for *Ageratum conyzoides* (2.156 cm²). IVI values indicated the dominance of *Ageratum conyzoides* (68.44) followed by *Bidens biternata* (36.19) and *Parthenium hysterophorus* (29.17).

Total 23 herb species were recorded from site at higher altitude. Highest value of density was recorded for *Bidens biternata* (5.00 ind./m²) and minimum for four species (0.10 ind./m²). Frequency was maximum (100%) in *Bidens biternata* and minimum (10%) in fourteen species. The maximum Abundance/Frequency (A/F) ratio was recorded for *Reinwardtia indica* (2.30) and the maximum value for total basal area (TBA) was recorded for *Eupatorium adenophorum* (2.836 cm²). IVI values showed the dominance of *Bidens biternata* (44.24). Among codominant species *Eupatorium adenophorum* (32.87) and *Anaphalis margaritacea* (24.96) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>2.40</td>
<td>40.00</td>
<td>6.00</td>
<td>0.15</td>
<td>15.38</td>
<td>2.56</td>
<td>0.228</td>
<td>4.45</td>
<td>22.40</td>
</tr>
<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>4.40</td>
<td>80.00</td>
<td>5.50</td>
<td>0.07</td>
<td>28.21</td>
<td>5.13</td>
<td>0.584</td>
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<td>44.72</td>
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<tr>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.64</td>
<td>0.64</td>
<td>0.283</td>
<td>5.15</td>
<td>6.80</td>
</tr>
<tr>
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<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
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<td>40.00</td>
<td>3.75</td>
<td>0.09</td>
<td>9.62</td>
<td>2.56</td>
<td>0.520</td>
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<td>1.67</td>
<td>0.06</td>
<td>3.21</td>
<td>1.92</td>
<td>0.066</td>
<td>1.29</td>
<td>6.42</td>
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<td>30.00</td>
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<td>0.16</td>
<td>8.97</td>
<td>1.92</td>
<td>0.070</td>
<td>1.37</td>
<td>12.27</td>
</tr>
<tr>
<td>7</td>
<td>Geranium nepalense Sweet</td>
<td>0.50</td>
<td>30.00</td>
<td>1.67</td>
<td>0.06</td>
<td>3.21</td>
<td>1.92</td>
<td>0.039</td>
<td>0.77</td>
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<td>7.00</td>
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<td>0.200</td>
<td>3.89</td>
<td>19.28</td>
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<tr>
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<td>6.00</td>
<td>0.60</td>
<td>3.85</td>
<td>0.64</td>
<td>0.068</td>
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<td>5.81</td>
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<td>30.00</td>
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<td>0.03</td>
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<td>1.92</td>
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<td>0.64</td>
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<td>1.92</td>
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<td>Varbascum thapsus L.</td>
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<td>40.00</td>
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<td>6.41</td>
<td>2.56</td>
<td>1.591</td>
<td>31.02</td>
<td>39.99</td>
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</table>

| TOTAL  | 15.60                                  | 430.00            | 44.58      | 1.83                   | 100.00           | 27.56            | 5.129                            | 100.00            | 227.56                |

Table 4.23 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) September 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>14.00</td>
<td>60.00</td>
<td>23.33</td>
<td>0.39</td>
<td>44.73</td>
<td>1.92</td>
<td>2.156</td>
<td>21.80</td>
<td>68.44</td>
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<td>20.00</td>
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<td>0.64</td>
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<td>0.84</td>
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<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
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<td>10.00</td>
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<td>1.275</td>
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<td>0.141</td>
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<td>7.00</td>
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<td>2.063</td>
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</tr>
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<td>0.32</td>
<td>0.019</td>
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<tr>
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<td>30.00</td>
<td>1.33</td>
<td>0.04</td>
<td>1.28</td>
<td>0.96</td>
<td>0.196</td>
<td>1.99</td>
<td>4.22</td>
</tr>
<tr>
<td>9</td>
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<td>12.50</td>
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<td>7.99</td>
<td>0.64</td>
<td>0.283</td>
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</tr>
<tr>
<td>10</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.32</td>
<td>0.32</td>
<td>0.020</td>
<td>0.20</td>
<td>0.84</td>
</tr>
<tr>
<td>11</td>
<td>Parthenium hysterophorus L.</td>
<td>4.60</td>
<td>40.00</td>
<td>11.50</td>
<td>0.29</td>
<td>14.70</td>
<td>1.28</td>
<td>1.305</td>
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<td>29.17</td>
</tr>
<tr>
<td>12</td>
<td>Plantago major L.</td>
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<td>0.32</td>
<td>0.053</td>
<td>0.54</td>
<td>1.18</td>
</tr>
<tr>
<td>13</td>
<td>Taraxacum officinale Weber.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>0.64</td>
<td>0.32</td>
<td>0.069</td>
<td>0.70</td>
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</tr>
<tr>
<td>14</td>
<td>Varbacum thapsus L.</td>
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<td>20.00</td>
<td>3.00</td>
<td>0.15</td>
<td>1.92</td>
<td>0.64</td>
<td>2.116</td>
<td>21.40</td>
<td>23.95</td>
</tr>
<tr>
<td>15</td>
<td>Youngia japonica(L.) DC.</td>
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<td>20.00</td>
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<td>0.64</td>
<td>0.031</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>31.30</strong></td>
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<td><strong>102.67</strong></td>
<td><strong>5.71</strong></td>
<td><strong>100.00</strong></td>
<td><strong>11.18</strong></td>
<td><strong>9.891</strong></td>
<td><strong>100.00</strong></td>
<td><strong>211.18</strong></td>
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</table>

Table 4.24 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) September 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>1.69</td>
<td>0.84</td>
<td>0.430</td>
<td>3.07</td>
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</tr>
<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>2.90</td>
<td>80.00</td>
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<td>12.24</td>
<td>3.38</td>
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<tr>
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<td>Argemone mexicana L.</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>0.84</td>
<td>0.42</td>
<td>1.312</td>
<td>1.01</td>
<td>3.53</td>
</tr>
<tr>
<td>4</td>
<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
<td>5.00</td>
<td>100.00</td>
<td>5.00</td>
<td>0.05</td>
<td>21.10</td>
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<td>2.656</td>
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</tr>
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<td>5</td>
<td>Bidens pilosa L.</td>
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<td>2.57</td>
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<td>2.95</td>
<td>0.458</td>
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<td>13.81</td>
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<tr>
<td>6</td>
<td>Cannabis sativa L.</td>
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<td>2.00</td>
<td>0.20</td>
<td>0.84</td>
<td>0.42</td>
<td>0.182</td>
<td>1.29</td>
<td>2.56</td>
</tr>
<tr>
<td>7</td>
<td>Cyanotis barbata D. Don</td>
<td>0.30</td>
<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>1.27</td>
<td>0.42</td>
<td>0.108</td>
<td>1.29</td>
<td>2.56</td>
</tr>
<tr>
<td>8</td>
<td>Cynoglossum lanceolatum Forssk.</td>
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<td>11.00</td>
<td>0.55</td>
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<td>0.84</td>
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<td>9</td>
<td>Dicliptera bupleuroides Nees</td>
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<td>2.00</td>
<td>0.20</td>
<td>0.84</td>
<td>0.42</td>
<td>0.182</td>
<td>1.29</td>
<td>2.56</td>
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<tr>
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<td>5.00</td>
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<td>2.836</td>
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<td>2.00</td>
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<td>0.84</td>
<td>0.42</td>
<td>0.027</td>
<td>0.19</td>
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<tr>
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<td>Gnaphalium polycaulon Pers.</td>
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<td>10.00</td>
<td>7.00</td>
<td>0.70</td>
<td>2.95</td>
<td>0.42</td>
<td>0.108</td>
<td>0.77</td>
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<tr>
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<td>1.00</td>
<td>0.10</td>
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<td>0.42</td>
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<td>1.01</td>
</tr>
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<td>2.00</td>
<td>0.20</td>
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<td>0.42</td>
<td>0.016</td>
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<td>1.251</td>
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<td>0.42</td>
<td>0.193</td>
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</table>
### Table 4.25 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) September 2013

<table>
<thead>
<tr>
<th></th>
<th>Scientific Name</th>
<th>Density</th>
<th>Frequency</th>
<th>Abundance/Frequency Ratio</th>
<th>IVI</th>
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<td><em>Swertia angustifolia</em> Buch.-Ham ex D. Don</td>
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<td>10.00</td>
<td>1.00</td>
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</tr>
<tr>
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<td></td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
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</tr>
<tr>
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<td></td>
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<td>1.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td><em>Tagetes erecta</em> L.</td>
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<td>1.00</td>
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</tr>
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<td>10.00</td>
<td>1.00</td>
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<td>10.00</td>
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<td></td>
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<td>1.35</td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>0.24</td>
<td>6.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td><em>Urtica dioica</em> L.</td>
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<td>20.00</td>
<td>2.50</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.10</td>
<td>0.84</td>
<td></td>
<td>0.454</td>
</tr>
<tr>
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<td>0.13</td>
<td>3.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.24</td>
<td>6.19</td>
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<td></td>
</tr>
<tr>
<td></td>
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</tr>
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Table 4.25 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) September 2013
4.3.1.7 Phytosociological Analysis of Herbaceous Vegetation in October 2013

At lower altitudinal site 12 species were recorded. Density was maximum for *Anaphalis margaritacea* (7.50 ind./m²) and minimum (0.20 ind./m²) for *Xanthium indicum*. Frequency values were highest in *Anaphalis margaritacea* (70%) and lowest (10%) frequency was recorded in *Argemone maxicana, Bidens pilosa* and *Xanthium indicum*. The highest Abundance/Frequency (A/F) ratio was recorded for species *Argemone maxicana* (1.00) and the maximum value for total basal area (TBA) was reported for *Anaphalis margaritacea* (3.394 cm²). IVI values showed that *Anaphalis margaritacea* (63.16) was dominant species and *Parthenium hysterophorus* (44.71) and *Ageratum conyzoides* (23.35) was codominant species.

At middle altitudinal site 18 species were recorded. Maximum density was shown by *Ageratum conyzoides* (13.70 ind/m²) and minimum by *Ajuga bracteosa, Cynoglossum deniculatum* and *Tagetes erecta* (0.10 ind./m²). Maximum frequency (70%) was reported for *Ageratum conyzoides* and minimum (10%) for eleven species. The highest Abundance/Frequency (A/F) ratio was recorded for *Euphorbia esula* (0.70) and the maximum value for total basal area (TBA) was recorded for *Ageratum conyzoides* (8.439 cm²). IVI values indicated the dominance of *Ageratum conyzoides* (88.07) followed by *Anaphalis margaritacea* (59.36) and *Bidens bitemnata* (31.97).

The higher altitudinal site showed total 17 species and the highest density of *Anaphalis margaritacea* (8.60 ind./m²) and lowest density for (0.10 ind./m²) was recorded four species species *Conyza japonica, Lactuca dissecta, Parthenium hysterophorus* and *Pimpinella diversifolia* and the maximum frequency was recorded for *Anaphalis margaritacea* (100%) and minimum value of frequency (10%) was recorded for seven species. The maximum Abundance/Frequency (A/F) ratio was recorded for species *Pouzolzia hirta* (2.20) and the maximum value for total basal area (TBA) was reported for *Taraxacum officinale* (2.078 cm²). IVI values indicated the dominance of *Anaphalis margaritacea* (55.90) followed by *Taraxacum officinale* (46.11) and *Eupatorium adenophorum* (25.64).
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Acanthospermum hispidum D.C.</td>
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<td>8.22</td>
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<td>1.635</td>
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<td>23.35</td>
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<tr>
<td>3</td>
<td>Ajuga bracteosa Wall ex.Benth.</td>
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<td>30.00</td>
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<td>1.37</td>
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<td>0.91</td>
</tr>
<tr>
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<td>70.00</td>
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<td>3.394</td>
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<tr>
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<td>4.00</td>
<td>0.20</td>
<td>3.65</td>
<td>0.91</td>
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<td>8.85</td>
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<td>9</td>
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<td>50.00</td>
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<td>2.044</td>
<td>15.49</td>
<td>44.71</td>
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<tr>
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<td>Taraxacum officinale Weber.</td>
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<td>0.07</td>
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<td>0.91</td>
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<td>0.063</td>
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</tr>
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<td>217.81</td>
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</table>

Table 4.26 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) October 2013
Table 4.27 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) October 2013

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>13.70</td>
<td>70.00</td>
<td>19.57</td>
<td>0.28</td>
<td>39.71</td>
<td>2.03</td>
<td>8.439</td>
<td>46.33</td>
<td>88.07</td>
</tr>
<tr>
<td>2</td>
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<td>0.10</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.29</td>
<td>0.29</td>
<td>0.053</td>
<td>0.29</td>
<td>0.87</td>
</tr>
<tr>
<td>3</td>
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<td>10.30</td>
<td>60.00</td>
<td>17.17</td>
<td>0.29</td>
<td>29.86</td>
<td>1.74</td>
<td>5.058</td>
<td>27.77</td>
<td>59.36</td>
</tr>
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<td>2.762</td>
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<td>31.97</td>
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<td>5</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>0.58</td>
<td>0.29</td>
<td>0.031</td>
<td>0.17</td>
<td>1.04</td>
</tr>
<tr>
<td>6</td>
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<td>0.10</td>
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<tr>
<td>7</td>
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<td>3.00</td>
<td>0.30</td>
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<td>0.370</td>
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<td>4.93</td>
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<td>0.70</td>
<td>2.03</td>
<td>0.29</td>
<td>0.108</td>
<td>0.59</td>
<td>2.91</td>
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<td>0.07</td>
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<td>0.58</td>
<td>0.083</td>
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<td>0.040</td>
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<td>0.029</td>
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<td>0.29</td>
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<td>ABUNDANCE FREQUENCY RATIO</td>
<td>RELATIVE DENSITY</td>
<td>RELATIVE FREQUENCY</td>
<td>TOTAL BASAL AREA OF SPECIES (cm²)</td>
<td>RELATIVE DOMINANCE</td>
<td>IMPORTANCE VALUE INDEX</td>
</tr>
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<td>0.35</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.35</td>
<td>0.35</td>
<td>0.016</td>
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<td>1.26</td>
</tr>
<tr>
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<td>Dicliptera bupleuroides Nees</td>
<td>1.30</td>
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<td>2.48</td>
<td>1.131</td>
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<td>2.00</td>
<td>0.20</td>
<td>0.71</td>
<td>0.35</td>
<td>0.016</td>
<td>0.20</td>
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<tr>
<td>9</td>
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<td>10.00</td>
<td>1.00</td>
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<td>0.35</td>
<td>0.042</td>
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<td>1.23</td>
</tr>
<tr>
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<td>20.00</td>
<td>7.50</td>
<td>0.38</td>
<td>5.32</td>
<td>0.71</td>
<td>0.382</td>
<td>4.82</td>
<td>10.85</td>
</tr>
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<td>4.20</td>
<td>0.08</td>
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<td>1.77</td>
<td>0.165</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.35</td>
<td>0.35</td>
<td>0.031</td>
<td>0.40</td>
<td>1.11</td>
</tr>
<tr>
<td>13</td>
<td>Paspalum distichum L.</td>
<td>0.70</td>
<td>30.00</td>
<td>2.33</td>
<td>0.08</td>
<td>2.48</td>
<td>1.06</td>
<td>0.002</td>
<td>0.03</td>
<td>3.57</td>
</tr>
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<td>Pimpinella diversifolia Dc.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.35</td>
<td>0.35</td>
<td>0.013</td>
<td>0.17</td>
<td>0.88</td>
</tr>
<tr>
<td>15</td>
<td>Pouzolzia hirta (Blume) Hassk.</td>
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<td>10.00</td>
<td>22.00</td>
<td>2.20</td>
<td>7.80</td>
<td>0.35</td>
<td>0.624</td>
<td>7.88</td>
<td>16.04</td>
</tr>
<tr>
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<td>3.00</td>
<td>0.15</td>
<td>2.13</td>
<td>0.71</td>
<td>0.047</td>
<td>0.60</td>
<td>3.43</td>
</tr>
<tr>
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<td>60.00</td>
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<td>0.14</td>
<td>17.73</td>
<td>2.13</td>
<td>2.078</td>
<td>26.25</td>
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</tr>
<tr>
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<td>100.00</td>
<td>18.79</td>
<td>7.916</td>
<td>100.00</td>
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</table>

Table 4.28 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) October October 2013
4.3.1.8 Phytosociological Analysis of Herbaceous Vegetation in November 2013

At lower altitudinal site 19 species were recorded. Density was maximum for *Frageria indica* (4.00 ind./m²) and minimum (0.10 ind./m²) for *Datura stramonium*. Frequency values were highest in *Anaphalis margaritacea*, *Frageria indica*, *Geranium nepalense* and *Taraxacum officinale* (50%) and lowest is (10%) frequency was recorded in five species. The highest Abundance/Frequency (A/F) ratio was recorded for *Euphorbia esula* (1.80) and the maximum value for total basal area (TBA) was reported for *Eupatorium adenophorum* (1.571 cm²). IVI values showed that *Frageria indica* (29.72) was dominant species and *Eupatorium adenophorum* (27.84) and *Verbascum thapsus* (24.49) was codominant species.

At middle altitudinal site 16 species were recorded. Maximum density was shown by *Euphorbia esula* (5.60 ind./m²) and minimum (0.10ind./m²) by five species. Maximum frequency (50 %) was reported for *Euphorbia esula* and *Verbascum thapsus* and minimum (10%) for eight species. The highest Abundance/Frequency (A/F) ratio was recorded for *Gnaphalium luteoalbum* (0.40) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (3.182 cm²). IVI values indicated the dominance of *Verbascum thapsus* (64.81) followed by *Euphorbia esula* (51.04) and *Anaphalis margaritacea* (37.36).

