CHAPTER 11

SITE DESCRIPTION, CLIMATE AND SOIL
Location and Topography

The present study deals with the "Ecological studies of two herbaceous species around Orai (Jalaun) in Bundelkhand region". The above study is confined to a grassland community situated in the premises of Bohadpura Sheep Farm, Orai at lat. 25°59' N, long 79°37' E, and is about 141.61 meters above mean sea level in northern part of the Bundelkhand region. The study site is at a distance of about five km towards north west of Orai, District Jalaun, U.P. (Fig. 2.1).

Bundelkhand is suitable for good growth of grasses and has a central position in the country. The site for investigation is a part of land bounded by Yamuna river in north, Betwa river in south and Madhya Pradesh State in the West.

Two species of Alysicarpus i.e. A. monilifer DC.(Plate-I) and A. rugosus DC.(Plate-II) were selected for present study because these two species were common in the grasslands of Orai (Jalaun).

Besides southern marginal area, the topography of this region is of undulating type. Trans-Yamuna plain is another name of Bundelkhand plain, which is topographically divisible into three east-west running belts i.e. Southern, Northern and Central belts.
Fig. 2.1: Map showing the location of study site.
PLATE - I: Showing *Alysicarpus monilifer*.
PLATE - II : Showing Alysicarpus rugosus.
Orai is located in Northern belt and confined along the bank of the river Yamuna in the form of high ground which represents the level of ancient flood plain but at present is badly cut into ravines.

**Lithology**

Sand stones, lime stones and shales are the common rocks. The special features of immense geographical interest in this region are quartz, reefs and dolarite dykes which are long and narrow with serrated ridges. The geological system is covered in the north west and north east by Ganga-Yamuna alluvial deposits in the form of an ‘embayment’.

**Natural Vegetation**

The region is ecologically degraded and the original vegetation has almost been removed for inhabitation and cultivation. Shrubs and grasses represent the secondary growth throughout the region. Babul is the principal type of Acacia. Khair is the common tree but not much utilized. Hingota, Karondha and Kareel are mostly utilized for grazing.

*Albizia procera* (Siris), *Anogeissus pendula* (Dhawana), *Tectona grandis* (Teak), *Butea monosperma* (Dhak), *Salmalia malabarica* (Semal), *Boswellia serrata* (Salai), *Dalbergia sissoo* (Shisham), *Acacia catechu* (Khair), *A. neolotica* (Babool), *Zizyphus mauritian* (Bair), *Carissa carandas* (Karondha), *Capparis*
aphylla (kareel), Balanites aegyptica (Hingota), Albizzia lebbek (Black Siris) are the main contributors in the natural vegetation of this region.

**Climate**

The climate of Bundelkhand Region is typically dry sub-humid and has a distinct seasonality. It is characterised by three seasons.

(i) Rainy season: (July to October) It is warm and wet.

(ii) Winter season: (November to February) It is cool and dry.

(iii) Summer season: (March to June) It is hot and dry.

The climatic records of Orai are summarized in Table 2.1 and depicted in Fig. 2.2A.

The summer season is dry and hot with scorching sun and strong westerly winds during the days. Maximum temperature rises up to 41.02°C. The amount of rainfall in summer is usually low i.e. 229.3 mm accounting for about 24.34% of the total annual precipitation. The relative humidity in summer ranged between 25.3 to 66.6%.

The summer is followed by the warm and humid rainy season of about 4 months (i.e. July-October). Monsoon brings rain by the end of the June. The rainy season receives most of the
**Table 2.1:** Climatic records at Orai (2002-2003)

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature</th>
<th>% Relative humidity</th>
<th>Wind velocity km/hr</th>
<th>Rainfall monthly (mm)</th>
<th>Solar radiation K cal/m² x 10⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean max.</td>
<td>Mean min.</td>
<td>Mean morn.</td>
<td>Mean evening</td>
<td>Mean month</td>
</tr>
<tr>
<td>July</td>
<td>34.82</td>
<td>22.93</td>
<td>28.87</td>
<td>69.16</td>
<td>64.71</td>
</tr>
<tr>
<td>August</td>
<td>36.16</td>
<td>22.90</td>
<td>29.06</td>
<td>62.48</td>
<td>58.03</td>
</tr>
<tr>
<td>September</td>
<td>37.30</td>
<td>21.78</td>
<td>29.50</td>
<td>53.90</td>
<td>35.40</td>
</tr>
<tr>
<td>October</td>
<td>34.94</td>
<td>18.31</td>
<td>26.62</td>
<td>49.70</td>
<td>39.58</td>
</tr>
<tr>
<td>November</td>
<td>30.96</td>
<td>16.70</td>
<td>23.83</td>
<td>57.13</td>
<td>50.13</td>
</tr>
<tr>
<td>December</td>
<td>25.27</td>
<td>8.51</td>
<td>16.89</td>
<td>54.70</td>
<td>50.20</td>
</tr>
<tr>
<td>January</td>
<td>22.50</td>
<td>6.07</td>
<td>14.28</td>
<td>54.30</td>
<td>40.90</td>
</tr>
<tr>
<td>February</td>
<td>26.24</td>
<td>7.36</td>
<td>16.80</td>
<td>49.90</td>
<td>34.80</td>
</tr>
<tr>
<td>March</td>
<td>33.20</td>
<td>13.27</td>
<td>23.23</td>
<td>44.70</td>
<td>43.00</td>
</tr>
<tr>
<td>April</td>
<td>40.99</td>
<td>21.30</td>
<td>31.14</td>
<td>39.50</td>
<td>31.10</td>
</tr>
<tr>
<td>May</td>
<td>41.02</td>
<td>25.86</td>
<td>33.44</td>
<td>22.10</td>
<td>22.90</td>
</tr>
<tr>
<td>June</td>
<td>39.86</td>
<td>24.55</td>
<td>32.20</td>
<td>61.56</td>
<td>52.33</td>
</tr>
</tbody>
</table>
rainfall (about 67.2% of the annual) resulting into a fall of atmospheric temperature to an average of 28.52°C. This is the season of maximum growth of the plant and biological activities. The average relative humidity during the season ranged between a minimum of 44.46% to a maximum of 66.95%.

The rainy season is followed by the winter season extending from November to February. The temperature begins to fall from early November and the coldest months are December and January. Days are sunny, bright and cool and nights are quite cold with minimum temperature going occasionally down to 6.07°C. The ground surface gets some moisture by dew formation early in the morning. The season is relatively dry with occasional sporadic showers in the month of January. Precipitation in winter is about 79.2mm i.e. nearly 8.41% of the total annual rainfall and the average relative humidity ranged between 42.35 to 53.63%. The total annual precipitation (i.e. from July, 2002 to June, 2003) was 941.7mm.

Gaussen (1960) has shown the effectiveness of the climatic factors like rainfall, monthly temperature and dry period during a year by means of Ombrothermic diagram. The same is depicted in Fig. 2.2B for the better understanding of the climatic factors. It is evident from this that an average, 8 month (i.e. November-June) were xeric during the study year when the thermic
**Fig. 2.2A: Climatic Condition of Orai (2002-2003)**

**Fig. 2.2B: Ombrothermal Diagram of Orai**
curve remained above the Ombric curve. Rest of the months were wet and heavy rains were recorded mostly from last part of June to September.

**Water Balance Computation**

Water is a basic need of all organisms. In nature it exists in three different physical forms. The major sinks are ocean, ice caps of the mountain and poles, underground, lakes, rivers etc. Precipitation imparts a small fraction of it which keeps the land surface moist. Water supply on land, its utilization by living organisms and ultimate return to major storage pools keep on operating in nature through the hydrological cycle. A systematic analysis of this income and expenditure of water in any particular region known as "Water balance computation" lies in the moisture content of the soil which supports vegetation growing over it.

Following the method of Thornthwait and Mather (1955) the water balance computation sheet of the study area for the year July, 2002- June, 2003 has been prepared (Table 2.2). Fig. 2.3 shows the water balance computation graph which has been drawn with the help of average precipitation, potential evapotranspiration and actual evapotranspiration increase with an increase in the atmospheric temperature and decrease with increasing the relative humidity of the region. Actual evapotranspiration is governed by the
Fig. 2.3: Water Balance Computation for Orai (2002-2003)
Table 2.2: Water balance computation at Orai (2002-2003)