Total 20 herb species were recorded from site at higher altitude. Highest value of density was recorded for *Taraxacum officinale* (6.90 ind./m²) and minimum for five species (0.10 ind./m²). Frequency was maximum (70%) in *Taraxacum officinale* and minimum (10%) in twelve species. The maximum Abundance/Frequency (A/F) ratio was recorded for *Tagetes erecta* (1.20) and the maximum value for total basal area (TBA) was recorded for *Taraxacum officinale* (1.063 cm²). IVI values showed the dominance of *Taraxacum officinale* (59.86). Among codominant species *Eupatorium adenophorum* (33.66)) and *Anaphalis margaritacea* (29.75) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY  (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>RELATIVE ABUNDANCE</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
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<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>2.25</td>
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<td>2.81</td>
<td>0.629</td>
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<td>0.56</td>
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<td>22.93</td>
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<td>7.00</td>
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<td>4.00</td>
<td>0.20</td>
<td>4.49</td>
<td>1.12</td>
<td>1.571</td>
<td>22.22</td>
<td>27.84</td>
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<td>50.00</td>
<td>2.40</td>
<td>0.05</td>
<td>6.74</td>
<td>2.81</td>
<td>0.094</td>
<td>1.33</td>
<td>10.88</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Lactuca dissecta D. Don</td>
<td>0.90</td>
<td>20.00</td>
<td>4.50</td>
<td>0.23</td>
<td>5.06</td>
<td>1.12</td>
<td>0.342</td>
<td>4.84</td>
<td>11.02</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Leibnitzia nepalensis (Kunze) Kitam.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.12</td>
<td>0.56</td>
<td>0.004</td>
<td>0.06</td>
<td>1.74</td>
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</tr>
<tr>
<td>15</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.12</td>
<td>0.56</td>
<td>0.016</td>
<td>0.22</td>
<td>1.91</td>
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</tr>
<tr>
<td>16</td>
<td>Polygonatum capitatum Hamilt. ex Don.</td>
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<td>0.33</td>
<td>7.30</td>
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<td>0.588</td>
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</tr>
<tr>
<td>17</td>
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<td>50.00</td>
<td>1.20</td>
<td>0.02</td>
<td>3.37</td>
<td>2.81</td>
<td>0.272</td>
<td>3.84</td>
<td>10.02</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Thalictrum foliolosum DC.</td>
<td>0.20</td>
<td>20.00</td>
<td>1.00</td>
<td>0.05</td>
<td>1.12</td>
<td>1.12</td>
<td>0.016</td>
<td>0.22</td>
<td>2.47</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Varbascum thapsus L.</td>
<td>0.50</td>
<td>30.00</td>
<td>1.67</td>
<td>0.06</td>
<td>2.81</td>
<td>1.69</td>
<td>1.414</td>
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<td>24.49</td>
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<tr>
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<td>470.00</td>
<td>78.60</td>
<td>4.86</td>
<td>100.00</td>
<td>26.40</td>
<td>7.073</td>
<td>100.00</td>
<td>226.40</td>
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Table 4.29 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) November 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ageratum conyzoides L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.62</td>
<td>0.62</td>
<td>0.031</td>
<td>0.49</td>
<td>1.72</td>
</tr>
<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>3.30</td>
<td>40.00</td>
<td>8.25</td>
<td>0.21</td>
<td>20.37</td>
<td>2.47</td>
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<td>14.52</td>
<td>37.36</td>
</tr>
<tr>
<td>3</td>
<td>Argemone mexicana L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.62</td>
<td>0.62</td>
<td>0.071</td>
<td>1.10</td>
<td>2.33</td>
</tr>
<tr>
<td>4</td>
<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
<td>0.20</td>
<td>20.00</td>
<td>1.00</td>
<td>0.05</td>
<td>1.23</td>
<td>1.23</td>
<td>0.016</td>
<td>0.24</td>
<td>2.10</td>
</tr>
<tr>
<td>5</td>
<td>Clematis orientalis L.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.62</td>
<td>0.62</td>
<td>0.005</td>
<td>0.08</td>
<td>1.31</td>
</tr>
<tr>
<td>6</td>
<td>Colebrookea oppositifolia Sm.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.62</td>
<td>0.62</td>
<td>0.071</td>
<td>1.10</td>
<td>2.33</td>
</tr>
<tr>
<td>7</td>
<td>Conyza japonica (Thunb.) Less. ex Less.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.23</td>
<td>0.62</td>
<td>0.016</td>
<td>0.24</td>
<td>2.10</td>
</tr>
<tr>
<td>8</td>
<td>Cynoglossum furcatum Wall.</td>
<td>2.30</td>
<td>40.00</td>
<td>5.75</td>
<td>0.14</td>
<td>14.20</td>
<td>2.47</td>
<td>0.219</td>
<td>3.39</td>
<td>20.06</td>
</tr>
<tr>
<td>9</td>
<td>Eupatorium adenophorum Spreng.</td>
<td>0.50</td>
<td>20.00</td>
<td>2.50</td>
<td>0.13</td>
<td>3.09</td>
<td>1.23</td>
<td>0.208</td>
<td>3.22</td>
<td>7.55</td>
</tr>
<tr>
<td>10</td>
<td>Euphorbia esula L.</td>
<td>5.60</td>
<td>50.00</td>
<td>11.20</td>
<td>0.22</td>
<td>34.57</td>
<td>3.09</td>
<td>0.862</td>
<td>13.38</td>
<td>51.04</td>
</tr>
<tr>
<td>11</td>
<td>Gnaphalium luteoalbum L.</td>
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<td>10.00</td>
<td>4.00</td>
<td>0.40</td>
<td>2.47</td>
<td>0.62</td>
<td>0.264</td>
<td>4.10</td>
<td>7.19</td>
</tr>
<tr>
<td>12</td>
<td>Plantago major L.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.62</td>
<td>0.62</td>
<td>0.066</td>
<td>1.03</td>
<td>2.26</td>
</tr>
<tr>
<td>13</td>
<td>Tagetes erecta L.</td>
<td>0.30</td>
<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>1.85</td>
<td>0.62</td>
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<td>3.79</td>
</tr>
<tr>
<td>14</td>
<td>Taraxacum officinale Weber.</td>
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<td>20.00</td>
<td>3.00</td>
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<td>3.70</td>
<td>1.23</td>
<td>0.272</td>
<td>4.21</td>
<td>9.15</td>
</tr>
<tr>
<td>15</td>
<td>Varbascum thapsus L.</td>
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<td>4.00</td>
<td>0.08</td>
<td>12.35</td>
<td>3.09</td>
<td>3.182</td>
<td>49.38</td>
<td>64.81</td>
</tr>
<tr>
<td>16</td>
<td>Xanthium indicum J. Koenig</td>
<td>0.30</td>
<td>20.00</td>
<td>1.50</td>
<td>0.08</td>
<td>1.85</td>
<td>1.23</td>
<td>0.094</td>
<td>1.46</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>16.20</td>
<td>340.00</td>
<td>51.20</td>
<td>2.45</td>
<td>100.00</td>
<td>20.99</td>
<td>6.445</td>
<td>100.00</td>
<td>220.99</td>
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Table 4.30 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) November 2013
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>RELETIVE DENSITY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acanthospermum hispidium D.C.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
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<td>0.92</td>
<td>0.46</td>
<td>0.083</td>
<td>1.94</td>
<td>3.33</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ageratum conyzoides L.</td>
<td>1.60</td>
<td>20.00</td>
<td>8.00</td>
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<td>7.37</td>
<td>0.92</td>
<td>0.283</td>
<td>6.61</td>
<td>14.91</td>
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<tr>
<td>3</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
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<td>0.10</td>
<td>16.13</td>
<td>2.76</td>
<td>0.465</td>
<td>10.86</td>
<td>29.75</td>
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</tr>
<tr>
<td>4</td>
<td>Argemone mexicana L.</td>
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<td>20.00</td>
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<td>6.00</td>
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<td>13.74</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.46</td>
<td>0.46</td>
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<td>0.67</td>
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<td>Conyza japonica (Thunb.) Less. ex Less.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.46</td>
<td>0.46</td>
<td>0.008</td>
<td>0.18</td>
<td>1.11</td>
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</tr>
<tr>
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<td>Cynoglossum fureatum Wall.</td>
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<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>1.38</td>
<td>0.46</td>
<td>0.029</td>
<td>0.67</td>
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<tr>
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<td>1.00</td>
<td>0.10</td>
<td>0.46</td>
<td>0.46</td>
<td>0.008</td>
<td>0.18</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
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<td>2.00</td>
<td>0.20</td>
<td>0.92</td>
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<td>2.85</td>
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</tr>
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<td>2.00</td>
<td>0.20</td>
<td>0.92</td>
<td>0.46</td>
<td>0.016</td>
<td>0.37</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Oxalis corniculata L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.46</td>
<td>0.46</td>
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<td>0.18</td>
<td>1.11</td>
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<tr>
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<td>6.45</td>
<td>1.38</td>
<td>0.440</td>
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<tr>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.46</td>
<td>0.46</td>
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<tr>
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<td>20.00</td>
<td>3.00</td>
<td>0.15</td>
<td>2.76</td>
<td>0.92</td>
<td>0.189</td>
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<td>8.09</td>
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<tr>
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<td>Prinsepia utilis Royle.</td>
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<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>0.92</td>
<td>0.46</td>
<td>0.019</td>
<td>0.44</td>
<td>1.83</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Tagetes erecta L.</td>
<td>1.20</td>
<td>10.00</td>
<td>12.00</td>
<td>1.20</td>
<td>5.53</td>
<td>0.46</td>
<td>0.136</td>
<td>3.17</td>
<td>9.16</td>
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</tr>
<tr>
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<td>70.00</td>
<td>9.86</td>
<td>0.14</td>
<td>31.80</td>
<td>3.23</td>
<td>1.063</td>
<td>24.83</td>
<td>59.86</td>
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</tr>
<tr>
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<td>21.70</td>
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<td>100.00</td>
<td>18.43</td>
<td>4.279</td>
<td>100.00</td>
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</tbody>
</table>

Table 4.31  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) November 2013
4.3.1.9 Phytosociological Analysis of Herbaceous Vegetation in December 2013

At lower altitudinal site 9 species were recorded. Density was maximum for *Oxalis corniculata* (3.70 ind./m²) and minimum (0.10 ind./m²) for *Kalanchoe sphathulata*. Maximum frequency values were recorded in *Anaphalis margaritacea* (70%) and lowest is (10%) in frequency in four species. The highest Abundance/Frequency (A/F) ratio was recorded for *Ajuga bracteosa* (0.80) and the maximum value for total basal area (TBA) was recorded for *Kalanchoe sphathulata* (1.308 cm²). IVI values showed that *Verbascum thapsus* (51.65) was dominant species and codominant species are *Oxalis corniculata* (39.29) and *Kalanchoe sphathulata* (35.52).

Total 7 herb species were recorded from site at middle altitude. Highest value of density was recorded for *Euphorbia esula* (7.20 ind./m²) and lowest (0.10 ind./m²) for *Gnaphalium leutoalbum* and *Taraxacum officinale*. Frequency was maximum (70%) in *Verbascum thapsus* and minimum (10%) for three species. The highest Abundance/Frequency (A/F) ratio was recorded for *Cynoglossum lanceolatum* (0.60) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (2.121cm²). IVI values indicated the dominance of *Euphorbia esula* (80.55) followed by *Verbascum thapsus* (67.11) and *Argemone maxicana* (32.54).

At higher altitudinal site 15 species were recorded. Maximum density was shown by *Argemone maxicana* (6.20 ind./ m²) and minimum by *Acanthospermum hispidium* and *Polygonatum capitatum* (0.20 ind./m²). Maximum frequency (90 %) was reported for *Argemone maxicana* and *Eupatorium adenophorum* and minimum (10%) for *Acanthospermum hispidium*, *Bidens biternata* and *Polygonatum capitatum*. The highest Abundance/Frequency (A/F) ratio was recorded for *Bidens biternata* (0.40) and the maximum value for total basal area (TBA) was recorded for *Verbascum thapsus* (7.661cm²). IVI values indicated the dominance of *Verbascum thapsus* (60.47). Among codominant species *Argemone maxicana* (44.06) and *Eupatorium adenophorum* (41.89) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ajgua bracteosa Wall ex.Benth.</td>
<td>0.80</td>
<td>10.00</td>
<td>8.00</td>
<td>0.80</td>
<td>6.90</td>
<td>0.86</td>
<td>0.529</td>
<td>13.67</td>
<td>21.42</td>
</tr>
<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>1.40</td>
<td>70.00</td>
<td>2.00</td>
<td>0.03</td>
<td>12.07</td>
<td>6.03</td>
<td>0.158</td>
<td>4.09</td>
<td>22.20</td>
</tr>
<tr>
<td>3</td>
<td>Argemone mexicana L.</td>
<td>1.70</td>
<td>40.00</td>
<td>4.25</td>
<td>0.11</td>
<td>14.66</td>
<td>3.45</td>
<td>0.534</td>
<td>13.81</td>
<td>31.92</td>
</tr>
<tr>
<td>4</td>
<td>Bupleurum hamiltonii N.P.Balakr</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.72</td>
<td>0.86</td>
<td>0.016</td>
<td>0.41</td>
<td>2.99</td>
</tr>
<tr>
<td>5</td>
<td>Kalanchoe spathulata DC.</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
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<td>0.86</td>
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<td>6</td>
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<td>31.90</td>
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<td>40.00</td>
<td>2.75</td>
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<td>0.124</td>
<td>3.22</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.72</td>
<td>0.86</td>
<td>0.016</td>
<td>0.41</td>
<td>2.99</td>
</tr>
<tr>
<td>9</td>
<td>Varbascum thapsus L.</td>
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Table 4.32 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) December 2013
### Table 4.33 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) December 2013

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>1.50</td>
<td>40.00</td>
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<td>3.07</td>
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<td>6.00</td>
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<td>0.78</td>
<td>0.424</td>
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</tr>
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<td>0.78</td>
<td>0.78</td>
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<td>1.00</td>
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<td>0.78</td>
<td>0.78</td>
<td>0.091</td>
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<tr>
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<td><strong>TOTAL</strong></td>
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<td><strong>17.05</strong></td>
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<td><strong>217.05</strong></td>
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<td>SL NO.</td>
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<td>DENSITY (ind./m²)</td>
<td>FREQUENCY %</td>
<td>ABUNDANCE</td>
<td>ABUNDANCE FREQUENCY</td>
<td>RELATIVE DENSITY</td>
<td>RELETIVE FREQUENCY</td>
<td>TOTAL BASAL AREA OF SPECIES (cm²)</td>
<td>RELATIVE DOMINANCE</td>
</tr>
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<td>------------------</td>
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<td>-------------------</td>
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<td>0.249</td>
<td>1.45</td>
</tr>
<tr>
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<td>6.89</td>
<td>0.08</td>
<td>21.68</td>
<td>3.15</td>
<td>3.293</td>
<td>19.23</td>
</tr>
<tr>
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<td>Bidens biternata (Lour.) Merr. &amp; Sherff</td>
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<td>10.00</td>
<td>4.00</td>
<td>0.40</td>
<td>1.40</td>
<td>0.35</td>
<td>0.053</td>
<td>0.31</td>
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<tr>
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<td>Cynoglossum furcatum Wall.</td>
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<td>20.00</td>
<td>1.50</td>
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<td>1.05</td>
<td>0.70</td>
<td>0.029</td>
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<td>Eupatorium adenophorum Spreng.</td>
<td>4.90</td>
<td>90.00</td>
<td>5.44</td>
<td>0.06</td>
<td>17.13</td>
<td>3.15</td>
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<td>0.23</td>
<td>3.15</td>
<td>0.70</td>
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<tr>
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<tr>
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<td>Gnaphalium polycaulon Pers.</td>
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<td>3.00</td>
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<td>5.24</td>
<td>1.75</td>
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<td>0.70</td>
<td>0.35</td>
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</tr>
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<td>2.10</td>
<td>0.70</td>
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<tr>
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<td>4.75</td>
<td>0.12</td>
<td>6.64</td>
<td>1.40</td>
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<td>14</td>
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<td>50.00</td>
<td>5.80</td>
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<td>1.75</td>
<td>1.205</td>
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<td>6.50</td>
<td>0.11</td>
<td>13.64</td>
<td>2.10</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>20.98</strong></td>
<td><strong>17.124</strong></td>
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</table>

Table 4.34 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) December 2013
4.3.1.10 Phytosociological Analysis of Herbaceous Vegetation in January 2014

At lower altitudinal site 16 species were recorded. Density was maximum for Anaphalis margaritacea (3.80 ind./m²) and minimum (0.10 ind./m²) for six species. Frequency values were highest in Anaphalis margaritacea (80%) and lowest (10%) for ten species. The maximum Abundance/Frequency (A/F) ratio was recorded for Dicliptera bupleuroides (0.90) and the maximum value for total basal area (TBA) was reported for Verbascum thapsus (1.839 cm²). IVI values showed that Anaphalis margaritacea (66.20) was dominant species and Verbascum thapsus (57.76) and Ageratum conyzoides (22.93) was codominant species.

At middle altitudinal site 13 species were recorded. Maximum density was shown by Euphorbia esula (6.90 ind./m²) and minimum by Dicliptera bupleorides, Lucas lanata, Urtica dioica and Vernonia cinera (0.10 ind./m²). Maximum frequency (70%) was reported for Euphorbia esula and minimum (10%) for eight species. The maximum Abundance/Frequency (A/F) ratio was recorded for Acanthospermum hispidium (0.50) and the maximum value for total basal area (TBA) was reported for Verbascum thapsus (8.855 cm²). IVI values indicated the dominance of Verbascum thapsus (66.77) followed by Euphorbia esula (64.46) and Argemone maxicana (42.18).

Total 8 herb species were recorded from site at higher altitude. Highest value of density was recorded for Anaphalis margaritacea (3.90 ind./m²) and minimum for Oxalis corniculata (0.2 ind./m²). Frequency was maximum (80%) in Anaphalis margaritacea and minimum (10%) in Gallium aparine and Oxalis corniculata. The maximum Abundance/Frequency (A/F) ratio was recorded for species Gallium aparine (1.10) and the maximum value for total basal area (TBA) was reported for Taraxacum officinale (4.777 cm²). IVI values showed the dominance of Taraxacum officinale (67.86). Among codominant species Eupatorium adinophorum (59.56) and Anaphalis margaritacea (37.54) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
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<td>0.219</td>
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<td>80.00</td>
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<td>0.76</td>
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<tr>
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<tr>
<td>14</td>
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Table 4.35 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) January 2014
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Acanthospermum hispidium D.C.</td>
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<td>0.402</td>
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<tr>
<td>2</td>
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<td>0.30</td>
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<td>3.00</td>
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<td>0.71</td>
<td>0.136</td>
<td>0.71</td>
<td>3.56</td>
</tr>
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<td>1.50</td>
<td>30.00</td>
<td>5.00</td>
<td>0.17</td>
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<td>2.14</td>
<td>0.570</td>
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<td>7.50</td>
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<td>1.43</td>
<td>5.775</td>
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<tr>
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<td>2.00</td>
<td>0.20</td>
<td>1.43</td>
<td>0.71</td>
<td>0.141</td>
<td>0.74</td>
<td>2.88</td>
</tr>
<tr>
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<td>Dicliptera bupleuroides Nees</td>
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<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.71</td>
<td>0.71</td>
<td>0.015</td>
<td>0.08</td>
<td>1.51</td>
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<td>6.90</td>
<td>70.00</td>
<td>9.86</td>
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<td>5.00</td>
<td>1.957</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.43</td>
<td>0.71</td>
<td>0.025</td>
<td>0.13</td>
<td>2.27</td>
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<td>20.00</td>
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<td>1.43</td>
<td>0.362</td>
<td>1.88</td>
<td>4.74</td>
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<td>0.10</td>
<td>0.71</td>
<td>0.71</td>
<td>0.951</td>
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<td>4.29</td>
<td>8.855</td>
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<td>66.77</td>
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<tr>
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<td>1.00</td>
<td>0.10</td>
<td>0.71</td>
<td>0.71</td>
<td>0.025</td>
<td>0.13</td>
<td>1.56</td>
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<td><strong>TOTAL</strong></td>
<td></td>
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<td><strong>280.00</strong></td>
<td><strong>43.19</strong></td>
<td><strong>2.40</strong></td>
<td><strong>100.00</strong></td>
<td><strong>20.00</strong></td>
<td><strong>19.229</strong></td>
<td><strong>100.00</strong></td>
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Table 4.36 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) January 2014
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>3.90</td>
<td>80.00</td>
<td>4.88</td>
<td>0.06</td>
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<td>0.689</td>
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<td>3.00</td>
<td>0.15</td>
<td>4.11</td>
<td>1.37</td>
<td>3.017</td>
<td>23.39</td>
<td>28.87</td>
</tr>
<tr>
<td>3</td>
<td>Eupatorium adenophorum Spreng.</td>
<td>3.30</td>
<td>70.00</td>
<td>4.71</td>
<td>0.07</td>
<td>22.60</td>
<td>4.79</td>
<td>4.149</td>
<td>32.17</td>
<td>59.56</td>
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<td>10.00</td>
<td>11.00</td>
<td>1.10</td>
<td>7.53</td>
<td>0.68</td>
<td>0.022</td>
<td>0.17</td>
<td>8.39</td>
</tr>
<tr>
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<td>Gnaphalium polycaulon Pers.</td>
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<td>20.00</td>
<td>7.00</td>
<td>0.35</td>
<td>9.59</td>
<td>1.37</td>
<td>0.133</td>
<td>1.03</td>
<td>11.99</td>
</tr>
<tr>
<td>6</td>
<td>Oxalis corniculata L.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>1.37</td>
<td>0.68</td>
<td>0.016</td>
<td>0.12</td>
<td>2.18</td>
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<tr>
<td>7</td>
<td>Rosa macrophylla Lindl.</td>
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<td>20.00</td>
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<td>0.08</td>
<td>2.05</td>
<td>1.37</td>
<td>0.094</td>
<td>0.73</td>
<td>4.16</td>
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<td>8</td>
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<td>70.00</td>
<td>5.43</td>
<td>0.08</td>
<td>26.03</td>
<td>4.79</td>
<td>4.777</td>
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<td>67.86</td>
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<tr>
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<td>39.52</td>
<td>2.08</td>
<td>100.00</td>
<td>20.55</td>
<td>12.897</td>
<td>100.00</td>
<td>220.55</td>
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</table>

Table 4.37 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) January 2014
4.3.1.11 Phytosociological Analysis of Herbaceous Vegetation in February 2014

At lower altitudinal site 17 species were recorded. Density was maximum for *Bupleurum hamiltonii* (4.20 ind./m²) and minimum (0.10 ind./m²) for four species. Frequency values were highest in *Taraxacum officinale* (60%) and lowest (10%) frequency was recorded for nine species. The highest Abundance/Frequency (A/F) ratio was recorded for species *Cannabis sativa* (1.20) and the maximum value for total basal area (TBA) was reported for *Urtica dioica* (5.728 cm²). IVI values showed that *Urtica dioica* (54.94) was dominant species and *Bupleurum hamiltonii* (34.61) and *Dicliptera bupleorides* (33.03) was codominant species.

At middle altitudinal site 12 species were recorded. Maximum density was shown by *Argemone mexicana* (2.60 ind/m²) and minimum by *Fragaria indica* and *Pimpinella diversifolia* (0.10 ind./m²). Maximum frequency (40%) was reported for *Euphorbia esula* and *Verbascum thapsus* and minimum (10%) for five species. The highest Abundance/Frequency (A/F) ratio was recorded for *Dicliptera bupleuroides* (1.40) and the maximum value for total basal area (TBA) was recorded for *Urtica dioica* (5.091 cm²). IVI values indicated the dominance of *Urtica dioica* (47.08) followed by *Taraxacum officinale* (34.56) and *Argemone Mexicana* (28.00).

The higher altitudinal site showed total 14 species and the highest density of *Eupatorium adenophorum* (8.20 ind./m²) and lowest density was recorded for *Leucas lanata* and *Verbascum thapsus* (0.10 ind./m²) and the maximum frequency was recorded for *Eupatorium adenophorum* (70%) and minimum value of frequency was recorded for four species (10%). The maximum Abundance/Frequency (A/F) ratio was recorded for species *Clematis orientalis* (1.00) and the maximum value for total basal area (TBA) was reported for *Argemone mexicana* (4.809 cm²). IVI values indicated the dominance of *Eupatorium adenophorum* (61.45) followed by *Argemone mexicana* (50.16) and *Bupleurum hamiltonii* (20.08).
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Anaphalis margaritacea</em> (L.) Benth. &amp; Hook.f.</td>
<td>1.80</td>
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<td>6.00</td>
<td>0.20</td>
<td>10.71</td>
<td>1.79</td>
<td>0.204</td>
<td>1.74</td>
<td>14.24</td>
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<tr>
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<td><em>Bupleurum hamiltonii</em> N.P.Balakr</td>
<td>4.20</td>
<td>40.00</td>
<td>10.50</td>
<td>0.26</td>
<td>25.00</td>
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<td>0.845</td>
<td>7.23</td>
<td>34.61</td>
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<td>10.00</td>
<td>12.00</td>
<td>1.20</td>
<td>7.14</td>
<td>0.60</td>
<td>0.136</td>
<td>0.16</td>
<td>8.90</td>
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<td>1.00</td>
<td>0.10</td>
<td>0.60</td>
<td>0.60</td>
<td>0.010</td>
<td>0.08</td>
<td>1.27</td>
</tr>
<tr>
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<td>1.70</td>
<td>30.00</td>
<td>5.67</td>
<td>0.19</td>
<td>10.12</td>
<td>1.79</td>
<td>2.470</td>
<td>7.23</td>
<td>33.03</td>
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<td>4.00</td>
<td>0.40</td>
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<td>0.60</td>
<td>0.113</td>
<td>0.97</td>
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<tr>
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<td>0.20</td>
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<td>2.00</td>
<td>0.20</td>
<td>1.19</td>
<td>0.60</td>
<td>0.043</td>
<td>0.37</td>
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<tr>
<td>9</td>
<td><em>Geranium nepalense</em> Sweet</td>
<td>2.90</td>
<td>30.00</td>
<td>9.67</td>
<td>0.32</td>
<td>17.26</td>
<td>1.79</td>
<td>0.228</td>
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<td>0.60</td>
<td>0.60</td>
<td>0.013</td>
<td>0.11</td>
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</tr>
<tr>
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<td><em>Taraxacum officinale</em> Weber.</td>
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<td>60.00</td>
<td>2.17</td>
<td>0.04</td>
<td>7.74</td>
<td>3.57</td>
<td>0.919</td>
<td>7.86</td>
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<td>20.00</td>
<td>2.50</td>
<td>0.13</td>
<td>2.98</td>
<td>1.19</td>
<td>0.039</td>
<td>0.34</td>
<td>4.50</td>
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<tr>
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<td><em>Urtica dioica</em> L.</td>
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<td>10.00</td>
<td>9.00</td>
<td>0.90</td>
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Table 4.38  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) February 2014
<table>
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<tr>
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<th>FREQUENCY</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
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<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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<td>Argemone mexicana L.</td>
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<tr>
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<td>14.00</td>
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<td>0.18</td>
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<tr>
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<td>Oxalis corniculata L.</td>
<td>0.20</td>
<td>20.00</td>
<td>1.00</td>
<td>0.05</td>
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<td>1.49</td>
<td>0.016</td>
<td>0.12</td>
<td>3.11</td>
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<tr>
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<td>0.75</td>
<td>0.013</td>
<td>0.10</td>
<td>1.60</td>
</tr>
<tr>
<td>10</td>
<td>Taraxacum officinale Weber.</td>
<td>1.50</td>
<td>30.00</td>
<td>5.00</td>
<td>0.17</td>
<td>11.19</td>
<td>2.24</td>
<td>2.715</td>
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<td>1.760</td>
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<td>100.00</td>
<td>18.66</td>
<td>12.850</td>
<td>100.00</td>
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</table>

Table 4.39  Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) February 2014
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE FREQUENCY</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook.f.</td>
<td>1.30</td>
<td>20.00</td>
<td>6.50</td>
<td>0.33</td>
<td>5.70</td>
<td>0.88</td>
<td>0.859</td>
<td>7.47</td>
<td>14.05</td>
</tr>
<tr>
<td>2</td>
<td>Argemone mexicana L.</td>
<td>1.70</td>
<td>20.00</td>
<td>8.50</td>
<td>0.43</td>
<td>7.46</td>
<td>0.88</td>
<td>4.809</td>
<td>41.83</td>
<td>50.16</td>
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<tr>
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<td>Bupleurum hamiltonii N.P.Balakr</td>
<td>2.40</td>
<td>20.00</td>
<td>12.00</td>
<td>0.60</td>
<td>10.53</td>
<td>0.88</td>
<td>0.998</td>
<td>8.68</td>
<td>20.08</td>
</tr>
<tr>
<td>4</td>
<td>Clematis orientalis L.</td>
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<td>10.00</td>
<td>10.00</td>
<td>1.00</td>
<td>4.39</td>
<td>0.44</td>
<td>0.050</td>
<td>0.44</td>
<td>5.26</td>
</tr>
<tr>
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<td>Crotalaria albida B. Heyne ex Roth</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>1.75</td>
<td>0.88</td>
<td>0.062</td>
<td>0.54</td>
<td>3.17</td>
</tr>
<tr>
<td>6</td>
<td>Cynoglossum furcatum Wall.</td>
<td>2.00</td>
<td>30.00</td>
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<td>0.22</td>
<td>8.77</td>
<td>1.32</td>
<td>0.190</td>
<td>1.65</td>
<td>11.74</td>
</tr>
<tr>
<td>7</td>
<td>Dicliptera bupleuroides Nees</td>
<td>0.90</td>
<td>20.00</td>
<td>4.50</td>
<td>0.23</td>
<td>3.95</td>
<td>0.88</td>
<td>1.076</td>
<td>9.36</td>
<td>14.18</td>
</tr>
<tr>
<td>8</td>
<td>Eupatorium adenophorum Spreng.</td>
<td>8.20</td>
<td>70.00</td>
<td>11.71</td>
<td>0.17</td>
<td>35.96</td>
<td>3.07</td>
<td>2.577</td>
<td>22.42</td>
<td>61.45</td>
</tr>
<tr>
<td>9</td>
<td>Geranium nepalense Sweet</td>
<td>2.20</td>
<td>60.00</td>
<td>3.67</td>
<td>0.06</td>
<td>9.65</td>
<td>2.63</td>
<td>0.173</td>
<td>1.50</td>
<td>13.78</td>
</tr>
<tr>
<td>10</td>
<td>Leucas lanata Benth.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.44</td>
<td>0.44</td>
<td>0.013</td>
<td>0.12</td>
<td>0.99</td>
</tr>
<tr>
<td>11</td>
<td>Oxalis corniculata L.</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>1.75</td>
<td>0.88</td>
<td>0.031</td>
<td>0.27</td>
<td>2.90</td>
</tr>
<tr>
<td>12</td>
<td>Taraxacum officinale Weber.</td>
<td>1.50</td>
<td>50.00</td>
<td>3.00</td>
<td>0.06</td>
<td>6.58</td>
<td>2.19</td>
<td>0.520</td>
<td>4.52</td>
<td>13.29</td>
</tr>
<tr>
<td>13</td>
<td>Trigonella foenum-graecum L.</td>
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<td>10.00</td>
<td>6.00</td>
<td>0.60</td>
<td>2.63</td>
<td>0.44</td>
<td>0.068</td>
<td>0.59</td>
<td>3.66</td>
</tr>
<tr>
<td>14</td>
<td>Varbascum thapsus L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.44</td>
<td>0.44</td>
<td>0.071</td>
<td>0.62</td>
<td>1.49</td>
</tr>
</tbody>
</table>

TOTAL    | 22.80                | 370.00              | 78.55              | 4.09                  | 100.00              | 16.23              | 11.496             | 100.00              | 216.23              |

Table 4.40 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) February 2014
4.3.1.12 Phytosociological Analysis of Herbaceous Vegetation in March 2014

At lower altitudinal site 14 species were recorded. Density was maximum for *Polygonatum capitatum* (5.10 ind./m²) and minimum (0.10 ind./m²) for *Argemone maxicana* and *Bupleurum hamiltonii*. Frequency values were highest in *Geranium nepalense* and *Polygonatum capitatum* (70%) and lowest is (10%) frequency was recorded in five species. The highest Abundance/Frequency (A/F) ratio was recorded for *Vernonia cinerea* (1.50) and the maximum value for total basal area (TBA) was reported for *Acanthospermum hispidium* (0.563 cm²). IVI values showed that *Polygonatum capitatum* (51.59) was dominant species and *Verbascum thapsus* (29.60), *Vernonia cinerea* (27.98) and *Acanthospermum hispidium* (25.98) was codominant species.

At middle altitudinal site 17 species were recorded. Maximum density was shown by *Euphorbia esula* (3.00 ind./m²) and minimum (0.10 ind./m²) by five species. Maximum frequency (40%) was reported for *Euphorbia esula* and *Oxalis corniculata* and minimum (10%) for eight species. The highest Abundance/Frequency (A/F) ratio was recorded for *Reinwardtia trigyna* (1.00) and the maximum value for total basal area (TBA) was recorded for *Acanthospermum hispidium* (0.563 cm²). IVI values indicated the dominance of *Euphorbia esula* (38.94) followed by *Acanthospermum hispidium* (32.35) and and *Verbascum thapsus* (25.60).

Total 22 herb species were recorded from site at higher altitudinal site. Highest value of density was recorded for *Bupleurum hamiltonii* (2.80 ind./m²) and minimum for *Cyanotis barbata* and *Ilex* sp.(0.10 ind./m²). Frequency was maximum (60%) in *Bupleurum hamiltonii* and *Geranium nepalense* and minimum (10%) in fourteen species. The maximum Abundance/Frequency (A/F) ratio was recorded for *Prunella vulgaris* (1.00) and the maximum value for total basal area (TBA) was recorded for *Eupatorium adenophorum* (0.629 cm²). IVI values showed the dominance of *Eupatorium adenophorum* (30.64). Among codominant species *Polygonatum capitatum* (25.45) and *Bupleurum hamiltonii* (24.12) were important.
## Table 4.41 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) March 2014

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acanthospermum hispidium D.C.</td>
<td>0.70</td>
<td>30.00</td>
<td>2.33</td>
<td>0.08</td>
<td>4.14</td>
<td>1.78</td>
<td>0.563</td>
<td>20.06</td>
<td>25.98</td>
</tr>
<tr>
<td>2</td>
<td>Anaphalis margaritacea (L.) Benth. &amp; Hook. f.</td>
<td>0.40</td>
<td>20.00</td>
<td>2.00</td>
<td>0.10</td>
<td>2.37</td>
<td>1.18</td>
<td>0.031</td>
<td>1.12</td>
<td>4.67</td>
</tr>
<tr>
<td>3</td>
<td>Argemone mexicana L.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.59</td>
<td>0.59</td>
<td>0.028</td>
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<td>2.19</td>
</tr>
<tr>
<td>4</td>
<td>Bupleurum hamiltonii N.P.Balakr</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.59</td>
<td>0.59</td>
<td>0.042</td>
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<td>3.00</td>
<td>0.30</td>
<td>1.78</td>
<td>0.59</td>
<td>0.015</td>
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<tr>
<td>6</td>
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<td>1.33</td>
<td>0.04</td>
<td>2.37</td>
<td>1.78</td>
<td>0.113</td>
<td>4.04</td>
<td>8.18</td>
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<tr>
<td>7</td>
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<td>1.70</td>
<td>20.00</td>
<td>8.50</td>
<td>0.43</td>
<td>10.06</td>
<td>1.18</td>
<td>0.192</td>
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<td>2.67</td>
<td>0.09</td>
<td>4.73</td>
<td>1.78</td>
<td>0.063</td>
<td>2.24</td>
<td>8.75</td>
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<tr>
<td>9</td>
<td>Geranium nepalense Sweet</td>
<td>2.10</td>
<td>70.00</td>
<td>3.00</td>
<td>0.04</td>
<td>12.43</td>
<td>4.14</td>
<td>0.165</td>
<td>5.88</td>
<td>22.45</td>
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<tr>
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<td>10.00</td>
<td>4.00</td>
<td>0.40</td>
<td>2.37</td>
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<td>0.045</td>
<td>1.61</td>
<td>4.57</td>
</tr>
<tr>
<td>11</td>
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<td>1.60</td>
<td>40.00</td>
<td>4.00</td>
<td>0.40</td>
<td>2.37</td>
<td>2.37</td>
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</tr>
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<td>5.10</td>
<td>70.00</td>
<td>7.29</td>
<td>0.10</td>
<td>30.18</td>
<td>4.14</td>
<td>0.485</td>
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<tr>
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<td>Varbascum thapsus L.</td>
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<td>10.06</td>
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<td>8.88</td>
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<td>0.520</td>
<td>18.52</td>
<td>27.98</td>
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<tr>
<td><strong>TOTAL</strong></td>
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Table 4.41 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) March 2014
Table 4.42 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) March 2014

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./m²)</th>
<th>FREQUENCY</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANCE VALUE INDEX</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Acanthospermum hispidium D.C.</td>
<td>0.70</td>
<td>20.00</td>
<td>3.50</td>
<td>0.18</td>
<td>5.88</td>
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<td>0.563</td>
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<td>0.28</td>
<td>9.24</td>
<td>1.68</td>
<td>0.120</td>
<td>3.36</td>
<td>0.69</td>
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<td>5</td>
<td>Eupatorium adenophorum Spreng.</td>
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<td>10.00</td>
<td>1.00</td>
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<td>0.84</td>
<td>0.120</td>
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<td>0.69</td>
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<td>0.84</td>
<td>0.120</td>
<td>5.29</td>
<td>10.34</td>
</tr>
<tr>
<td>8</td>
<td>Leibnizia nepalensis (Kunze) Kitam.</td>
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<td>1.00</td>
<td>0.05</td>
<td>1.68</td>
<td>1.68</td>
<td>0.004</td>
<td>0.17</td>
<td>3.53</td>
</tr>
<tr>
<td>9</td>
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<td>40.00</td>
<td>3.00</td>
<td>0.08</td>
<td>10.08</td>
<td>3.36</td>
<td>0.094</td>
<td>4.15</td>
<td>17.59</td>
</tr>
<tr>
<td>10</td>
<td>Phyllanthus fraternus G. L. Webster</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.84</td>
<td>0.84</td>
<td>0.018</td>
<td>0.78</td>
<td>2.46</td>
</tr>
<tr>
<td>11</td>
<td>Polygonatum capitatum Hamilt. ex Don.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>0.84</td>
<td>0.84</td>
<td>0.011</td>
<td>0.50</td>
<td>2.18</td>
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<td>10.00</td>
<td>1.00</td>
<td>8.40</td>
<td>0.84</td>
<td>0.113</td>
<td>4.98</td>
<td>14.22</td>
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<td>Stellaria media (L.) Vill.</td>
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<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>2.52</td>
<td>0.84</td>
<td>0.136</td>
<td>5.98</td>
<td>9.34</td>
</tr>
<tr>
<td>14</td>
<td>Torenia cordifolia Roxb.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
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<td>ABUNDANCE</td>
<td>ABUNDANCE FREQUENCY</td>
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<td>RELATIVE FREQUENCY</td>
<td>TOTAL BASAL AREA OF SPECIES (cm²)</td>
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<td>IMPORTANCE VALUE INDEX</td>
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<td>Abundance/Frequency</td>
<td>Importance Value Index</td>
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Table 4.43 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) March 2014
4.3.2 Phytosociological Analysis of Tree Vegetation

At lower altitudinal site 7 species were recorded. Density was maximum for *Pinus roxburghii* (4.50 ind./100m²) and minimum (0.10 ind./100m²) for *Aesculus indica*. Maximum frequency values were recorded for *Pinus roxburghii* (80%) and lowest is (10%) for *Aesculus indica*. The highest Abundance/Frequency (A/F) ratio was recorded for *Quercus leucotrichophora* (0.16) and the maximum value for total basal area (TBA) was recorded for *Pinus roxburghii* (34737.481 cm²). IVI values showed that *Pinus roxburghii* (130.91) was dominant species. Among codominant species *Quercus leucotrichophora* (42.93) and *Cupressus torulosa* (23.70) were important.

Total 13 herb species were recorded from site at middle altitude. Highest value of density was recorded for *Pinus roxburghii* (4.30 ind./100 m²) and lowest for seven species (0.10 ind./m²). Frequency was maximum (80%) in *Pinus roxburghii* and minimum (10%) in seven species. The maximum Abundance/Frequency (A/F) ratio was recorded for seven species (0.10) and the maximum value for total basal area (TBA) was recorded for *Cupressus torulosa* (16509.821 cm²). IVI values indicated the dominance of *Pinus roxburghii* (80.83) followed by *Vachellia nilotica* (29.97) and *Cupressus torulosa* (29.78).

At higher altitudinal site 7 species were recorded. Maximum density was shown by *Quercus leucotrichophora* (4.40 ind./100 m²) and minimum by *Grevillea robusta* (0.20 ind./100m²). Maximum frequency (100 %) was reported for *Quercus leucotrichophora* and minimum (10%) for the *Grevillea robusta* and *Vachellia nilotica*. The highest Abundance/Frequency (A/F) ratio was recorded for *Vachellia nilotica* (0.30) and the maximum value for total basal area (TBA) was recorded for *Quercus leucotrichophora* (34825.219 cm²). IVI values indicated the dominance of *Quercus leucotrichophora* (115.79). Among codominant species *Myrica esculenta* (40.05), *Rhododendron arboreum* (32.83) and *Pinus roxburghii* (21.92) were important.
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./100m²)</th>
<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANT VALUE INDEX</th>
</tr>
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<td>1</td>
<td><em>Aesculus indica</em> Colebr. ex (Cambess) Hook</td>
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<td>10.00</td>
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<td>0.09</td>
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<td>2.60</td>
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<td>58.44</td>
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Table 4.44 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Tree Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora)
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<th>SL NO.</th>
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<th>FREQUENCY (%)</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY</th>
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<th>RELATIVE FREQUENCY</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANT VALUE INDEX</th>
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</thead>
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<td>1.28</td>
<td>389.773</td>
<td>3.15</td>
</tr>
<tr>
<td>10</td>
<td>Prunus cerasoides D.Don.</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>1.28</td>
<td>1.28</td>
<td>7857.143</td>
<td>11.73</td>
</tr>
<tr>
<td>11</td>
<td>Stranvaesia nussia Buch.-Ham. ex D. Don</td>
<td>0.10</td>
<td>10.00</td>
<td>1.00</td>
<td>0.10</td>
<td>1.28</td>
<td>1.28</td>
<td>71.591</td>
<td>14.30</td>
</tr>
<tr>
<td>12</td>
<td>Toona hexandra M.Roem.</td>
<td>0.30</td>
<td>30.00</td>
<td>1.00</td>
<td>0.03</td>
<td>3.85</td>
<td>3.85</td>
<td>5.57</td>
<td>13.26</td>
</tr>
<tr>
<td>13</td>
<td>Vachellia nilotica (L.) P.J.H.Hurter &amp; Mabb.</td>
<td>1.50</td>
<td>40.00</td>
<td>3.75</td>
<td>0.09</td>
<td>19.23</td>
<td>5.13</td>
<td>5.61</td>
<td>29.97</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>7.80</td>
<td>290.00</td>
<td>21.13</td>
<td>1.06</td>
<td>100.00</td>
<td>37.18</td>
<td>66973.935</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 4.45 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Tree Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora)
<table>
<thead>
<tr>
<th>SL NO.</th>
<th>NAME OF PLANTS</th>
<th>DENSITY (ind./100m²)</th>
<th>FREQUENCY %</th>
<th>ABUNDANCE</th>
<th>ABUNDANCE FREQUENCY RATIO</th>
<th>RELATIVE DENSITY</th>
<th>RELATIVE FREQUENCY</th>
<th>TOTAL BASAL AREA OF SPECIES (cm²)</th>
<th>RELATIVE DOMINANCE</th>
<th>IMPORTANT VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cupressus torulosa D.Don.</td>
<td>0.50</td>
<td>30.00</td>
<td>1.67</td>
<td>0.06</td>
<td>5.49</td>
<td>3.30</td>
<td>2806.364</td>
<td>4.55</td>
<td>13.34</td>
</tr>
<tr>
<td>2</td>
<td>Grevillea robusta A.Cunn. ex R.Br.</td>
<td>0.20</td>
<td>10.00</td>
<td>2.00</td>
<td>0.20</td>
<td>2.20</td>
<td>1.10</td>
<td>525.994</td>
<td>0.85</td>
<td>4.15</td>
</tr>
<tr>
<td>3</td>
<td>Myrica esculenta Buck-Ham.</td>
<td>1.60</td>
<td>80.00</td>
<td>2.00</td>
<td>0.03</td>
<td>17.58</td>
<td>8.79</td>
<td>8440.812</td>
<td>13.68</td>
<td>40.05</td>
</tr>
<tr>
<td>4</td>
<td>Pinus roxburghii Sarg.</td>
<td>0.80</td>
<td>60.00</td>
<td>1.33</td>
<td>0.02</td>
<td>8.79</td>
<td>6.59</td>
<td>4034.635</td>
<td>6.54</td>
<td>21.92</td>
</tr>
<tr>
<td>5</td>
<td>Quercus leucotrichphora A. Camus</td>
<td>4.40</td>
<td>100.00</td>
<td>4.40</td>
<td>0.04</td>
<td>48.35</td>
<td>10.99</td>
<td>34825.219</td>
<td>56.45</td>
<td>115.79</td>
</tr>
<tr>
<td>6</td>
<td>Rhododendron arboreum Sm.</td>
<td>1.30</td>
<td>30.00</td>
<td>4.33</td>
<td>0.14</td>
<td>14.29</td>
<td>3.30</td>
<td>9408.392</td>
<td>15.25</td>
<td>32.83</td>
</tr>
<tr>
<td>7</td>
<td>Vachellia nilotica (L.) P.J.H.Hurter &amp; Mabb.</td>
<td>0.30</td>
<td>10.00</td>
<td>3.00</td>
<td>0.30</td>
<td>3.30</td>
<td>1.10</td>
<td>1655.871</td>
<td>2.68</td>
<td>7.08</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>9.10</td>
<td>320.00</td>
<td>18.73</td>
<td>0.79</td>
<td>100.00</td>
<td>35.16</td>
<td>61697.287</td>
<td>100.00</td>
<td>235.16</td>
</tr>
</tbody>
</table>

Table 4.46 Density, Frequency, Abundance/Frequency Ratio and Importance Value Index (IVI) of Tree Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora)
4.4 DIVERSITY MEASUREMENT

Species diversity is a measure of the diversity within an ecological community that incorporates both species richness (the number of species in a community) and the evenness of species' abundances. Species diversity is one component of the concept of biodiversity. Diversity index indicates the species diversity, higher the value diversity index (H) greater the species diversity.

Species dominance is the degree to which a taxon is more numerous than its competitors in an ecological community, or makes up more of the biomass. Most ecological communities are defined by their dominant species.

Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species.

Species evenness refers to how close in numbers each species in an environment is. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically.

4.4.1 Diversity Indices for Herb Vegetation at Lower Altitudinal Site

Table 4.47 present the Shannon weaver diversity index, concentration dominance, evenness and species richness at lower altitudinal site from April 2013 to March 2014. At lower altitudinal site the highest species diversity (2.854) for herb species was recorded in July 2013 followed by species diversity (2.587) in August 2013 and species diversity (2.581) in November 2013.

Species dominance for herb species at lower altitudinal sites ranged from 0.075 to 0.281. Highest value of dominance (0.281) was recorded in May 2013 followed by October 2013 (0.210) and December 2013 (0.195).
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Month</th>
<th>Shannon Weaver Index</th>
<th>Simpson's Index</th>
<th>Evenness Index</th>
<th>Species Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April</td>
<td>2.482</td>
<td>0.127</td>
<td>0.781</td>
<td>4.383</td>
</tr>
<tr>
<td>2</td>
<td>May</td>
<td>1.678</td>
<td>0.281</td>
<td>0.729</td>
<td>1.731</td>
</tr>
<tr>
<td>3</td>
<td>June</td>
<td>2.520</td>
<td>0.111</td>
<td>0.872</td>
<td>3.233</td>
</tr>
<tr>
<td>4</td>
<td>July</td>
<td>2.854</td>
<td>0.075</td>
<td>0.857</td>
<td>4.786</td>
</tr>
<tr>
<td>5</td>
<td>August</td>
<td>2.587</td>
<td>0.096</td>
<td>0.837</td>
<td>3.877</td>
</tr>
<tr>
<td>6</td>
<td>September</td>
<td>2.189</td>
<td>0.148</td>
<td>0.829</td>
<td>2.574</td>
</tr>
<tr>
<td>7</td>
<td>October</td>
<td>1.921</td>
<td>0.210</td>
<td>0.773</td>
<td>2.041</td>
</tr>
<tr>
<td>8</td>
<td>November</td>
<td>2.581</td>
<td>0.101</td>
<td>0.876</td>
<td>3.474</td>
</tr>
<tr>
<td>9</td>
<td>December</td>
<td>1.816</td>
<td>0.195</td>
<td>0.826</td>
<td>1.683</td>
</tr>
<tr>
<td>10</td>
<td>January</td>
<td>2.118</td>
<td>0.167</td>
<td>0.764</td>
<td>3.072</td>
</tr>
<tr>
<td>11</td>
<td>February</td>
<td>2.307</td>
<td>0.132</td>
<td>0.814</td>
<td>3.123</td>
</tr>
<tr>
<td>12</td>
<td>March</td>
<td>2.195</td>
<td>0.150</td>
<td>0.832</td>
<td>2.534</td>
</tr>
</tbody>
</table>

Table 4.47 Shannon Weaver Index, Simpson's Index, Evenness and Species Richness of Herb Vegetation in Lower Altitudinal Site at Banri Devi Forest (Almora) 2013-14

Evenness value at lower altitudinal sites varies from 0.729 to 0.876. Highest value of evenness (0.876) was recorded in November 2013 followed by second highest value (0.872) in June 2013 and next higher value (0.857) was observed in July 2013.

The value of species richness at lower altitudinal sites varies from 1.683 to 4.786. Highest value of species richness (4.786) was recorded in July 2013 and followed by second highest value (4.383) in April 2013 and next higher value (3.877) was observed in August 2013.
4.4.2 Diversity Indices for Herb Vegetation at Middle Altitude

Shannon weaver diversity index, concentration dominance, evenness and species richness at middle altitudinal sites from April 2013 to March 2014 was shown in table 4.48. At middle altitudinal sites the highest species diversity (2.893) for herb species was recorded in July 2013 followed by species diversity (2.620) in August 2013 and species diversity (2.397) in March 2014.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Month</th>
<th>Shannon Weaver Index</th>
<th>Simpson's Index</th>
<th>Evenness Index</th>
<th>Species Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April</td>
<td>2.066</td>
<td>0.159</td>
<td>0.763</td>
<td>2.693</td>
</tr>
<tr>
<td>2</td>
<td>May</td>
<td>1.900</td>
<td>0.205</td>
<td>0.764</td>
<td>2.198</td>
</tr>
<tr>
<td>3</td>
<td>June</td>
<td>2.176</td>
<td>0.153</td>
<td>0.824</td>
<td>2.517</td>
</tr>
<tr>
<td>4</td>
<td>July</td>
<td>2.893</td>
<td>0.076</td>
<td>0.868</td>
<td>4.699</td>
</tr>
<tr>
<td>5</td>
<td>August</td>
<td>2.620</td>
<td>0.086</td>
<td>0.890</td>
<td>3.455</td>
</tr>
<tr>
<td>6</td>
<td>September</td>
<td>1.800</td>
<td>0.254</td>
<td>0.665</td>
<td>2.436</td>
</tr>
<tr>
<td>7</td>
<td>October</td>
<td>1.673</td>
<td>0.272</td>
<td>0.579</td>
<td>2.909</td>
</tr>
<tr>
<td>8</td>
<td>November</td>
<td>1.961</td>
<td>0.201</td>
<td>0.707</td>
<td>2.948</td>
</tr>
<tr>
<td>9</td>
<td>December</td>
<td>1.241</td>
<td>0.382</td>
<td>0.638</td>
<td>1.235</td>
</tr>
<tr>
<td>10</td>
<td>January</td>
<td>1.649</td>
<td>0.295</td>
<td>0.643</td>
<td>2.428</td>
</tr>
<tr>
<td>11</td>
<td>February</td>
<td>2.216</td>
<td>0.123</td>
<td>0.892</td>
<td>2.246</td>
</tr>
<tr>
<td>12</td>
<td>March</td>
<td>2.397</td>
<td>0.120</td>
<td>0.846</td>
<td>3.348</td>
</tr>
</tbody>
</table>

Table 4.48 Shannon Weaver Index, Simpson's Index, Evenness and Species Richness of Herb Vegetation in Middle Altitudinal Site at Banri Devi Forest (Almora) 2013-14
Species dominance for herb species at middle altitudinal sites ranged from 0.076 to 0.382. Highest value of dominance (0.382) was recorded in December 2013 followed by January 2014 (0.295) dominance value and October 2013 (0.272) dominance value.

Evenness value at middle altitudinal sites varies from 0.579 to 0.892. Highest value of evenness (0.892) was recorded in February 2014 followed by second highest value (0.890) in August 2013 and next higher value (0.868) was observed in July 2013.

The value of species richness at middle altitudinal sites varies from 1.235 to 4.699. Highest value of species richness (4.699) was recorded in July 2013 and followed by second highest value (3.455) in August 2013 and next higher value (3.348) was observed in March 2014.

4.4.3 Diversity Indices for Herb Vegetation at Higher Altitude

Table 4.49 present the Shannon weaver diversity index, concentration dominance, evenness and species richness at higher altitudinal sites from April 2013 to March 2014. At higher altitudinal sites the highest species diversity (2.819) for herb species was recorded in July 2013 followed by species diversity (2.763) in March 2014 and species diversity (2.657) in May 2013.

Species dominance for herb species at higher altitudinal sites ranged from 0.076 to 0.207. Highest value of dominance (0.207) was recorded in January 2014 followed by February 2014 (0.175) dominance value and November 2013 (0.161) dominance value. The values of dominance followed irregular pattern.

Evenness value at higher altitudinal sites varies from 0.748 to 0.911. Highest value of evenness (0.911) was recorded in April 2013 followed by second highest value (0.894) in March 2014 and next higher value (0.873) was observed in May 2013.

The value of species richness at higher altitudinal sites varies from 1.405 to 4.780. Highest value of species richness (4.780) was recorded in July 2013 and followed
by second highest value (4.272) in May 2013 and next higher value (4.023) was observed in September 2013.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Month</th>
<th>Shannon Weaver Index</th>
<th>Simpson's Index</th>
<th>Evenness Index</th>
<th>Species Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April</td>
<td>2.582</td>
<td>0.090</td>
<td>0.911</td>
<td>2.860</td>
</tr>
<tr>
<td>2</td>
<td>May</td>
<td>2.657</td>
<td>0.090</td>
<td>0.873</td>
<td>4.272</td>
</tr>
<tr>
<td>3</td>
<td>June</td>
<td>2.357</td>
<td>0.126</td>
<td>0.832</td>
<td>3.043</td>
</tr>
<tr>
<td>4</td>
<td>July</td>
<td>2.819</td>
<td>0.085</td>
<td>0.837</td>
<td>4.780</td>
</tr>
<tr>
<td>5</td>
<td>August</td>
<td>2.415</td>
<td>0.114</td>
<td>0.836</td>
<td>3.035</td>
</tr>
<tr>
<td>6</td>
<td>September</td>
<td>2.550</td>
<td>0.104</td>
<td>0.813</td>
<td>4.023</td>
</tr>
<tr>
<td>7</td>
<td>October</td>
<td>2.179</td>
<td>0.158</td>
<td>0.769</td>
<td>2.836</td>
</tr>
<tr>
<td>8</td>
<td>November</td>
<td>2.239</td>
<td>0.161</td>
<td>0.748</td>
<td>3.532</td>
</tr>
<tr>
<td>9</td>
<td>December</td>
<td>2.281</td>
<td>0.126</td>
<td>0.842</td>
<td>2.475</td>
</tr>
<tr>
<td>10</td>
<td>January</td>
<td>1.728</td>
<td>0.207</td>
<td>0.831</td>
<td>1.405</td>
</tr>
<tr>
<td>11</td>
<td>February</td>
<td>2.130</td>
<td>0.175</td>
<td>0.807</td>
<td>2.394</td>
</tr>
<tr>
<td>12</td>
<td>March</td>
<td>2.763</td>
<td>0.076</td>
<td>0.894</td>
<td>3.927</td>
</tr>
</tbody>
</table>

Table 4.49 Shannon Weaver Index, Simpson's Index, Evenness and Species Richness of Herb Vegetation in Higher Altitudinal Site at Banri Devi Forest (Almora) 2013-14

4.4.4 Diversity Measurement for Tree Vegetation

Table 4.50 present the Shannon weaver diversity index, concentration dominance, evenness and species richness at lower altitudinal, middle altitudinal and
higher altitudinal sites. The highest species diversity (1.547) for tree species was recorded in middle altitudinal site followed by species diversity (1.505) in higher altitudinal site and lowest species diversity (1.290) in lower altitudinal site.

Species dominance for tree species ranged from 0.297 to 0.390. Highest value of dominance (0.390) was recorded in lower altitudinal site followed by middle altitudinal site (0.351) dominance value and higher altitudinal site (0.297) lowest dominance value.

Evenness value varies from 0.603 to 0.773. Highest value of evenness was recorded in higher altitudinal site (0.773) and lowest evenness value in middle altitudinal site (0.603).

The value of species richness varies from 1.330 to 2.754. Highest value of species richness was recorded in middle altitudinal site (2.754) and the lowest in higher altitudinal site (1.330).

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Site/Altitude</th>
<th>H' Sd (Shannon-Weiner Index)</th>
<th>Cd Shimpson Index</th>
<th>Evenness</th>
<th>Species Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower</td>
<td>1.290</td>
<td>0.390</td>
<td>0.663</td>
<td>1.381</td>
</tr>
<tr>
<td>2</td>
<td>Middle</td>
<td>1.547</td>
<td>0.351</td>
<td>0.603</td>
<td>2.754</td>
</tr>
<tr>
<td>3</td>
<td>Higher</td>
<td>1.505</td>
<td>0.297</td>
<td>0.773</td>
<td>1.330</td>
</tr>
</tbody>
</table>

Table 4.50 Shannon Weaver Index, Simpson's Index, Evenness and Species Richness of Tree Vegetation in Different Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest in 2013-14
4.5 SIMILARITY AND DISSIMILARITY INDEX

The similarity indices indicate how “close” two sample are to one another and dissimilarity indices indicate how “far apart” they are. Sorenson, 1948 has given simple formulae to establish the index of similarity between two stands of vegetation. Whether two stands are positively or negatively associated can be calculated with the help of law of probability.

4.5.1 Similarity and Dissimilarity Index between Lower and Middle Altitudinal sites for Herbs

The similarity and dissimilarity between lower and middle altitudinal sites from April to March in 2013-14 was presented in Table 4.51. The highest similarity index value was calculated in February and September (0.621) and the lowest value was recorded in August (0.439). The value of dissimilarity was highest in August (0.561) and the lowest in February and September (0.379).

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Month</th>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Altitude</td>
<td>Middle Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>1</td>
<td>April</td>
<td>24</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>May</td>
<td>10</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>June</td>
<td>18</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>July</td>
<td>28</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>August</td>
<td>22</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>September</td>
<td>14</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>October</td>
<td>12</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>November</td>
<td>19</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 4.51 Similarity and Dissimilarity Index for Herb Species at Banri Devi Forest (Almora) between Lower and Middle Altitudinal sites from April 2013 to March 2014

4.5.2 Similarity and Dissimilarity Index between Lower and Higher Altitudinal sites for Herbs

Table 4.52 represent the similarity and dissimilarity between lower and higher altitudinal sites from April to March in 2013-14. The highest similarity index value was calculated in February (0.581) and the lowest value was recorded in April (0.341). The value of dissimilarity was highest in April (0.659) and the lowest in February (0.419).
Table 4.52 Similarity and Dissimilarity Index for Herb Species at Banri Devi Forest (Almora) between Lower and Higher Altitudinal sites from April 2013 to March 2014

### 4.5.3 Similarity and Dissimilarity Index between Middle and Higher Altitudinal sites for Herbs

Table 4.53 represent the similarity and dissimilarity between middle and higher altitudinal sites from April to March in 2013-14. The highest similarity index value was calculated in August (0.649) and the lowest value was recorded in January (0.286). The value of dissimilarity was highest in January (0.714) and the lowest in August (0.351).

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Month</th>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Middle Altitude</td>
<td>Higher Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>1</td>
<td>April</td>
<td>15</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>May</td>
<td>12</td>
<td>21</td>
<td>8</td>
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<tr>
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<td>June</td>
<td>14</td>
<td>17</td>
<td>8</td>
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<tr>
<td>4</td>
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<td>18</td>
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<td>15</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>October</td>
<td>18</td>
<td>17</td>
<td>9</td>
</tr>
</tbody>
</table>
### Table 4.53 Similarity and Dissimilarity Index for Herb Species at Banri Devi Forest (Almora) between Middle and Higher Altitudinal sites from April 2013 to March 2014

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Month</th>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Middle Altitude</td>
<td>Higher Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>8</td>
<td>November</td>
<td>16</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>December</td>
<td>7</td>
<td>15</td>
<td>4</td>
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<tr>
<td>10</td>
<td>January</td>
<td>13</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>February</td>
<td>12</td>
<td>14</td>
<td>7</td>
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<tr>
<td>12</td>
<td>March</td>
<td>17</td>
<td>22</td>
<td>7</td>
</tr>
</tbody>
</table>

4.5.4 Similarity and Dissimilarity Index for Tree

Table 4.54 represent the similarity and dissimilarity between lower and middle altitudinal sites for tree. The similarity index value was calculated (0.40) for tree vegetation and the value of dissimilarity was (0.60).

Table 4.55 represent the similarity and dissimilarity between lower and higher altitudinal sites for tree. The similarity index value was calculated (0.71) for tree vegetation and the value of dissimilarity was (0.29).

Table 4.56 represent the similarity and dissimilarity between of middle and higher altitudinal sites for tree. The similarity index value was calculated (0.40) for tree vegetation and the value of dissimilarity was (0.60).
### Table 4.54 Similarity and Dissimilarity Index for Tree Species at Banri Devi Forest (Almora) between Lower and Middle Altitudinal sites

<table>
<thead>
<tr>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Altitude</td>
<td>Middle Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 4.55 Similarity and Dissimilarity Index for Tree Species at Banri Devi Forest (Almora) between Lower and Higher Altitudinal sites

<table>
<thead>
<tr>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Altitude</td>
<td>Higher Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 4.56 Similarity and Dissimilarity Index for Tree Species at Banri Devi Forest (Almora) between Middle and Higher Altitudinal sites

<table>
<thead>
<tr>
<th>Species Present</th>
<th>Similarity</th>
<th>Dissimilarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Altitude</td>
<td>Higher Altitude</td>
<td>Common</td>
</tr>
<tr>
<td>13</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>


4.6 BIOMASS ESTIMATION

Biomass is biological material derived from living, or recently living organisms. It is organic, plant-based material which absorbs carbon dioxide from the atmosphere throughout its lifetime. When biomass is burnt carbon is released into the atmosphere as carbon dioxide. Biomass is regarded as an important indicator of ecological and management processes in the vegetation. Plants that dominate a site in terms of biomass are a reflection of the plants that are controlling the nutrient, water, and solar resources on the site. Therefore biomass is often measured to assess the ecological status of a site. Estimates of biomass and residual biomass also strongly influence the hydrologic properties of the site including infiltration, runoff, and erosion. Seasonal and annual climatic fluctuations affect biomass therefore production is not a suitable measure for long-term trend studies that compare data taken in different years.

4.6.1 Aboveground Biomass (gm/m²) of Herb Species for Three Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest

At lower altitudinal site biomass value showed a fluctuating trend from April 2013 to March 2014 (fig.4.12). Peak value was obtained in September (38.00 gm/m²) and the second highest biomass value was obtained in July (32.67 gm/m²) followed by November (31.67 gm/m²). The lowest value of biomass was shown by plants in February (11.67 gm/m²). Aboveground biomass mean value at lower altitudinal site is 24.17 with standard deviation 8.47.

At middle altitudinal site biomass value also had a tendency to fluctuate with time (fig. 4.13). Peak value was obtained in September (33.33 gm/m²) followed by November (33.00 gm/m²) and lowest value was shown by plants in January (15.00 gm/m²). Biomass value reported in July and August was approximately constant. However rest of the month showed no regular pattern. Aboveground biomass mean value at middle altitudinal site is 22.53 with standard deviation 6.52.

At higher altitudinal site biomass value showed an increasing pattern from April to October and then showed a fluctuating pattern from November to April. Peak
value was obtained in October (41.67 gm/m²) followed by September (28.67 gm/m²) and lowest value of biomass was reported in March and April (12.33 gm/m²). Aboveground biomass mean value at higher altitudinal site is 20.33 with standard deviation 8.56.

<table>
<thead>
<tr>
<th>Month</th>
<th>Lower Altitude Biomass gm /m²</th>
<th>Middle Altitude Biomass gm /m²</th>
<th>Higher Altitude Biomass gm /m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>13.67</td>
<td>19.00</td>
<td>12.33</td>
</tr>
<tr>
<td>May</td>
<td>18.00</td>
<td>22.00</td>
<td>13.67</td>
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<tr>
<td>June</td>
<td>20.33</td>
<td>26.00</td>
<td>16.33</td>
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<tr>
<td>July</td>
<td>32.67</td>
<td>17.00</td>
<td>16.00</td>
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<tr>
<td>August</td>
<td>29.00</td>
<td>16.67</td>
<td>18.33</td>
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<tr>
<td>September</td>
<td>38.00</td>
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<td>28.67</td>
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<td>30.00</td>
<td>22.67</td>
</tr>
<tr>
<td>January</td>
<td>21.67</td>
<td>15.00</td>
<td>26.33</td>
</tr>
<tr>
<td>February</td>
<td>11.67</td>
<td>18.33</td>
<td>15.00</td>
</tr>
<tr>
<td>March</td>
<td>16.00</td>
<td>22.00</td>
<td>12.33</td>
</tr>
<tr>
<td>Mean±Sd</td>
<td>24.17±8.47</td>
<td>22.53±6.52</td>
<td>20.33±8.56</td>
</tr>
</tbody>
</table>

Table 4.57 Total Aboveground Biomass (gm/m²) of Herb Species for Three Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora)
Fig. 4.13 Aboveground Biomass (gm/m²) Values of Herb Species in Lower Altitudinal Site at Banri Devi Forest (Almora)

Fig. 4.14 Aboveground Biomass (gm/m²) Values of Herb Species in Middle Altitudinal Site at Banri Devi Forest (Almora)
Fig. 4.15 Aboveground Biomass (gm/m²) Values of Herb Species in Higher Altitudinal Site at Banri Devi Forest (Almora)

4.6.2 Belowground Biomass (gm/m²) of Herb Species for Three Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest

At lower altitudinal site biomass showed a fluctuating pattern from April 2013 to March 2014. (fig no. 4.15). It showed an increasing pattern from April to July and then goes a fluctuating trend with decreased in August, increase in September and then again decreased till March. Peak value was obtained in July (21.67 gm/m²) and lowest value was shown by plants in April (8.00 gm/m²). Belowground biomass mean value at lower altitudinal site is 14.01 with standard deviation 4.19.

At middle altitudinal site biomass value also fluctuate with time from April 2013 to March 2014 (fig no. 4.16). Maximum value of biomass was obtained in November (20.50 gm/m²) followed by March and June (17.00 gm/m²) and minimum
biomass value was shown by plants in August (8.67 gm/m²). Belowground biomass mean value at middle altitudinal site is 12.45 with standard deviation 3.82.

At higher altitudinal site belowground biomass value also had tendency to fluctuate with time from April 2013 to March 2014 (fig no. 4.17). Peak value was obtained in June and October (18.67 gm/m²) and lowest biomass value was shown by plants in April (9.67 gm/m²). Biomass value reported in July, August and January was same 11.00 gm/m². Belowground biomass mean value at higher altitudinal site is 13.53 with standard deviation 3.09.

<table>
<thead>
<tr>
<th>Month</th>
<th>Lower Altitude Biomass Gm /M²</th>
<th>Middle Altitude Biomass Gm /M²</th>
<th>Higher Altitude Biomass Gm /M²</th>
</tr>
</thead>
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<td>9.33</td>
<td>9.67</td>
</tr>
<tr>
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<td>July</td>
<td>21.67</td>
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<td>11.00</td>
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<tr>
<td>September</td>
<td>20.00</td>
<td>12.00</td>
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<td>October</td>
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</tr>
<tr>
<td>January</td>
<td>12.00</td>
<td>9.00</td>
<td>11.00</td>
</tr>
<tr>
<td>February</td>
<td>11.33</td>
<td>11.67</td>
<td>13.33</td>
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<tr>
<td>March</td>
<td>10.67</td>
<td>17.00</td>
<td>10.67</td>
</tr>
<tr>
<td>Mean±Sd</td>
<td>14.01±4.19</td>
<td>12.45±3.82</td>
<td>13.53±3.09</td>
</tr>
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</table>

Table 4.58 Total Belowground Biomass (gm/m²) of Herb Species at Three Altitudinal Sites (Lower, Middle and Higher) at Banri Devi Forest (Almora)
Fig. 4.16 Belowground Biomass (gm/m²) Values of Herb Species in Lower Altitudinal Site at Banri Devi Forest (Almora)

Fig. 4.17 Belowground Biomass (gm/m²) Values of Herb Species in Middle Altitudinal Site at Banri Devi Forest (Almora)
Fig. 4.18 Belowground Biomass (gm/m²) Values of Herb Species in Higher Altitudinal Site at Banri Devi Forest (Almora)
4.7 PHENOLOGICAL STUDY

Plants and animals have life cycle events that seemingly occur like clockwork every year. Phenology is an important subject to study, because it helps us to understand the health of species and ecosystems. The timing of one species phenological events can be very important to the survival of another species. The scientific study of cyclical biological events, such as flowering, breeding, and migration, in relation to climatic conditions. Phenological records of the dates on which seasonal phenomena occur provide important information on how climate change affects ecosystems over time.

The study of phenological aspects of plants involves the observation, recording and interpretation of the timing of their life history events. The phenology of plant communities can be studied by dealing with particular life-history stages separately, such as leafing, flowering, fruiting, seed dispersal and germination. Each of these events occurs in its own calendar slot, but there is clearly some interdependence between them. Fruiting must wait upon flowering; seed dispersal cannot proceed fruiting. Each phenomenon can be studied at different levels of organization. For example, even an individual flower undergoes a sequence of events (bud burst, stigma ripening, pollen shedding, fertilization, fruit swelling, etc.) whose phenology differs between species and is presumed to be the result of natural selection. At each level, the constraints and selective forces which influence timing are different. (Finner, 1998). An understanding of the phenology of plants is crucial to the understanding of community function and diversity. The phenological records allow estimating future trends of plant phenological development.

This section includes the phenological study of dominant and codominant species selected on the basis of importance value index.

1. *Parthenium hysterophorus* (103.31 IVI)
2. *Ageratum conyzoides* (88.07 IVI)
3. *Euphorbia esula* (80.55 IVI)
4.7.1 *Parthenium hysterophorus* L.

**Kingdom**  
Plantae

**Order**  
Asterales

**Family**  
Asteraceae

**Genus**  
*Parthenium*

**Species**  
hysterophorus L.

**Vernacular**  
Gajar Ghans

**Description**

Parthenium is a common weed that found along the road side. It germinates during spring and early summer and produce flower throughout its life in the present study. Parthenium weed can germinate, grow, mature and set seed in four weeks. Its large and persistent soil seed bank, fast germination rate and ability to undergo dormancy make it well adapted to all environments. It produces four or five generations in one season and plant dies around late autumn.

**Natality**

The germination period of parthenium is March to October during the study period and it produces flower and seed throughout its life. Its natality rate is higher during summer and decrease with the upcoming of autumn. Under favorable condition it can grow and produce flower throughout the year.

**Mortality**

The mortality rate of parthenium is very low during growing season i.e. from march to September. However, with the end of September mortality rate start increasing and reach it peak by the end of October as most of the plant died.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>CHARACTER</th>
<th>NUMBER OF HARVEST</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1</td>
<td>WHOLE PLANT LENGTH (in cm)</td>
<td>11.00</td>
</tr>
<tr>
<td>2</td>
<td>SHOOT LENGTH (in cm)</td>
<td>7.50</td>
</tr>
<tr>
<td>3</td>
<td>ROOT LENGTH (in cm)</td>
<td>3.50</td>
</tr>
<tr>
<td>4</td>
<td>DRY WEIGHT OF WHOLE PLANT (g plant⁻¹)</td>
<td>0.410</td>
</tr>
<tr>
<td>5</td>
<td>DRY WEIGHT OF SHOOT (g plant⁻¹)</td>
<td>0.330</td>
</tr>
<tr>
<td>6</td>
<td>DRY WEIGHT OF ROOT (g plant⁻¹)</td>
<td>0.080</td>
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<tr>
<td>7</td>
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</tr>
<tr>
<td>8</td>
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<td>5</td>
</tr>
<tr>
<td>9</td>
<td>NO. OF FLOWER</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>TOTAL LEAF DRY WEIGHT (g plant⁻¹)</td>
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</tr>
<tr>
<td>11</td>
<td>LEAF AREA (in cm²)</td>
<td>2.60</td>
</tr>
<tr>
<td>12</td>
<td>CHLOROPHYLL a (mg g⁻¹)</td>
<td>0.846</td>
</tr>
<tr>
<td>13</td>
<td>CHLOROPHYLL b (mg g⁻¹)</td>
<td>-0.275</td>
</tr>
<tr>
<td>14</td>
<td>TOTAL CHLOROPHYLL (mg g⁻¹)</td>
<td>0.571</td>
</tr>
</tbody>
</table>

Table 4.59 The Phenological Characters of *Parthenium hysterophorus* during the Experimental Period (Mean across all sampling interval)
4.7.1.1 Total Cumulative Dry Weight of Shoot (g plant⁻¹)

Total cumulative dry weight of shoots varied significantly with sampling dates (P>0.05). It shows an increasing pattern (fig. 4.19) till tenth harvest. Highest value of cumulative total shoot biomass was recorded in the tenth harvest (10.10 g plant⁻¹) and the lowest value of cumulative total shoot biomass (0.330 g plant⁻¹) was recorded in first harvest. During first to forth harvest there is very little rise in cumulative total shoot biomass. After fifth harvest cumulative total shoot biomass started rising till tenth harvest.

![Fig. 4.19 Total Cumulative Dry Weight of Parthenium hysterophorus Shoot (g plant⁻¹) during the Experimental Period](image)

4.7.1.2 Total Cumulative Dry Weight of Root (g plant⁻¹)

Total cumulative dry weight of roots varied significantly with sampling dates (P>0.05). Fig. 4.20 shows that total cumulative dry weight of root continuously increased till the tenth harvest. The peak value of cumulative total dry weight of root was obtained in tenth harvest (1.80 g plant⁻¹) and the lowest value of dry weight of root was obtained in first harvest that is (0.08 g plant⁻¹).
4.7.1.3 Total Cumulative Leaf Dry Weight (g plant⁻¹)

Total cumulative leaf dry weight varied significantly with sampling dates (P>0.05). Total cumulative leaf dry weight shows an increasing pattern till tenth harvest (fig. 4.21). The highest value of total cumulative leaf dry weight was obtained in tenth harvest (4.255 g plant⁻¹) and the lowest value of leaf biomass was obtained in first harvest (0.032 g plant⁻¹). From first to fifth harvest the value of total cumulative leaf dry weight showed a slight increase. Thereafter the value increased considerably and peak value was obtained in tenth harvest.

4.7.1.4 Total Cumulative Plant Dry Weight (g plant⁻¹)

Total cumulative plant dry weight varied significantly with sampling dates (P>0.05). It increased with time upto tenth harvest (fig. 4.22). The highest value of total cumulative dry weight of whole plant was obtained in tenth harvest (11.900 g plant⁻¹) and the lowest value of biomass of Parthenium was obtained in first harvest (0.410 g plant⁻¹) whereas from second to fifth increased was not noticeable.
Fig. 4.21 Total Cumulative Leaf Dry Weight (g plant⁻¹) of Parthenium hysterophorus during the Experimental Period

Fig. 4.22 Total Cumulative Dry Weight of Parthenium hysterophorus Whole Plant (g plant⁻¹) during the Experimental Period
4.7.1.5 Shoot Weight Ratio (SWR)

Shoot weight ratio varied significantly with sampling dates (P>0.05). It shows a fluctuating pattern with considerable variations during study period (fig.4.23). The highest value of shoot weight ratio (0.849) was obtained in tenth harvest and the lowest (0.768) was recorded in fifth harvest.

![Shoot Weight Ratio (SWR) of Parthenium hysterophorus during the Experimental Period](image)

4.7.1.6 Root Weight Ratio (RWR)

Root weight ratio varied significantly with sampling dates (P>0.05). Root weight ratio shows a fluctuating trend with time (fig.4.24). The highest value of root weight ratio (0.232) was obtained in fifth harvest and the lowest (0.151) was recorded in tenth harvest.
4.7.1.7 Root: Shoot Ratio (R : S Ratio)

Root: shoot ratio varied significantly with sampling dates (P>0.05). Root : shoot ratio also had a fluctuating pattern with time (fig.4.25). Root: shoot ratio increase in the beginning and then fall down. The peak value of root : shoot weight ratio (0.302) was seen in the fifth harvest and the lowest value (0.178) was recorded in tenth harvest.

4.7.1.8 Leaf Weight Ratio (LWR)

Leaf weight ratio varied significantly with sampling dates (P>0.05). Leaf weight ratio shows irregular pattern with time. It shows an increasing pattern (fig. 4.26) till tenth harvest. Highest value of leaf weight ratio was recorded in tenth harvest (0.358) and the lowest was recorded in first harvest (0.078).
Chapter IV

Fig. 4.25 Root : Shoot Ratio of *Parthenium hysterophorus* during the Experimental Period

Fig. 4.26 Leaf Weight Ratio of *Parthenium hysterophorus* during the Experimental Period
4.7.1.9 Total Leaf Area (TLA; cm² plant⁻¹)

Total leaf area varied significantly with sampling dates (P>0.05). Fig. (4.27) shows that total leaf area (cm²/g) increased with time. The highest value of total leaf area of *Parthenium hysterophorus* was obtained in tenth harvest (1978.00 cm² plant⁻¹) and the lowest value was obtained in first harvest (20.80 cm² plant⁻¹).

![Fig. 4.27 Total Leaf Area (cm² plant⁻¹) of Parthenium hysterophorus during the Experimental Period](image)

4.7.1.10 Relation between Total Leaf Area (cm² plant⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹)

Relation between total leaf area and total cumulative plant dry weight is presented in fig. (4.28). Total leaf area had a positive relationship with total cumulative dry weight of plant. The highest values of total leaf area (1978.00 cm² plant⁻¹) and total cumulative dry weight of plant (11.90 g plant⁻¹) were recorded in the tenth harvest. The
lowest value of total leaf area (20.80 cm² plant⁻¹) and total cumulative dry weight of plant (0.410 g plant⁻¹) were shown in the initial harvest.

![Graph showing relation between Total Leaf Area and Total Cumulative Plant Dry Weight of Parthenium hysterophorus during the Experimental Period](image)

**Fig. 4.28 Relation between Total Leaf Area and Total Cumulative Plant Dry Weight of Parthenium hysterophorus during the Experimental Period**

### 4.7.1.11 Total Chlorophyll (mg g⁻¹)

Total chlorophyll varied significantly with sampling dates (P>0.05). Fig. (4.29) shows the total chlorophyll (mg g⁻¹). Total chlorophyll tended to remain same in all harvest except second harvest. The highest value of total chlorophyll was recorded in the second harvest (1.213 mg g⁻¹) and the lowest value in the tenth harvest (0.518 mg g⁻¹). The value of total chlorophyll was almost constant from forth to tenth harvest.

### 4.7.1.12 Chlorophyll a (mg g⁻¹)

Chlorophyll a varied significantly with sampling dates (P>0.05). Fig. (4.30) shows the value of chlorophyll a (mg g⁻¹). Chlorophyll a shows irregular pattern with time. The highest value of chlorophyll a was recorded in the second harvest (1.023 mg g⁻¹) and the lowest value was recorded in forth and tenth harvest (0.818 mg g⁻¹).
Fig. 4.29 Total Chlorophyll (mg g⁻¹) of *Parthenium hysterophorus* during the Experimental Period

Fig. 4.30 Chlorophyll a (mg g⁻¹) of *Parthenium hysterophorus* during the Experimental Period
4.7.1.13 Chlorophyll b (mg g\(^{-1}\))

Chlorophyll b varied significantly with sampling dates (P>0.05). Fig. (4.31) shows negative value of chlorophyll b except in the second harvest in *Parthenium hysterophorus*. Highest value of chlorophyll b was recorded in second harvest (0.190 mg g\(^{-1}\)) and the lowest was recorded in ninth harvest (-0.321 mg g\(^{-1}\)).

Fig. 4.31 Chlorophyll b (mg g\(^{-1}\)) of *Parthenium hysterophorus* during the Experimental Period

4.7.1.14 Relation between Total Chlorophyll (mg g\(^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))

Relation between total chlorophyll (mg g\(^{-1}\)) and cumulative total plant dry weight (g plant\(^{-1}\)) was shown in fig. (4.32). The value of total chlorophyll showed fluctuating pattern with increasing total plant dry weight. The highest value of total chlorophyll (1.213 mg g\(^{-1}\)) was recorded in second harvest and total plant dry weight (11.900 g plant\(^{-1}\)) was recorded in tenth harvest. The lowest value of total chlorophyll (0.518 mg g\(^{-1}\)) was obtained in tenth harvest and total cumulative plant dry weight (0.410 g plant\(^{-1}\)) was obtained in first harvest.
4.7.1.15 Relation between Chlorophyll a (mg g⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Relation between chlorophyll a (mg g⁻¹) and cumulative total plant dry weight (g plant⁻¹) was shown in fig. (4.33). The value of Chlorophyll a showed fluctuating pattern with increasing total plant dry weight. The highest value of chlorophyll a (1.023 mg g⁻¹) was recorded in second harvest and total plant dry weight (11.900 g plant⁻¹) was recorded in tenth harvest. The lowest value of chlorophyll a (0.818 mg g⁻¹) was recorded in forth and tenth harvest and total cumulative plant dry weight (0.410 g plant⁻¹) was recorded in first harvest.
Fig. 4.33 Relation between Chlorophyll a (mg g⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹) of Parthenium hysterophorus during the Experimental Period

4.7.1.16 Relation between Chlorophyll b (mg g⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Fig. (4.34) shows the relation between chlorophyll b (mg g⁻¹) and cumulative total plant dry weight (g plant⁻¹). Chlorophyll b value showed fluctuating pattern while cumulative total plant dry weight tended to increased from first to tenth harvest. The highest value of chlorophyll b (0.190 mg g⁻¹) was recorded in second harvest and cumulative total plant dry weight (11.900 g plant⁻¹) was recorded in tenth harvest and the lowest value chlorophyll b (-0.321 mg g⁻¹) was estimated in ninth harvest and that of cumulative total plant dry weight (0.410 g plant⁻¹) in first harvest respectively.
Fig. 4.34 Relation between Chlorophyll b (mg g⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹) of *Parthenium hysterophorus* during the Experimental Period

4.7.1.17 Relative Growth Rate (RGR; gg⁻¹d⁻¹)

Relative growth rate varied significantly with sampling dates (P>0.05). Relative growth rate (gg⁻¹d⁻¹) was shown in fig. 4.35. The relative growth rate was highest in second sampling interval and then fall down. The highest value of relative growth rate (0.082 gg⁻¹d⁻¹) was obtained in second sampling interval and the lowest value in last sampling interval (0.014 gg⁻¹d⁻¹).

4.7.1.18 Relation between Relative Growth Rate (gg⁻¹d⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Fig. 4.36 shows the relation between relative growth rate (gg⁻¹d⁻¹) and cumulative total plant dry weight (g plant⁻¹). Relative growth rate increased initially and then it declined with increasing cumulative total plant dry weight with number of harvest. The highest value relative growth rate (0.082 gg⁻¹d⁻¹) was recorded in second sampling interval and cumulative total plant dry weight (11.900 g plant⁻¹) in tenth harvest.
Fig. 4.35 Relative Growth Rate (\(g g^{-1} d^{-1}\)) of *Parthenium hysterophorus* during the Experimental Period

Fig. 4.36 Relation between Relative Growth Rate (\(g g^{-1} d^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\)) of *Parthenium hysterophorus* during the Experimental Period
4.7.1.19 Net Assimilation Rate (NAR; gcm$^{-2}$d$^{-1}$)

Net assimilation rate varied significantly with sampling dates (P>0.05). Fig. 4.37 shows the net assimilation rate (gcm$^{-2}$d$^{-1}$). Net assimilation rate followed a fluctuating pattern in first to last sampling interval. The highest net assimilation rate was recorded in the sixth sampling interval (0.030 gm$^{-2}$d$^{-1}$) and the lowest value in last sampling interval (0.010 gm$^{-2}$d$^{-1}$) showing declining of photosynthesis area.

![Fig. 4.37 Net Assimilation Rate (gcm$^{-2}$d$^{-1}$) of *Parthenium hysterophorus* during the Experimental Period](image-url)
4.7.2 *Ageratum conyzoides* L.

**Kingdom**  
Plantae

**Order**  
Astelaes

**Family**  
Asteraceae

**Genus**  
*Ageratum*

**Species**  
conyzoides L.

**Vernacular Name**  
Billy goat weed

**Description**

*Ageratum conyzoides* can grows in all habitats and thus invades forest, woodland, grassland, cultivated land, garden and agricultural field. It is an erect, branching, soft herb with shallow, fibrous roots. It is an annual plant which can reaches to approximately 1 m in height. The stems and leaves are covered with fine white hairs; stem is red with unpleasant aromatic leaves which are egg-shaped with broad end at base (ovate) up to 7.5 cm long. The flowers are purple, arranged in close terminal flower-heads. Flowering occurred from July to September in the present study. The flowers are hermaphrodite (have both male and female organs) and are pollinated by insects. The seed germination is induced by light.

**Natality**

*Ageratum conyzoides* can grow throughout the year but its germination rate was high from April to September during the study period. Flowering occurred throughout the study period and seeds were viable and germinated without any dormancy.

**Mortality**

Mortality was considerably low throughout the study period. Very low mortality was reported from April to September which increased slowly thereafter.
Table 4.60 The Phenological Characters of *Ageratum conyzoides* during the Experimental Period (Mean across all sampling interval)
4.7.2.1 Total Cumulative Dry Weight of Shoot (g plant⁻¹)

Total cumulative shoot biomass varied significantly with sampling dates (P>0.05). It shows an increasing pattern till ninth harvest (fig. 4.38). Highest value of total cumulative shoot biomass was recorded in the ninth harvest (4.848 g plant⁻¹) and the lowest value of cumulative total shoot biomass (0.099 g plant⁻¹) was recorded in first harvest. During first to fifth harvest there is very little rise in cumulative total shoot biomass. After fifth harvest cumulative total shoot biomass started rising till ninth harvest.

![Fig. 4.38 Total Cumulative Dry Weight of Ageratum conyzoides Shoot (g plant⁻¹) during the Experimental Period](image_url)

4.7.2.2 Total Cumulative Dry Weight of Root (g plant⁻¹)

Total cumulative root biomass varied significantly with sampling dates (P>0.05). Fig. (4.39) Shows that total cumulative dry weight of root continuously increased till the ninth harvest. The peak value of cumulative total dry weight of root was obtained in ninth harvest (0.301 g plant⁻¹) and the lowest value of dry weight of root was obtained in first harvest that is (0.005 g plant⁻¹).
4.7.2.3 Total Cumulative Leaf Dry Weight (g plant⁻¹)

Total cumulative leaf dry weight varied significantly with sampling dates (P>0.05). Total cumulative leaf dry weight shows an increasing pattern till ninth harvest (fig. 4.40). The highest value of total cumulative leaf dry weight was obtained in ninth harvest (1.476 g plant⁻¹) and the lowest value of leaf biomass was obtained in first harvest (0.015 g plant⁻¹). From first to fifth harvest the value of total cumulative leaf dry weight showed a slight increase. Thereafter the value increased considerably and peak value was obtained in ninth harvest.
4.7.2.4 Total Cumulative Plant Dry Weight (g plant⁻¹)

Total cumulative dry weight of whole plant varied significantly with sampling dates (P>0.05). It increased with time up to ninth harvest (fig. 4.41). The highest value of total cumulative dry weight of whole plant was obtained in ninth harvest (5.149 g plant⁻¹) and the lowest value of biomass of Ageratum was obtained in first harvest (0.104 g plant⁻¹) whereas from second to fifth increased was not noticeable.

4.7.2.5 Shoot Weight Ratio (SWR)

Shoot weight ratio varied significantly with sampling dates (P>0.05). It shows a fluctuating pattern with considerable variations during study period. The initial value declined up to the forth harvest and then increased up to eighth harvest and declined again (fig.4.42). The highest value of shoot weight ratio was obtained in first harvest (0.952) and the lowest were recorded in forth harvest (0.903).
Fig. 4.41 Total Cumulative Dry Weight of *Ageratum conyzoides* Whole Plant (g plant⁻¹) during the Experimental Period

Fig. 4.42 Shoot Weight Ratio (SWR) of *Ageratum conyzoides* during the Experimental Period
4.7.2.6 Root Weight Ratio (RWR)

Root weight ratio varied significantly with sampling dates (P>0.05). Root weight ratio shows a fluctuating trend with time (fig.4.43). It increased till forth harvest and then decreased upto eighth harvests and again increased in ninth harvest. The highest value of root weight ratio was obtained in forth harvest (0.097) and the lowest was recorded in first harvest (0.048).

![Fig. 4.43 Root Weight Ratio (RWR) of Ageratum conyzoides during the Experimental Period](image)

4.7.2.7 Root : Shoot Ratio (R: S Ratio)

Root : shoot ratio varied significantly with sampling dates (P>0.05). Root : shoot ratio also had a fluctuating pattern with time (fig.4.44). Root: shoot ratio increase in the beginning and then fall down. The peak value of root shoot weight ratio was seen in the forth harvest (0.108) and the lowest value was recorded in first harvest (0.051).
4.7.2.8 Leaf Weight Ratio (LWR)

Leaf weight ratio varied significantly with sampling dates (P>0.05). Leaf weight ratio shows irregular pattern with time. It decreased in the beginning from first to sixth harvest and then increased till ninth harvest. Highest value of leaf weight ratio was recorded in ninth harvest (0.287) and the lowest was recorded in sixth harvest (0.097) fig. (4.45).

4.7.2.9 Total Leaf Area (TLA; cm² plant⁻¹)

Total leaf area varied significantly with sampling dates (P>0.05). Fig.4.46 shows that total leaf area (cm²/g) increased with time. The highest value of total leaf area of Ageratum conyzoides was obtained in ninth harvest (501.02 cm² plant⁻¹) and the lowest value was obtained in first harvest (8.01 cm²/g).
Fig. 4.45 Leaf Weight Ratio of *Ageratum conyzoides* during the Experimental Period

Fig. 4.46 Total Leaf Area (cm² plant⁻¹) of *Ageratum conyzoides* during the Experimental Period
4.7.2.10 Relation between Total Leaf Area (cm² plant⁻¹) And Total Cumulative Plant Dry Weight (g plant⁻¹)

Relation between total leaf area and total cumulative plant dry weight is presented in fig. (4.47). Total leaf area had a positive relationship with total cumulative dry weight of plant. The highest values of total leaf area (501.02 cm² plant⁻¹) and total cumulative dry weight of plant (5.149 g plant⁻¹) were recorded in the ninth harvest. The lowest value of total leaf area (8.01 cm² plant⁻¹) and total cumulative dry weight of plant (0.104 g plant⁻¹) were shown in the initial harvest.

![Fig. 4.47 Relation between Total Leaf Area and Total Cumulative Plant Dry Weight of Ageratum conyzoides during the Experimental Period](Image)

4.7.2.11 Total Chlorophyll (mg g⁻¹)

Total chlorophyll varied significantly with sampling dates (P>0.05). The total chlorophyll (mg g⁻¹) tended to increase till ninth harvest (fig. 4.48). The highest value of total chlorophyll was recorded in the ninth harvest (2.618 mg g⁻¹) and the lowest value in the second harvest (1.240 mg g⁻¹).
4.7.2.12 Chlorophyll a (mg g⁻¹)

Chlorophyll a varied significantly with sampling dates (P>0.05). Chlorophyll a decreased upto second harvest and then increased continuously upto ninth harvest (fig. 4.49). The highest value of chlorophyll a was recorded in the ninth harvest (1.814 mg g⁻¹) and the lowest value in the second harvest (0.884 mg g⁻¹).

4.7.2.13 Chlorophyll b (mg g⁻¹)

Chlorophyll b varied significantly with sampling dates (P>0.05). Fig. (4.50) shows that chlorophyll b declined initially upto the second harvest, then increased slightly upto the sixth harvest and remained constant upto eighth harvest and increased considerably during the ninth harvest. Highest value of chlorophyll b was recorded in ninth harvest (0.804 mg g⁻¹) and the lowest was recorded in second harvest (0.356 mg g⁻¹).
Fig. 4.49 Chlorophyll a (mg g⁻¹) of *Ageratum conyzoides* during the Experimental Period

Fig. 4.50 Chlorophyll b (mg g⁻¹) of *Ageratum conyzoides* during the Experimental Period
4.7.2.14 Relation between Total Chlorophyll (mg g⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Relation between total chlorophyll (mg g⁻¹) and cumulative total plant dry weight (g plant⁻¹) was shown in fig 4.51. The highest value of total chlorophyll (2.618 mg g⁻¹) and cumulative total plant dry weight (5.149 g plant⁻¹) was recorded in ninth harvest whereas lowest was recorded in the second harvest for total chlorophyll (1.240 mg g⁻¹) and in first harvest for cumulative total plant dry weight (0.104 g plant⁻¹) and thus it had a positive relationship.

![Fig. 4.51 Relation between Total Chlorophyll and Total Cumulative Plant Dry Weight of Ageratum conyzoides during the Experimental Period](image)

4.7.2.15 Relation between Chlorophyll a (mg g⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Relation between chlorophyll a (mg g⁻¹) and cumulative total plant dry weight (g plant⁻¹) was shown in fig. 4.52. In second harvest the value of chlorophyll declined with increasing total plant dry weight and then showed a positive relationship as
it increased with increasing total plant dry weight. The highest value of both chlorophyll a (1.814 mg g⁻¹) and total plant dry weight (5.149 g plant⁻¹) was reported in ninth harvest and the lowest value chlorophyll a (0.884 mg g⁻¹) in second harvest whereas total cumulative plant dry weight (0.104 g plant⁻¹) in first harvest was reported.

![Fig. 4.52 Relation between Chlorophyll a (mg g⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹) of Ageratum conyzoides during the Experimental Period](image)

4.7.2.16 Relation between Chlorophyll b (mg g⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Fig. 4.53 shows the relationship of chlorophyll b (mg g⁻¹) and cumulative total plant dry weight (g plant⁻¹). Chlorophyll b showed irregular pattern with increasing cumulative total plant dry weight. The highest value of chlorophyll b (0.804 mg g⁻¹) and cumulative total plant dry weight( 5.149 g plant⁻¹) was recorded in ninth harvest and the lowest value of chlorophyll b (0.356 mg g⁻¹) was recorded in second harvest and that of cumulative total plant dry weight (0.104 g plant⁻¹) in first harvest respectively. Both had a positive relationship with minor fluctuation during the experimental period.
4.7.2.17 Relative Growth Rate (RGR; gg⁻¹d⁻¹)

Relative growth rate varied significantly with sampling dates (P>0.05). Relative growth rate (gg⁻¹d⁻¹) was shown in fig 4.54. The relative growth rate increased till forth sampling interval and then fall down. The highest value of relative growth rate (0.088 gg⁻¹d⁻¹) was recorded in forth sampling interval and the lowest value in last sampling interval (0.039 gg⁻¹d⁻¹).

4.7.2.18 Relation between Relative Growth Rate (gg⁻¹d⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹)

Fig. 4.55 shows the relation between relative growth rate (gg⁻¹d⁻¹) and cumulative total plant dry weight (g plant⁻¹). Relative growth rate increased in the beginning till forth sampling interval and then declined with increasing cumulative total plant dry. The highest value of relative growth rate (0.088 gg⁻¹d⁻¹) was reported in forth sampling interval and cumulative total plant dry weight (5.149 g plant⁻¹) was reported in ninth harvest.
Fig. 4.54 Relative Growth Rate ($gg^{-1}d^{-1}$) of *Ageratum conyzoides* during the Experimental Period

Fig. 4.55 Relation between Relative Growth Rate ($gg^{-1}d^{-1}$) and Cumulative Total Plant Dry Weight (g plant$^{-1}$) of *Ageratum conyzoides* during the Experimental Period
4.7.2.19 Net Assimilation Rate (NAR; gcm⁻²day⁻¹)

Net assimilation rate varied significantly with sampling dates (P>0.05). Net assimilation rate also follows an increasing pattern from first to seventh sampling interval (fig.4.56). The highest net assimilation rate was recorded in the fifth and seventh sampling interval (0.039 gcm⁻²day⁻¹) and the lowest value in first sampling interval (0.004 gcm⁻²day⁻¹).

Fig. 4.56 Net Assimilation Rate (gm⁻²d⁻¹) of Ageratum conyzoides during the Experimental Period
4.7.3 *Euphorbia esula* L.

**Kingdom**  
Plantae

**Order**  
Malpighiales

**Family**  
Euphorbiaceae

**Genus**  
*Euphorbia*

**Species**  
estula L.

**Vernacular**  
Green Spurge

**Description**

It is an herbaceous perennial plant growing to 20-90 cm tall, with several stems branched from the base. The leaves are small, 4-8.5 cm long and up to 1 cm broad. Flowers develop from May to July during study period. All parts of the plant contain a toxic white milky sap. Leafy spurge seedlings are capable of vegetative regeneration within a week of emergence. It reproduces readily by seeds that have a high germination rate and also spreads vegetatively from the root system.

**Natality**

It is one of the earliest plants to emerge in the spring, usually in mid-April to late May. The development of terminal flower clusters begins 1 to 2 weeks after stem emergence. Its natality rate is higher from April to June during the study period and decrease with the upcoming of summer.

**Mortality**

The mortality rate of Euphorbia was considerably very low during study season. Very low mortality was reported from April to June which increased slowly thereafter.
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<td>DRY WEIGHT OF ROOT (g plant⁻¹)</td>
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<tr>
<td>9</td>
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</table>

Table 4.61 The Phenological Characters of *Euphorbia esula* during the Experimental Period (Mean across all sampling interval)
4.7.3.1 Total Cumulative Dry Weight of Shoot (g plant\(^{-1}\))

Total cumulative shoot biomass varied significantly with sampling dates (P>0.05). It shows an increasing pattern fig. (4.57) till eighth harvest. Highest value of total cumulative shoot biomass was recorded in the eighth harvest (1.781 g plant\(^{-1}\)) and the lowest value of cumulative total shoot biomass (0.158 g plant\(^{-1}\)) was recorded in first harvest.

![Graph showing total cumulative dry weight of shoot over harvesting periods](image)

**Fig. 4.57 Total Cumulative Dry Weight of *Euphorbia esula* Shoot (g plant\(^{-1}\)) during the Experimental Period**

4.7.3.2 Total Cumulative Dry Weight of Root (g plant\(^{-1}\))

Total cumulative root biomass varied significantly with sampling dates (P>0.05). Fig. (4.58) Shows that total cumulative dry weight of root increased continuously till the eighth harvest. The peak value of total cumulative dry weight of root was obtained in eighth harvest (2.22 g plant\(^{-1}\)) and the lowest value of dry weight of root was obtained in first harvest that is (1.10 g plant\(^{-1}\)).
4.7.3.3 Total Cumulative Leaf Dry Weight (g plant⁻¹)

Total cumulative leaf dry weight varied significantly with sampling dates (P>0.05). Total cumulative leaf dry weight shows an increasing pattern till eighth harvest (fig. 4.59). The highest value of total cumulative leaf dry weight was obtained in eighth harvest (0.910 g plant⁻¹) and the lowest value of leaf biomass was obtained in first harvest (0.105 g plant⁻¹). From fifth to eighth harvest the value of total cumulative leaf dry weight showed a slight increase. Thereafter the value increased considerably and peak value was obtained in eighth harvest.

4.7.3.4 Total Cumulative Plant Dry Weight (g plant⁻¹)

Total cumulative dry weight of whole plant varied significantly with sampling dates (P>0.05). It increased with time upto eighth harvest (fig. 4.60). The highest value of total cumulative dry weight of whole plant was obtained in eighth harvest (4.001 g plant⁻¹) and the lowest value of biomass of *Euphorbia esula* was obtained in first harvest (1.258 g plant⁻¹) whereas from sixth to eighth increase was not noticeable.
Fig. 4.59 Total Cumulative Leaf Dry Weight (g plant⁻¹) of *Euphorbia esula* during the Experimental Period

Fig. 4.60 Total Cumulative Dry Weight of *Euphorbia esula* during the Experimental Period
4.7.3.5 Shoot Weight Ratio (SWR)

Shoot weight ratio varied significantly with sampling dates (P>0.05). It shows a increasing pattern with number of harvest during study period (fig.4.61). The highest value of shoot weight ratio (0.445) of *Euphorbia esula* was recorded in eighth harvest and lowest was recorded in first harvest (0.126).

![Fig. 4.61 Shoot Weight Ratio of *Euphorbia esula* during the Experimental Period](image)

4.7.3.6 Root Weight Ratio (RWR)

Root weight ratio varied significantly with sampling dates (P>0.05). Root weight ratio shows a declining trend with time (fig.4.62). The highest value of root weight ratio was obtained in first harvest (0.874) and the lowest was recorded in eighth harvest (0.555).
4.7.3.7 Root: Shoot Ratio (R: S Ratio)

Root: shoot ratio varied significantly with sampling dates (P>0.05). Root: shoot ratio also had a declining pattern with time (fig.4.63). The peak value of root: shoot ratio was seen in the first harvest (6.962) whereas the lowest value was recorded in eighth harvest (1.246).

4.7.3.8 Leaf Weight Ratio (LWR)

Leaf weight ratio varied significantly with sampling dates (P>0.05). Leaf weight ratio shows an increasing pattern (fig.4.64). Highest value of leaf weight ratio (0.227) was recorded in eighth harvest and the lowest value (0.083) was recorded in first harvest.
Chapter IV

Fig. 4.63 Root-Shoot Weight Ratio of *Euphorbia esula* during the Experimental Period

Fig. 4.64 Leaf Weight Ratio of *Euphorbia esula* during the Experimental Period
4.7.3.9 Total Leaf Area (cm² plant⁻¹)

Total leaf area varied significantly with sampling dates (P>0.05). Fig.4.65 shows that total leaf area (cm²/g) increased with time. The highest value of total leaf area of *Euphorbia esula* was obtained in eighth harvest (115.50 cm² plant⁻¹) and the lowest value was obtained in first harvest (16.80 cm²/g).

![Graph showing total leaf area (cm² plant⁻¹) of Euphorbia esula during the Experimental Period](image)

**Fig. 4.65 Total Leaf Area (cm² plant⁻¹) of *Euphorbia esula* during the Experimental Period**

4.7.3.10 Relation between Total Leaf Area (cm² plant⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹)

Relation between total leaf area and total cumulative plant dry weight is presented in fig (4.66). Total leaf area had a positive relationship with total cumulative dry weight of plant increased. The highest value of total leaf area (115.50 cm² plant⁻¹) and total cumulative dry weight of plant (4.001 g plant⁻¹) were recorded in the eighth harvest. And the lowest value of total leaf area (16.80 cm² plant⁻¹) and total cumulative dry weight of plant (1.258 g plant⁻¹) were shown in the initial harvest.
4.7.3.11 Total Chlorophyll (mg g⁻¹)

Total chlorophyll varied significantly with sampling dates (P>0.05). Total chlorophyll tended to increase in the beginning till forth harvest (fig. 4.67) and then start declining. The highest value of total chlorophyll (1.849 mg g⁻¹) was recorded in the forth harvest and the lowest value (0.820 mg g⁻¹) was recorded in the eighth harvest. The value of total chlorophyll was almost constant from forth to seventh harvest.

4.7.3.12 Chlorophyll a (mg g⁻¹)

Chlorophyll a varied significantly with sampling dates (P>0.05). Chlorophyll a also tended to increase in the beginning till forth harvest (fig. 4.68) and then start declining. The highest value of chlorophyll a (1.340 mg g⁻¹) was recorded in the forth harvest and the lowest value of chlorophyll a (0.647 mg g⁻¹) was recorded in eighth harvest.
Fig. 4.67 Total Chlorophyll (mg g⁻¹) of *Euphorbia esula* during the Experimental Period

Fig. 4.68 Chlorophyll a (mg g⁻¹) of *Euphorbia esula* during the Experimental Period
4.7.3.13 Chlorophyll b (mg g \(^{-1}\))

Chlorophyll b varied significantly with sampling dates (P>0.05). Fig 4.69 shows value of chlorophyll b in *Euphorbia esula*. Highest value of chlorophyll b (0.509 mg g \(^{-1}\)) was recorded in forth harvest and the lowest (0.173 mg g \(^{-1}\)) was recorded in eighth harvest. It also had an increasing trend in the beginning.

![Fig. 4.69 Chlorophyll b (mg g \(^{-1}\)) of *Euphorbia esula* during the Experimental Period](image)

4.7.3.14 Relation between Total Chlorophyll (mg g \(^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))

Relation between total chlorophyll (mg g \(^{-1}\)) and cumulative total plant dry weight (g plant\(^{-1}\)) was shown in fig. 4.70. It had a positive relationship with cumulative total plant dry weight till forth harvest. The highest value of total chlorophyll (1.849 mg g \(^{-1}\)) was calculated in forth harvest and total plant dry weight (4.001 g plant\(^{-1}\)) was reported in eighth harvest. The lowest value of total chlorophyll (0.820 mg g \(^{-1}\)) was reported in eighth harvest and total cumulative plant dry weight (1.258 g plant\(^{-1}\)) was reported in first harvest.

![Fig. 4.70 Relation between Total Chlorophyll (mg g \(^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))](image)
4.7.3.15 Relation between Chlorophyll a (mg g \(^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))

Relation between chlorophyll a (mg g \(^{-1}\)) and cumulative total plant dry weight (g plant\(^{-1}\)) was shown in fig 4.71. Upto forth harvest the value of chlorophyll a increase as total plant dry weight increases and then chlorophyll a declined with increasing total plant dry weight. The highest value of chlorophyll a (1.340 mg g \(^{-1}\)) was reported in forth harvest and total plant dry weight (4.001 g plant\(^{-1}\)) was reported in eighth harvest. The lowest value chlorophyll a (0.647 mg g \(^{-1}\)) in eighth harvest whereas total cumulative plant dry weight (1.258 g plant\(^{-1}\)) was reported in first harvest.

4.7.3.16 Relation between Chlorophyll b (mg g \(^{-1}\)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))

Fig. 4.72 shows the relation between chlorophyll b (mg g \(^{-1}\)) and cumulative total plant dry weight (g plant\(^{-1}\)). Chlorophyll b value tended to increased till forth harvest while cumulative total plant dry weight increased upto eighth harvest. The highest value of chlorophyll b (0.509 mg g \(^{-1}\)) was recorded in forth harvest and
cumulative total plant dry weight (4.001 g plant⁻¹) was recorded in eighth harvest. The lowest value of chlorophyll b (0.173 mg g⁻¹) was estimated in eighth harvest and that of cumulative total plant dry weight (1.258 g plant⁻¹) in first harvest respectively.

Fig. 4.71 Relation between Chlorophyll a (mg g⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹) of *Euphorbia esula* during the Experimental Period

Fig. 4.72 Relation between Chlorophyll b (mg g⁻¹) and Total Cumulative Plant Dry Weight (g plant⁻¹) of *Euphorbia esula* during the Experimental Period
4.7.3.17 Relative Growth Rate (RGR; \( gg^{-1}d^{-1} \))

Relative growth rate varied significantly with sampling dates (P>0.05). Relative growth rate (\( gg^{-1}d^{-1} \)) was shown in fig4.73. The relative growth rate increased till second sampling interval and then starts declining. The highest value of relative growth rate (0.049 \( gg^{-1}d^{-1} \)) was reported in second sampling interval harvest and the lowest value (0.006 \( gg^{-1}d^{-1} \)) in seventh sampling interval.

![Bar chart showing relative growth rate over sampling intervals.]

Fig. 4.73 Relative Growth Rate (\( gg^{-1}d^{-1} \)) of *Euphorbia esula* during the Experimental Period

4.7.3.18 Relation between Relative Growth Rate (\( gg^{-1}d^{-1} \)) and Cumulative Total Plant Dry Weight (g plant\(^{-1}\))

Fig.4.74 shows the relation between relative growth rate (\( gg^{-1}d^{-1} \)) and cumulative total plant dry weight (g plant\(^{-1}\)). Relative growth rate increased in the beginning and then declined with increasing cumulative total plant dry with number of harvest. The highest value relative growth rate (0.049 \( gg^{-1}d^{-1} \)) was reported in second sampling interval and cumulative total plant dry weight (4.001 g plant\(^{-1}\)) was reported in eighth harvest.
Fig. 4.74 Relation between Relative Growth Rate (gg⁻¹d⁻¹) and Cumulative Total Plant Dry Weight (g plant⁻¹) of *Euphorbia esula* during the Experimental Period

4.7.3.19 Net Assimilation Rate (NAR; g cm⁻²d⁻¹)

Net assimilation rate varied significantly with sampling dates (P>0.05). Net assimilation rate increased till second sampling interval and then start declining (fig. 4.75). The highest net assimilation rate was recorded in second sampling interval (0.067 g cm⁻²d⁻¹) and the lowest value in seventh sampling interval (0.015 g cm⁻²d⁻¹) showing declining of photosynthesis area.

Fig. 4.75 Net Assimilation Rate (g cm⁻²d⁻¹) of *Euphorbia esula* during the Experimental Period
Plate 4.1 Whole Plant of *Parthenium hysterophorus*

Plate 4.2 Shoot of *Parthenium hysterophorus*

Plate 4.3 Root of *Parthenium hysterophorus*

Plate 4.4 Leaves of *Parthenium hysterophorus*
Plate 4.5 Whole Plant of *Ageratum conyzoides*

Plate 4.6 Shoot of *Ageratum conyzoides*

Plate 4.7 Root of *Ageratum conyzoides*

Plate 4.8 Leaves of *Ageratum conyzoides*
Plate 4.9 Whole Plant of *Euphorbia esula*

Plate 4.10 Shoot of *Euphorbia esula*

Plate 4.11 Root of *Euphorbia esula*

Plate 4.12 Leaves of *Euphorbia esula*
Estelar
4.8 ENUMERATION OF ETHNOBOTANICAL PLANT SPECIES OF BANRI DEVI FOREST OF ALMORA

Ethnobotany is the scientific study of the relationships that exist between peoples and plants. Ethnobotanists aim to document, describe and explain complex relationships between cultures and plants, focusing primarily on how plants are used, managed and perceived across human societies. This includes use for food, clothing, currency, ritual, medicine, dye, construction, cosmetics and a lot more. Richard Evans Schultes, called the "father of ethnobotany", explained the discipline in this way:

Ethnobotanical knowledge encompasses both wild and domesticated species, and is rooted in observation, relationship, needs, and traditional ways of knowing. Such knowledge evolves over time, and is therefore always changing and adding new discoveries, ingenuity and methods. Ethnobotany is an integrative, multi-disciplinary field of learning. So the tools of ethnobotanical investigations are many: botany, mycology, taxonomy, anthropology, ethnography, archaeology, comparative folklore, religious studies, medicine, chemistry, pharmacology, and more.

The present study was carried out to assess and document ethnobotanical knowledge of herbs and trees of Banri Devi forest of Almora as the area has diverse flora and high ethnobotanical potential. It was found that 89 different plant species are used for medicinal, timber, fuel wood, fodder, ornamental, agricultural tools, Thatching, fencing, naming (folk lore) and fruit yielding purposes. Plant species are arranged in alphabetic order and categorized as herb and tree. Each entry gives the following information: Plant’s scientific name with family, their vernacular name, their habit, part(s) used, flowering period, ethnobotanical uses and traditional uses (based upon various studies Nautiyal et al. (2000), Badola and Aitken (2003), Rao et al., 2003, Sharma and Mishra (2009), Kumari et al.; 2011 and Mathur; 2011) of the reported plants in Banri Devi Almora have been presented below.
4.8.1 Ethnobotany of Herbaceous species

A total of 76 ethnobotanical important herbaceous species belonging to 68 genera and 31 families were reported (fig. 4.78). The most privileged family used for different purposes was Asteraceae (19 species) followed by Lamiaceae (8 species), Fabaceae (5 species), Euphorbiaceae (4 species), Rosaceae (4 species) and Acanthaceae (3 species) (fig. 4.79). Although all plant parts were used in various forms. Fig. 4.80 shows that whole plant (64.47 %), leaves (25.00 %), root (14.47 %) and seed (13.16 %) were frequently used.

1. **Botanical Name** Acanthospermum hispidum, D.C.  
   **Family** Asteraceae  
   **Vernacular Name** Starbur and Goat’s head  
   **Habit** An annual herb grows up to 60 cm tall.  
   **Flowering period** June to October  
   **Part (s) Used** Whole plant  
   **Medicinal Use / Uses** Crushed herb is use in the form of the paste to treat the skin ailments and leaf juice is used to relieve the fever. It is used for the treatment of jaundice, malaria, vomiting, head-ache, abdominal pain, stomachache, constipation and malaria.

2. **Botanical Name** Ageratum conyzoides L.  
   **Family** Asteraceae  
   **Vernacular Name** Goat weed, Billy goat weed and Jangli pudina  
   **Habit** An annual herbaceous weed, which grows up to a height of 2.5 feet.  
   **Flowering period** July to September.  
   **Part (s) Used** Whole plant
Medicinal Use / Uses  
Ageratum is used in the treatment of leprosy, anti-itch, rheumatism, sleeping sickness, mouthwash for toothache, antitusive and vermifuge. It is also used as insecticide and nematicide.

3. Botanical Name  
*Ajuga bracteosa* Wall ex. Benth.  
Family  
Lamiaceae  
Vernacular Name  
Neelkhanth and Ratpatia  
Habit  
A perennial evergreen herb.  
Flowering period  
March to August  
Part (s) Used  
Whole plant  
Medicinal Use / Uses  
The juice of the root is used in the treatment of diarrhoea and dysentery. The juice of the leaves is used as a blood purifier and also for fever and the powdered of leaves for burns and boils. The plant exhibited anticancer activity also.

4. Botanical Name  
*Anaphalis margaritacea* (L.) Benth. & Hook.f.  
Family  
Asteraceae  
Vernacular Name  
Western pearly everlasting, Pearly everlasting and Bakol  
Habit  
A Perennial herb that grows erect up to about 1.2 meters.  
Flowering period  
August  
Part (s) Used  
Leaves  
Medicinal Use / Uses  
The rubbed and rolled dry leaves were used in intestinal disorder.

5. Botanical Name  
*Argemone Mexicana* L.  
Family  
Papaveraceae  
Vernacular Name  
Mexican Prickly Poppy
Habit

An annual herb, growing up to 150 cm.

Flowering period

June to August

Part (s) Used

Whole plant

Medicinal Use / Uses

Latex is used as eye drop in eye disease. The fresh yellow milky sap used in treatment of warts, cold sores, cutaneous infection, skin diseases and itches etc. A semi drying oil is obtained from seed is used for lighting and soaps.

6. Botanical Name

*Artemisia parviflora* Roxb. ex D. Don

Family

Asteraceae

Vernacular Name

Japonise wornwood

Habit

A Perennial herb that grows up to 40-80 cm tall.

Flowering period

August to October

Part (s) Used

Whole plant

Medicinal Use / Uses

The arial parts of plant have been used in the treatment of vaginitis and skin diseases. The plant is also used for crafting aromatic wreaths and is used for flavoring of vermouth.

7. Botanical Name

*Asparagus filicinus* Buch.-Ham. ex D. Don

Family

Asparagaceae

Vernacular Name

Fern Asparagus and Chiriya- kanda

Habit

A Perennial herb growing 0.7m tall.

Flowering period

May to June

Part (s) Used

Root and tuber

Medicinal Use / Uses

Used for the treatment of diabetes, diarrhoea and dysentery.
<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Vernacular Name</th>
<th>Habit</th>
<th>Flowering period</th>
<th>Part (s) Used</th>
<th>Medicinal Use / Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td><em>Barleria auriculata</em> Schumach.</td>
<td><em>Acanthaceae</em></td>
<td>Gokulakanta</td>
<td>It is herbaceous plant that reaches up to the height of 180 cm.</td>
<td>August to March</td>
<td>Whole plant</td>
<td>It is used to cure jaundice, rheumatism, urino-genital tract and cancer. It is also used for removal of gall blader stone.</td>
</tr>
<tr>
<td>9.</td>
<td><em>Barleria cristata</em> L.</td>
<td><em>Acanthaceae</em></td>
<td>Philippine violet and Bluebell barleria</td>
<td>It is a shrub that grows up to 60 –100 cm tall.</td>
<td>December</td>
<td>Whole plant</td>
<td>It acts as diuretic and blood purifier. It is also strung into garlands of flowers for women to wear in their hair and also used as garden hedge.</td>
</tr>
<tr>
<td>10.</td>
<td><em>Bidens biternata</em> (Lour.) Merr. &amp; Sherff</td>
<td><em>Asteraceae</em></td>
<td>Yellow flowered black jack</td>
<td>An erect annual herb up to 1m tall.</td>
<td>August to November</td>
<td>Whole plant</td>
<td>It is used to cure leprosy and skin diseases. Dried flower buds are used in toothache and also useful to cure</td>
</tr>
</tbody>
</table>
coughs, bites, wounds, colic, eye sore and heal ulcers.

11. **Botanical Name** *Bidens pilosa* L.
    **Family** Asteraceae
    **Vernacular Name** Beggar tick
    **Habit** An annual herb that grows up to the height of 1.8m.
    **Flowering period** May to October.
    **Part(s) Used** Whole plant
    **Medicinal Use / Uses** Used to cure cough, bronchitis and leukoderma.

12. **Botanical Name** *Boenninghausenia albiflora* (Hook.) Rchb. ex Meisn.
    **Family** Rutaceae
    **Vernacular Name** White Himalayan rue and Pissumar
    **Habit** It is herb that reaches the height of 1.2m.
    **Flowering period** May to November
    **Part(s) Used** Whole plant
    **Medicinal Use / Uses** The crushed leaves are used to cure cuts, wounds, malaria, scabies and headaches. Whereas decoction of roots are used to cure malaria. The dried leaves are also used as flea repellent.

13. **Botanical Name** *Buchnera hispida* Buch.-Ham.
    **Family** Scrophulariaceae
    **Vernacular Name** Karonji
    **Habit** It is erect annual herb with 15 to 20 cm height.
    **Flowering period** October
    **Part(s) Used** Whole plant
    **Medicinal Use / Uses** The dried powdered plant is mixed with castor oil to treat
scabies and eczema.

14. **Botanical Name** *Bupleurum hamiltonii* N.P.Balakr
   **Family** Apiaceae
   **Vernacular Name** Jangli jeera
   **Habit** An Annual, or short-lived perennial herbs that grow upto 10–100 cm,
   **Flowering period** September to October
   **Part (s) Used** Root
   **Medicinal Use / Uses** Root used in stomach and liver disorder.

15. **Botanical Name** *Cannabis sativa* L.
    **Family** Cannabaceae
    **Vernacular Name** Bhang
    **Habit** Cannabis is an annual herb that grows up to 4m.
    **Flowering period** April to September
    **Part (s) Used** Leaves, bark, seed, flower and fruit
    **Medicinal Use / Uses** Used for blood clearing, relieving temperature and discharging of puss. Oil was extracted from the seeds and seed are also used in the form of chutney.

16. **Botanical Name** *Capsella bursa-pastoris* (L.) Medik
    **Family** Brassicaceae
    **Vernacular Name** Ladies purse and Shepherd’s purse
    **Habit** A small annual herb that grows up to 0.2 to 0.5 m.
    **Flowering period** Throughout the year.
    **Part (s) Used** Whole plant
    **Medicinal Use / Uses** Used as tea or tincture both internally and externally to
treat disorder of skin, locomotor system, homeostasis and problem. Also used as animal feed and cosmetics.

17. **Botanical Name** *Cassia tora* L.
   **Family** Fabaceae
   **Vernacular Name** Sickle pod, Coffee pod and Pumar
   **Habit** An annual herb, with a height of 30 to 90 cm
   **Flowering period** July to September
   **Part (s) Used** Leaves, seed and root
   **Medicinal Use / Uses** Decoction of the fruit of *Cassia tora* is used in the treatment of fever. It is very useful in treating skin diseases like ringworm and itching or body scratch and also acts as a liver stimulant, mild laxative and heart tonic, helps the body in maintaining the normal level of cholesterol. Its powder proves useful in combating indigestion, toning up heart muscles and purifying blood. The leaves ad seeds of *Cassia tora* are useful in leprosy, flatulence, colic, dyspepsia, constipation, cough, bronchitis and cardiac disorders. It is also used as a coffee substitute.

18. **Botanical Name** *Clematis orientalis* L.
   **Family** Ranunculaceae
   **Vernacular Name** Chinese clematis and Orange peel
   **Habit** A Deciduous shrub that grows 1m per year.
   **Flowering period** August to September
   **Part (s) Used** Whole plant
   **Medicinal Use / Uses** Used to treat dog bites and ulcerated throat by gargling its infusion. Also grown as an ornamental plant.
<table>
<thead>
<tr>
<th>19. Botanical Name</th>
<th>Colebrookea oppositifolia Sm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Lamiaceae</td>
</tr>
<tr>
<td>Vernacular Name</td>
<td>Indian squirrel tail and Bhamber</td>
</tr>
<tr>
<td>Habit</td>
<td>It is a shrub growing up to 1-3 m tall.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>December to April.</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Leaves and root</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>Cures cough and dysentery and in treatment of wounds. Also used as fodder and fuel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>20. Botanical Name</th>
<th>Crotalaria albida B. Heyne ex. Roth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Vernacular Name</td>
<td>Narrowleaf rattlepod and Ban methi</td>
</tr>
<tr>
<td>Habit</td>
<td>It is short lived or perennial herbs.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>May to December</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Whole plant</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>It is recorded useful in the treatment for warts, especially on the sole of the foot and a juice obtained from the roots is given for indigestion, used in cases of urinary tract infections, boils and cough.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>21. Botanical Name</th>
<th>Cyanotis barbata D. Don</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Commelinaceae</td>
</tr>
<tr>
<td>Vernacular Name</td>
<td>Wandering dew grass</td>
</tr>
<tr>
<td>Habit</td>
<td>A perennial herb growing 2 to 18 in. high.</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Root</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>Root used to treat swelling and snake bite.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>22. Botanical Name</th>
<th>Cynoglossum lanceolatum Forssk.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>Boraginaceae</td>
</tr>
</tbody>
</table>

229
<table>
<thead>
<tr>
<th>Vernacular Name</th>
<th>Lanceleaf and Forget me not</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>This plant is a biennial herb that grows up to 1.8 m in height.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>June to August</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Whole plant</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>Used for internal indications, e.g. for nephritic edema, acute nephritis, and toothache. Also used as a fodder.</td>
</tr>
</tbody>
</table>

23. **Botanical Name**  
*Datura stramonium* L.

<table>
<thead>
<tr>
<th>Family</th>
<th>Solanaceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernacular Name</td>
<td>Dhatura</td>
</tr>
<tr>
<td>Habit</td>
<td>An Annual herb that grow 2 to 5 ft tall.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>July to October</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Leaves and seed</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>Used to cure cough, backache, swelling on feet and hand, childbirth and dysentery.</td>
</tr>
</tbody>
</table>

24. **Botanical Name**  
*Dicliptera bupleuroides* Nees

<table>
<thead>
<tr>
<th>Family</th>
<th>Acanthaceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernacular Name</td>
<td>Roxburgh’s foldwing</td>
</tr>
<tr>
<td>Habit</td>
<td>An erect up to 50 cm tall perennial herb.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>November to June.</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Whole plant</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>It is used to cure cold and cough.</td>
</tr>
</tbody>
</table>

25. **Botanical Name**  
*Dracunculus vulgaris* Schott

<table>
<thead>
<tr>
<th>Family</th>
<th>Araceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernacular Name</td>
<td>Dagon arum and Dragon wort</td>
</tr>
<tr>
<td>Habit</td>
<td>An herb that grow up to 2 m high.</td>
</tr>
</tbody>
</table>
Flowering period  March to May
Part (s) Used  Fruit and tuber
Medicinal Use / Uses  Tubers and the fruits is use for the treatment of rheumatism and hemorrhoids.

Family  Asteraceae
Vernacular Name  Bangua
Habit  It is an herbaceous plant.
Flowering period  June to October
Part (s) Used  Seed and root
Medicinal Use / Uses  Used as a stimulating diuretic in febrile condition.

27. Botanical Name  *Eupatorium adenophorum* Spreng.
Family  Asteraceae
Vernacular Name  Crofton weed and Sticky snakerooot
Habit  It is a perennial herbaceous shrub that may grow to 1 or 2 m.
Flowering period  April to August
Part (s) Used  Leaves
Medicinal Use / Uses  Use to cure wounds and skin diseases.

28. Botanical Name  *Euphorbia esula* L.
Family  Euphorbiaceae
Vernacular Name  Leafy spurge and Dudhila
Habit  It is a herbaceous perennial plant growing to 1-1.2 m tall.
Flowering period  March to August
Part (s) Used  Whole plant
Medicinal Use / Uses  It is grazed by domestic animal.
<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical Name</th>
<th>Scientific Name</th>
<th>Family</th>
<th>Vernacular Name</th>
<th>Habit</th>
<th>Flowering period</th>
<th>Part (s) Used</th>
<th>Medicinal Use / Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.</td>
<td>Botanical Name</td>
<td><em>Euphorbia geniculata</em> Ortega</td>
<td>Euphorbiaceae</td>
<td>Fire plant</td>
<td>An annual herb grows to 60 cm high.</td>
<td>May to June</td>
<td>Leaves and seed</td>
<td>Seeds and small leaves are used in the form of powder given in butter milk in bowel complaint, worm and gonorrhea.</td>
</tr>
<tr>
<td>30.</td>
<td>Botanical Name</td>
<td><em>Euphorbia thymifolia</em> L.</td>
<td>Euphorbiaceae</td>
<td>Lal dudhi</td>
<td>It is annual herb.</td>
<td>June to November</td>
<td>Whole plant</td>
<td>It is used to cures dysentery and spermatorrhoea.</td>
</tr>
<tr>
<td>31.</td>
<td>Botanical Name</td>
<td><em>Flemingia fruticulosa</em> Wallich ex Benth</td>
<td>Fabaceae</td>
<td>Churan</td>
<td>It is an undershrub.</td>
<td>August to October</td>
<td>Leaves and root</td>
<td>Root socked with water and then taken with butter in irregular menstruation.</td>
</tr>
<tr>
<td></td>
<td>Botanical Name</td>
<td>Family</td>
<td>Vernacular Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td><em>Fragaria indica</em> Andrews</td>
<td>Rosaceae</td>
<td>Bhiun kaphal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Habit**
It is evergreen perennial herb growing from 0.1m to 1 m in height.

**Flowering period**
May to October

**Part (s) Used**
Leaves and fruit

**Medicinal Use / Uses**
Leaf juice are given to cure diarrhoea and leucorrhoea. Fruit are also edible by wildlife.

<table>
<thead>
<tr>
<th></th>
<th>Botanical Name</th>
<th>Family</th>
<th>Vernacular Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.</td>
<td><em>Galinsoga parviflora</em> Cav.</td>
<td>Asteraceae</td>
<td>Gallant soldier and Potato weed</td>
</tr>
</tbody>
</table>

**Habit**
It is an annual herbaceous plant that grows up to the height of 75 cm.

**Flowering period**
July to September

**Part (s) Used**
Whole plant

**Medicinal Use / Uses**
It can be used to treat nettle stings and also to treat cuts and wounds.

<table>
<thead>
<tr>
<th></th>
<th>Botanical Name</th>
<th>Family</th>
<th>Vernacular Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.</td>
<td><em>Galium aparine</em> L.</td>
<td>Rubiaceae</td>
<td>Goose grass and Cleaver</td>
</tr>
</tbody>
</table>

**Habit**
It is an annual herb.

**Flowering period**
April to August

**Part (s) Used**
Whole plant

**Medicinal Use / Uses**
Poultries and washes made from it were used to treat a variety of skin ailments, wounds and burns. The leaves and stems of the plant can also be cooked as a leaf
vegetable if gathered before the fruits appear. The fruits of cleavers have often been dried and roasted, and then used as a coffee substitute which contains less caffeine.

35. Botanical Name: *Geranium nepalense* Sweet
   Family: Geraniaceae
   Vernacular Name: Laljari and syuli
   Habit: It is a perennial herb which grows up to the height of 60 cm.
   Flowering period: April to October
   Part (s) Used: Whole plant
   Medicinal Use / Uses: Whole plant is used to cure pain and resolve inflammation. It is used in kidney disease. Due to red colour also used as colouring matter.

36. Botanical Name: *Gnaphalium luteoalbum* L.
   Family: Asteraceae
   Vernacular Name: Jersey Cudweed
   Habit: An annual herb grows 15-45 cm long.
   Flowering period: November to January
   Part (s) Used: Whole plant
   Medicinal Use / Uses: It is used to stop bleeding of wound.

37. Botanical Name: *Gnaphalium polycaulon* Pers.
   Family: Asteraceae
   Vernacular Name: Tiny cudweed and Bukhlu
   Habit: It is small annual herb grows up to 25 cm tall.
   Flowering period: Throughout the year
   Part (s) Used: Whole plant
Chapter IV

Medicinal Use / Uses  
Plant ash mixed with coconut oil is applied on burns.

38. Botanical Name  
*Gypsophila cerastioides* D. Don

Family  
Caryophyllaceae

Vernacular Name  
Bakarchee

Habit  
It is perennial herb.

Flowering period  
May and June

Part (s) Used  
Whole plant

Medicinal Use / Uses  
Used to cure boils, cuts and wounds.

39. Botanical Name  
*Indigofera linifolia* (L. f.) Retz.

Family  
Fabaceae

Vernacular Name  
Ratanjot

Habit  
It is a perennial herb.

Flowering period  
April to June

Part (s) Used  
Whole plant

Medicinal Use / Uses  
Plant is used to cure fever.

40. Botanical Name  
*Lactuca dissecta* D. Don

Family  
Asteraceae

Vernacular Name  
Split leaf lettuce

Habit  
It is an annual herb growing to 40 cm tall.

Flowering period  
April to September

Part (s) Used  
Whole plant

Medicinal Use / Uses  
Used as fodder plant.

41. Botanical Name  
*Lantana camara* L.

Family  
Verbenaceae

Vernacular Name  
Baramasi
Habit
It is a perennial shrub which can grow up to 2 m tall.

Flowering period
March to October.

Part(s) Used
Whole plant

Medicinal Use/Uses
It is used in the treatment of bronchitis and leaves decoction is used in treating constipation. It stalks have been used in the construction of furniture, such as chairs and tables and also used as ornamental plant.

42. Botanical Name
Launaea nudicaulis (L.) Hook. f.

Family
Asteraceae

Vernacular Name
Bold-leaf launaea and Muskani

Habit
It is an herbaceous plant.

Flowering period
April and May

Part(s) Used
Whole plant

Medicinal Use/Uses
It is nutritive, diuretic, stomachic and blood purifier. It is used as antidote for poisoning. Roots relieve jaundice and skin disorders. Leaves and roots are also given in leprosy and leucorrhoea.

43. Botanical Name
Leucas lanata Benth.

Family
Lamiaceae

Vernacular Name
Bis- kapra

Habit
It is a perennial herb growing to 0.4 m.

Flowering period
April to September.

Part(s) Used
Whole plant

Medicinal Use/Uses
The plant juice is used for treatment of headache and stomach-ache. Leaves are made into a paste and applied externally for cuts and wounds. A poultice of leaves is placed on affected area to promote exudation of pus from boils. Young shoots are also used as a vegetable.
44. Botanical Name: *Lycopodium sp.*  
   Family: Lycopodiaceae  
   Vernacular Name: Creeping cedar  
   Habit: Fern  
   Part(s) Used: Whole plant  
   Medicinal Use / Uses: Used for treatment of skin, liver, kidneys and urinary tract, infections, rheumatism, and gout.

45. Botanical Name: *Micromeria biflora* (Buch.-Ham.ex D.Don) Benth.  
   Family: Lamiaceae  
   Vernacular Name: Gorkhapaan and Ban-ajwain  
   Habit: It is 10-30cm tall herb.  
   Flowering period: Throughout year.  
   Part(s) Used: Leaves and root  
   Medicinal Use / Uses: The flowers and leaves are used as a tea. A powder of the dried flowers and leaves is used as flavoring in lentil soups and curries. The plant is also burnt as incense.

46. Botanical Name: *Nepeta ciliaris* Benth.  
   Family: Lamiaceae  
   Vernacular Name: White Leaved Catmint and Nueet  
   Habit: An annual or perennial herb.  
   Flowering period: April to September  
   Part(s) Used: Leaves and seed  
   Medicinal Use / Uses: Decoction of leaves and seed is given in fever. Leaves also yield essential oil.
47. Botanical Name: *Origanum vulgare* L.  
Family: Lamiaceae  
Vernacular Name: Bantulsi  
Habit: It is a perennial herb growing to 0.6 m to 0.8 m tall.  
Flowering period: July to September  
Part (s) Used: Whole plant  
Medicinal Use / Uses: Plant extract used in bronchitis, colic and diarrhoea. Leaves are also eaten and used as flavoring agent.

48. Botanical Name: *Oxalis acerosella* L.  
Family: Oxalidaceae  
Vernacular Name: Common wood sorrel  
Habit: A perennial herb growing to 0.1m to 0.3m in height.  
Flowering period: April to May  
Part (s) Used: Leaves  
Medicinal Use / Uses: The leaves are crushed and applied locally to dispel boils and abscesses, they also have an astringent affect on wounds. The acidic leaves are eaten.

49. Botanical Name: *Oxalis corniculata* L.  
Family: Oxalidaceae  
Vernacular Name: India sorrel and Khatti-buti  
Habit: A perennial herb growing to 0.1m to 0.3m in height.  
Flowering period: June to September  
Part (s) Used: Leaves  
Medicinal Use / Uses: The leaves are used as an antidote to poisoning by the seeds of Datura, arsenic and mercury. The leaf juice is applied to insect bites, burns and skin eruptions. The acidic leaves are also eaten as salad or as spinach.
<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Vernacular Name</th>
<th>Habit</th>
<th>Flowering period</th>
<th>Part(s) Used</th>
<th>Medicinal Use / Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.</td>
<td>Parthenium hysterophorus L.</td>
<td>Asteraceae</td>
<td>Congress grass and Gajar ghans</td>
<td>An annual herb and grows up to 1 m in length</td>
<td>March to October</td>
<td>Whole plant</td>
<td>Used in traditional medicine to treat fever, diarrhoea, neurologic disorders, urinary tract infections, dysentery, malaria and as remedy for inflammation, eczema, skin rashes, herpes, rheumatic pain, cold, heart trouble and gynecological ailments. Removal of heavy metals and dye from the environment, eradication of aquatic weeds, also use as substrate for commercial enzyme production, additive in cattle manure for biogas production, as biopesticide, as green manure and compost.</td>
</tr>
<tr>
<td>51.</td>
<td>Paspalum distichum L.</td>
<td>Poaceae</td>
<td>Knotgrass</td>
<td>It is a perennial grass reaches up to the height of 60 cm.</td>
<td></td>
<td>Whole plant</td>
<td>It is good fodder grass.</td>
</tr>
<tr>
<td>52.</td>
<td>Perilla fraternus (L.) Britt.</td>
<td>Lamiaceae</td>
<td>Beefsteak plant</td>
<td>An annual herb grows to 0.6m in height.</td>
<td>July to August</td>
<td>Whole plant</td>
<td></td>
</tr>
</tbody>
</table>
Medicinal Use / Uses  The leaves are used in the treatment of colds, chest stuffiness, vomiting, and abdominal pain. It is also grown as ornamental plant.

53.  Botanical Name  *Phyllanthus fraternus* Webster  
Family  Euphorbiaceae  
Vernacular Name  Gulf leaf-flower  
Habit  The plant is annual having the length of 20-50 cm.  
Part (s) Used  Whole plant  
Medicinal Use / Uses  Used for the treatment of various ailments such as flu, dropsy, diabetes and jaundice.

54.  Botanical Name  *Pimpinella diversifolia* DC.  
Family  Apiaceae  
Vernacular Name  Teroi  
Habit  A small herb up to 1 m tall.  
Flowering period  August to September  
Part (s) Used  Whole plant  
Medicinal Use / Uses  Plant extract given in digestive disorder as well as cold and cough. Fresh leaves and twigs are also used in chutneys and curries to improve taste and as a carminative agent.

55.  Botanical Name  *Plantago major* L.  
Family  Plantaginaceae  
Vernacular Name  Broadleaf plantain  
Habit  It is an herbaceous perennial plant with a rosette of leaves 15–30 cm in diameter.  
Flowering period  May to September
<table>
<thead>
<tr>
<th>Part(s) Used</th>
<th>Leaves, seed and flower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicinal Use / Uses</td>
<td>Adding fresh seeds or flower heads to a tea will act as an effective lubricating and bulking laxative and soothes sore throats. The leaves are also edible as a salad when young and tender.</td>
</tr>
</tbody>
</table>

**56. Botanical Name**  
*Polygonatum capitatum* Buch.-Ham. Ex Don.

**Family**  
Polygonaceae

**Vernacular Name**  
Pinkhead smartweed

**Habit**  
A perennial herb with stems up to 20 inches (50 cm) long

**Flowering period**  
Throughout the year

**Part(s) Used**  
Whole plant

**Medicinal Use / Uses**  
It is used to cure sore throat and ulcer, dysentery, wound with blood stasis and swelling.

**57. Botanical Name**  
*Pouzolzia hirta* (Blume) Hassk.

**Family**  
Urticaceae

**Habit**  
It is an annual or perennial herb growing up to 75 cm tall.

**Flowering period**  
May to September

**Part(s) Used**  
Whole plant

**Medicinal Use / Uses**  
They are used to treat boils and abscesses, abdominal cramps in females and leucorrhoea. They are also used to treat bone dislocations and fractures. An infusion of the whole plant is drunk by children suffering from atrophy and indigestion. Fiber from the bark is also used for making string.

**58. Botanical Name**  
*Prinsepia utilis* Royle.

**Family**  
Rosaceae
<table>
<thead>
<tr>
<th>Vernacular Name</th>
<th>Himalayan cherry prinsepia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>It is a shrub growing to 3.5 m by 3 m.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>February</td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Seed</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>The oil is also applied to the forehead and temples in the treatment of coughs and colds. Also used to cure rheumatic pain, diarrhoea, pile and stomach disorders. An edible oil is obtained from the seed, it is used in cooking.</td>
</tr>
</tbody>
</table>

59. Botanical Name  
Prunella vulgaris L.  
Family  
Lamiaceae  
Vernacular Name  
Common self-heal  
Habit  
It is herb that grows up to 5 cm to 30 cm high.  
Flowering period  
June to August  
Part (s) Used  
Whole plant  
Medicinal Use / Uses  
A poultice of the plant is applied to irritated skin, as a disinfecting agent and to pack wounds in the absence of other wound-care material. It is edible and can be used in salads, soups and stews. |

60. Botanical Name  
Reinwardtia indica Dumort  
Family  
Linaceae  
Vernacular Name  
Yellow flax  
Habit  
It is shrub grows to 3 feet.  
Flowering period  
October to April  
Part (s) Used  
Whole plant  
Medicinal Use / Uses  
It is used as mouth wash and also as an ornamental plant.
<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Vernacular Name</th>
<th>Habit</th>
<th>Flowering period</th>
<th>Part(s) Used</th>
<th>Medicinal Use / Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>Reinwardtia trigyna</td>
<td>Linaceae</td>
<td>Basant and Pyuli</td>
<td>Shrub up to 1 m tall.</td>
<td>February to May.</td>
<td>Leaves, stem and root</td>
<td>The plants are used for the treatment of paralysis. Crushed leaves and stems are applied to wounds.</td>
</tr>
<tr>
<td>62</td>
<td>Rosa macrophylla</td>
<td>Rosaceae</td>
<td>Himalayan rose and Ban gulab</td>
<td>A shrub 8 to 12 ft high.</td>
<td>June to July</td>
<td>Flower</td>
<td>Fresh juice flower is dropped in earache and also useful in cold and cough.</td>
</tr>
<tr>
<td>63</td>
<td>Rubus ellipticus</td>
<td>Rosaceae</td>
<td>Hisalu</td>
<td>It is a perennial shrub.</td>
<td>December- May</td>
<td>Root and fruit</td>
<td>Root paste is applied on ulcer and skin infection. Ripe fruit is also eaten.</td>
</tr>
<tr>
<td>64</td>
<td>Rumex hastatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family</td>
<td>Polygonaceae</td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vernacular Name</td>
<td>Bhilmora</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habit</td>
<td>Rumex is common perennial herb.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowering period</td>
<td>June to October</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part (s) Used</td>
<td>Whole Plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>Leaves juice is given in abdominal colic. The leaf extract of plant are applied on wounds and cuts to check bleeding. Plant is also believed to relieve from suffering of nettle sting. Root is laxative alternative, tonic, and can be used in skin disease. Leaves are also used as salad and in making chutney.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

65. **Botanical Name** | *Stellaria media* (L.) Vill. |
| **Family** | Caryophyllaceae |
| **Vernacular Name** | Chickweed |
| **Habit** | An annual herb growing to 0.1 m. |
| **Flowering period** | May to October |
| **Part (s) Used** | Whole plant |
| **Medicinal Use / Uses** | It has been used as a remedy to treat itchy skin conditions and pulmonary diseases. A poultice of chickweed can be applied to cuts, burns and bruises. |

66. **Botanical Name** | *Swertia angustifolia* Buch.-Ham. ex D. Don |
| **Family** | Gentianaceae |
| **Vernacular Name** | Narrow leaved swertia |
| **Habit** | An annual herb ranging from 2.4 cm. to 1.5 m in height. |
| **Flowering period** | July to November |
| **Part (s) Used** | Whole plant |
| **Medicinal Use / Uses** | Plant is crushed and boiled in water and two teaspoonful |
decoctions is given to treat malaria fever 2-3 times a day; root juice is also taken to give relief from cold and cough.

67. **Botanical Name** *Tagetes erecta* L.
   
   **Family** Asteraceae
   
   **Vernacular Name** Mexican marigold and Hazari
   
   **Habit** An annual herb growing to 1 m tall.
   
   **Flowering period** July
   
   **Part (s) Used** Leaves and flower
   
   **Medicinal Use / Uses** It is used as a skin wash and paste of leaves is applied on cuts. The dried flower petals, ground to a powder, may be used in poultry feed to ensure a good colouration of egg yolks and broiler skin.

68. **Botanical Name** *Taraxacum officinale* Weber.
   
   **Family** Asteraceae
   
   **Vernacular Name** Dandelion
   
   **Habit** A perennial herb that grows up to 5 to 40 cm tall.
   
   **Flowering period** May to April
   
   **Part (s) Used** Whole plant
   
   **Medicinal Use / Uses** It has been used in herbal medicine to treat infections, bile and liver problems. The leaves are used as salad and also boiled to be consumed as a vegetable. The flowers are also used to make dandelion wine and the roots have been used to make a coffee substitute.

69. **Botanical Name** *Thalictrum foliolosum* DC.
   
   **Family** Ranunculaceae
   
   **Vernacular Name** Gold thread Root, Leafy Meadow-Rue and Pilijari
### Habit
It is a perennial herb.

### Part(s) Used
Whole Plant

### Medicinal Use / Uses
Useful in improving eye sight, in asthma, diabetes, relieves cough and Cold. Also used to cure digestive problems, skin diseases and fever.

#### 70. Botanical Name
*Trigonella foenum-graecum* L.

#### Family
Fabaceae

#### Vernacular Name
Methi and Mutti

#### Habit
An annual herb growing to 0.6 m in height.

#### Flowering period
June to August

#### Part(s) Used
Leaves and seed

#### Medicinal Use / Uses
Boiled seeds in milk and filter it, after filtration 2-4 drop of milk is put in ear disease. Seed and leaves are used either raw or cooked.

#### 71. Botanical Name
*Urtica dioica* L.

#### Family
Urticaceae

#### Vernacular Name
Bichu ghass and Sisna

#### Habit
It is a perennial herb grows to 30-150 cm tall.

#### Flowering period
July to September

#### Part(s) Used
Leaves, seed and root

#### Medicinal Use / Uses
It is useful in rheumatism, skin ailments, hair-wash for avoiding baldness and boils. Young leaves as a good source of iron used as spinach substitute and eaten cooked and also used to make tea.

#### 72. Botanical Name
*Varbascum thapsus* L.
<table>
<thead>
<tr>
<th>Family</th>
<th>Scrophulariaceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernacular Name</td>
<td>Great mullein, Common mullein and Ikelbir</td>
</tr>
<tr>
<td>Habit</td>
<td>It is a biennial plant that can grow up to 2 m.</td>
</tr>
<tr>
<td>Flowering period</td>
<td>June to September</td>
</tr>
<tr>
<td>Part(s) Used</td>
<td>Whole plant</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>As a remedy for skin, throat and breathing ailments. Leaf paste is rubbed on chest to relieve pain due to cold. Inflorescence smokes used in bronchitis. The boiled leaves are used as tea as a remedy for cough, diarrhoea, asthma, ulcers, tumors and piles. It is also used in dyeing and making torches.</td>
</tr>
</tbody>
</table>

73. Botanical Name | Vernonia cinera Less. |
| Family            | Asteraceae             |
| Vernacular Name   | Kalgira and Sahadevi   |
| Habit             | An annual herb grows to 1.3 m tall. |
| Flowering period  | Throughout year        |
| Part(s) Used      | Whole plant            |
| Medicinal Use / Uses | It is used in dysentery, cold and cough. |

74. Botanical Name | Viola serpens Wall. Ex Roxb. |
| Family            | Violaceae               |
| Vernacular Name   | Gul- banafsha           |
| Habit             | It is an herbaceous plant. |
| Part(s) Used      | Whole plant             |
| Medicinal Use / Uses | Useful in curing asthma, bleeding piles and constipation. |

75. Botanical Name | Xanthium indicum J. Koenig |
| Family            | Asteraceae               |
| Vernacular Name   | Burweed                 |
Habit: An annual herb that grows up to a height of 1 m.

Flowering period: Throughout the year

Part(s) Used: Leaves and stem

Medicinal Use / Uses: To control sugar in diabetic patients and for treatment of rheumatic pain. Leaf sap is dropped into eyes to cure conjunctivitis.

76. Botanical Name: *Youngia japonica* (L.) DC

Family: Asteraceae

Vernacular Name: Oriental Hawksbeard

Habit: It is a biennial herb growing to 0.6 m.

Flowering period: February to May

Part(s) Used: Whole plant

Medicinal Use / Uses: It is used in the treatment of boils and snakebites. It also used to reduce inflammation. Young plant and leaves are also eaten raw or cooked.

![Graph showing the distribution of families, genera, and species used for ethnobotanical purposes.](image-url)
Fig. 4.77 Families of Herb Species Used for Ethnobotanical Purposes of Herb Species
4.8.2 Ethnobotany of Tree species

A total of 17 ethnobotanical important tree species belonging to 17 genera and 13 families were reported (fig. 4.81). The most privileged family used for different purposes was Rosaceae (3 species), Fabaceae (2 species), and Pinaceae (2 species) (fig. 4.82). Although all plant parts were used in various forms. Fig. 4.83 shows that whole plant (47.06 %), leaves (35.29 %), bark (23.53 %) and fruit (17.65 %) were frequently used.

1. **Botanical Name**  
   Aesculus indica Colebr. ex (Cambess) Hook
   **Family**  
   Sapindaceae
   **Vernacular Name**  
   Indian horse chestnut and Ban akhrot
   **Habit**  
   An attractive tree growing to about 30 meters
   **Flowering Period**  
   June to July
   **Part(s) Used**  
   Leaves and seed
   **Medicinal Use / Uses**  
   Used for the treatment of some skin diseases,
rheumatism and in the relief of headaches. Its leaves are used as cattle fodder. Its seeds are dried and ground into bitter flour, called *tattawakher* used with wheat flour to make chappatis and also served as a *dalia* during fasting periods.

2. **Botanical Name**: Cedrus deodara Roxb. Ex D. Don  
**Family**: Pinaceae  
**Vernacular Name**: Deodar  
**Habit**: An evergreen tree growing to 33 m  
**Flowering Period**: October and November  
**Part(s) Used**: Whole plant  
**Medicinal Use / Uses**: A decoction of the wood is used in the treatment of fevers, flatulence, pulmonary and urinary disorders, rheumatism, piles, kidney stones, insomnia, diabetes etc. It can also be used in shelterbelt plantings. Wood is used for construction, furniture, boats etc.

3. **Botanical Name**: Celtis australis L.  
**Family**: Cannabaceae  
**Vernacular Name**: European nettle tree and Kharik  
**Habit**: The tree can grow to 25 m in height, though 10 m is more common in cooler climates.  
**Flowering Period**: March and April  
**Part(s) Used**: Whole plant  
**Medicinal Use / Uses**: The decoction can be used in the treatment of diarrhoea, dysentery, colic and peptic ulcers. It is planted as an ornamental tree as it is resistant to
air pollution. The fruit is sweet and edible and can be eaten raw or cooked. A yellow dye is obtained from the bark. The wood is very tough, pliable, durable and widely used by turners; the flexible thin shoots are used as walking sticks.

4. **Botanical Name** Cupressus torulosa D.Don  
   **Family** Cupressaceae  
   **Vernacular Name** Himalayan cypress and Surai  
   **Habit** It is an evergreen conifer tree growing to 40m.  
   **Flowering Period** March and April  
   **Part (s) Used** Whole plant  
   **Medicinal Use / Uses** Used as timber and incense. It is also planted as an ornamental plant.

5. **Botanical Name** Eriobotrya japonica (Thunb.) Lindl.  
   **Family** Rosaceae  
   **Vernacular Name** Chinese plum and Loquat  
   **Habit** It is a large evergreen shrub or small tree can grow to 5–10 m.  
   **Flowering Period** October to November  
   **Part (s) Used** Fruit  
   **Medicinal Use / Uses** Used for soothing the throat and is a popular ingredient for cough drops. It is eaten as a fresh fruit and mixes well with other fruits in fresh fruit salads or fruit cups. The fruits are also commonly used to make jam, jelly, and chutney.

6. **Botanical Name** Ficus palmata Forssk.
<table>
<thead>
<tr>
<th>Family</th>
<th>Moraceae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vernacular Name</td>
<td>Wild fig and Bedu</td>
</tr>
<tr>
<td>Habit</td>
<td>A deciduous, moderate-sized tree, 6 to 10 metres in height</td>
</tr>
<tr>
<td>Flowering Period</td>
<td>March and April</td>
</tr>
<tr>
<td>Part(s) Used</td>
<td>Fruit</td>
</tr>
<tr>
<td>Medicinal Use/Uses</td>
<td>They are used in constipation and in the diseases of the lungs and the bladder. They are also used as a poultice. Fruit is eaten raw or cooked.</td>
</tr>
</tbody>
</table>

7. Botanical Name: *Grevillea robusta* A.Cunn. ex R.Br.
   - Family: Proteaceae
   - Vernacular Name: Silver oak
   - Habit: It is a deciduous medium-sized to large tree 12-25 m tall.
   - Flowering Period: October and November
   - Part(s) Used: Whole plant
   - Medicinal Use/Uses: Used to treat sore throats, earache, chest problems, flu and toothache. It is grown as ornamental tree. The cut leaves are used in flower arrangement. It has been used in the manufacture of furniture, cabinetry, and fences.

8. Botanical Name: *Grewia oppositifolia* Roxb. ex DC.
   - Family: Tiliaceae
   - Vernacular Name: Bhimal
   - Habit: It is a tree.
   - Flowering Period: April and June
   - Part(s) Used: Leaves, Seed and Bark
Medicinal Use / Uses

Use to cure eruption, fever, veterinary and bone fracture as splinter. Also used as Fodder, Fiber and Fuel.

   - Family: Myricaceae
   - Vernacular Name: Bayberry and Kaphal
   - Habit: It is a small tree or large shrub 20 to 25 ft.
   - Flowering Period: August and October
   - Part(s) Used: Bark
   - Medicinal Use / Uses: It is used to treat wound, toothache, joint pain, headache and improving digestive system. Its fruit are eaten and it is also used as fuel and timber.

    - Family: Pinaceae
    - Vernacular Name: Pine and Chir
    - Habit: It is a large evergreen tree reaching up to 30–50 m.
    - Flowering Period: February and April
    - Part(s) Used: Whole plant
    - Medicinal Use / Uses: It is used to cure measles. It is used as fuel wood, roof thatching, fodder, small broom and timber. Their raisins are used to extract turpentine which have various importances.

11. Botanical Name: *Populus ciliate* Wall. ex Royle
    - Family: Salicaceae
<table>
<thead>
<tr>
<th>Vernacular Name</th>
<th>Himalayan poplar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>It is a large deciduous tree.</td>
</tr>
<tr>
<td>Part(s) Used</td>
<td>Whole plant</td>
</tr>
<tr>
<td>Medicinal Use / Uses</td>
<td>The paste of the bark when mixed with the ash of cow dung can be used to treat muscular swellings. It is used to feed livestock during the times of food shortage and also as fuel wood and also used for making boxes for packing purposes, poles, trucks, barrow-trays, coaches, furniture and cross-beams.</td>
</tr>
</tbody>
</table>

12. **Botanical Name** | *Prunus cerasoides* D.Don.  
**Family** | Rosaceae  
**Vernacular Name** | Himalayan flowering cherry and Payain  
**Habit** | It is a large deciduous tree growing to 30 m tall.  
**Flowering Period** | April  
**Part(s) Used** | Leaves, fruit and bark  
**Medicinal Use / Uses** | The juice of the bark is applied externally to treat backaches. Fruit are used either raw or cooked. A green dye can also be obtained from the leaves. |

13. **Botanical Name** | *Pyrus pashia* Buch.-Ham. ex D.Don  
**Family** | Rosaceae  
**Vernacular Name** | Wild Himalayan pear and Mehal  
**Habit** | It is small to medium sized deciduous tree.  
**Flowering Period** | February and April  
**Part(s) Used** | Leaves  
**Medicinal Use / Uses** | Use to treat eye and digestive problem and its fruit is edible. |
14. **Botanical Name**: *Quercus leucotrichphora* A. Camus  
**Family**: Fabaceae  
**Vernacular Name**: Oak and Banj  
**Habit**: It is an evergreen tree.  
**Flowering Period**: April and May  
**Part(s) Used**: Whole plant  
**Medicinal Use / Uses**: It is used for fodder, fuel and wood for building purposes.

15. **Botanical Name**: *Rhododendron arboreum* Sm.  
**Family**: Ericaceae  
**Vernacular Name**: Burans  
**Habit**: It is a tree of heights up to 20 m.  
**Flowering Period**: March and May  
**Part(s) Used**: Flower, leaves and bark  
**Medicinal Use / Uses**: It is effective in diarrhoea, cold, headache and dysentery. Flowers are used to prepare juice, sauce, jam, jellies and refreshing drinks.

16. **Botanical Name**: *Toona hexandra* M.Roem.  
**Family**: Meliaceae  
**Vernacular Name**: Toon and Tuni  
**Habit**: It is a tree.  
**Flowering Period**: March and April  
**Part(s) Used**: Whole plant  
**Medicinal Use / Uses**: Its decoction is given orally in malarial fever. It can also be used as timber and fodder.

17. **Botanical Name**: *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.
Family: Fabaceae
Vernacular Name: Babul and Kikar
Habit: It is a tree 5 to 20 m high.
Part(s) Used: Leaves and stem
Medicinal Use/Uses: The tender twig of this plant is used as a toothbrush. It is used as forage, fodder, hedge and in making tool handles and lumber for boats.

Fig. 4.79 Total number of Families, Genera and Species of Tree Vegetation Used for Ethnobotanical Purposes
Fig. 4.80 Families of Tree Species Used for Ethnobotanical Purpose

Fig. 4.81 Percentage of Plant Part(s) of Tree Species Used for Ethnobotanical Purpose
Plate 4.13 *Acanthospermum hispidium*

Plate 4.14 *Ageratum conyzoides*

Plate 4.15 *Anaphalis margaritacea*

Plate 4.16 *Argemone Mexicana*
Plate 4.17 *Barleria auriculata*

Plate 4.18 *Bidens biternata*

Plate 4.19 *Bidens pilosa*

Plate 4.20 *Boenninghausenia albiflora*
Plate 4.21 Cannabis sativa

Plate 4.22 Capsella bursa-pastoris

Plate 4.23 Cassia tora

Plate 4.24 Colebrookea oppositifolia
Plate 4.25 Cynoglossum lanceolatum

Plate 4.26 Datura stramonium

Plate 4.27 Erigeron asteroides

Plate 4.28 Eupatorium adenophorum
Plate 4.29 *Euphorbia esula*

Plate 4.30 *Euphorbia thymifolia*

Plate 4.31 *Galinsoga parviflora*

Plate 4.32 *Galium aparine*
Plate 4.37 *Origanum vulgare*

Plate 4.38 *Oxalis acetosella*

Plate 4.39 *Parthenium hysterophorus*

Plate 4.40 *Paspalum distichum*
Plate 4.41 *Polygonatum capitatum*  

Plate 4.42 *Rosa macrophylla*  

Plate 4.43 *Rubus ellipticus*  

Plate 4.44 *Rumex hastatus*
Plate 4.45 *Stellaria media*

Plate 4.46 *Tagetes erecta*

Plate 4.47 *Taraxacum officinale*

Plate 4.48 *Thalictrum foliolosum*
Plate 4.49 *Trigonella foenum-graecum*  
Plate 4.50 *Urtica dioica*

Plate 4.51 *Varbascum Thapsus*  
Plate 4.52 *Youngia japonica*
Estelar
Plate 4.53 *Cedrus deodara*

Plate 4.54 *Cupressus torulosa*

Plate 4.55 *Eriobotrya japonica*

Plate 4.56 *Ficus palmate*
Plate 4.57  *Grevillea robusta*

Plate 4.58  *Myrica esculenta*

Plate 4.59  *Pinus roxburghii*

Plate 4.60  *Populus ciliate*
Plate 4.61 *Quercus leucotrichophora*  
Plate 4.62 *Rhododendron arboretum*  
Plate 4.63 *Toona hexandra*
Estelar