Lat. N 25°59' 30" Long. E 79°3' 30" at 141.61 m a.m.s.l.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T°C</td>
<td>28.87</td>
<td>29.06</td>
<td>29.54</td>
<td>26.62</td>
<td>23.83</td>
<td>16.89</td>
<td>14.28</td>
<td>16.80</td>
<td>23.23</td>
<td>31.14</td>
<td>33.44</td>
<td>32.20</td>
<td></td>
</tr>
<tr>
<td>UPE</td>
<td>15.45</td>
<td>15.61</td>
<td>15.89</td>
<td>13.59</td>
<td>9.00</td>
<td>21.00</td>
<td>-</td>
<td>21.00</td>
<td>79.00</td>
<td>16.85</td>
<td>17.88</td>
<td>17.39</td>
<td></td>
</tr>
<tr>
<td>P E</td>
<td>180.7</td>
<td>174.8</td>
<td>162.0</td>
<td>134.54</td>
<td>81.9</td>
<td>19.11</td>
<td>-</td>
<td>18.69</td>
<td>81.37</td>
<td>178.6</td>
<td>205.6</td>
<td>198.2</td>
<td>1435.42</td>
</tr>
<tr>
<td>P (mm)</td>
<td>371.2</td>
<td>136.4</td>
<td>115.2</td>
<td>10.4</td>
<td>62.1</td>
<td>11.8</td>
<td>5.3</td>
<td>0.00</td>
<td>1.8</td>
<td>-</td>
<td>33.0</td>
<td>194.5</td>
<td>941.7</td>
</tr>
<tr>
<td>P-PE=Δ</td>
<td>190.5</td>
<td>-38.4</td>
<td>-46.8</td>
<td>-124.1</td>
<td>-19.8</td>
<td>-7.3</td>
<td>5.3</td>
<td>-186.9</td>
<td>-9.5</td>
<td>-178.6</td>
<td>-172.6</td>
<td>-3.7</td>
<td></td>
</tr>
<tr>
<td>Σ Δ</td>
<td>190.5</td>
<td>-38.4</td>
<td>-85.2</td>
<td>-209.3</td>
<td>-229.1</td>
<td>-236.4</td>
<td>5.3</td>
<td>-186.9</td>
<td>-1.964</td>
<td>-375.0</td>
<td>547.6</td>
<td>551.3</td>
<td></td>
</tr>
<tr>
<td>St</td>
<td>237.5</td>
<td>264.0</td>
<td>225.0</td>
<td>149.0</td>
<td>139.0</td>
<td>136.0</td>
<td>141.3</td>
<td>160.0</td>
<td>155.0</td>
<td>85.0</td>
<td>47.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>ΔSt</td>
<td>190.5</td>
<td>26.5</td>
<td>-39.0</td>
<td>-76.0</td>
<td>-10.0</td>
<td>-3.0</td>
<td>5.3</td>
<td>18.7</td>
<td>-5.0</td>
<td>-70.0</td>
<td>-38.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>AE</td>
<td>180.7</td>
<td>162.9</td>
<td>154.2</td>
<td>86.4</td>
<td>72.1</td>
<td>14.8</td>
<td>-</td>
<td>18.69</td>
<td>6.8</td>
<td>70.0</td>
<td>71.0</td>
<td>194.5</td>
<td></td>
</tr>
<tr>
<td>W D</td>
<td>-</td>
<td>11.9</td>
<td>7.8</td>
<td>48.14</td>
<td>9.8</td>
<td>4.31</td>
<td>-</td>
<td>-</td>
<td>74.57</td>
<td>108.6</td>
<td>134.6</td>
<td>3.7</td>
<td>403.42</td>
</tr>
<tr>
<td>W S</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>R O</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

T°C = Mean monthly temperature
i = Heat index
UPE = Unadjusted potential evapotranspiration
PE = Potential evapotranspiration
AE = Actual evapotranspiration
P = Mean monthly precipitation

Σ Δ = Summation data (Potential water loss)
St = Storage
WD = Water deficit
WS = Water surplus
RO = Run-off
water available for plant growth and soil moisture storage. In the rainy season, when there was sufficient water for plant growth and soil moisture storage, the rate of actual evapotranspiration was found maximum by the end of rainy season (i.e. during October) when precipitation was less than potential evapotranspiration, a decrease in the rate of actual evapotranspiration was recorded and this decrease continued till April except a few exceptions due to occasional rains.

It is evident from Table 2.2 that soil moisture was being utilized by actual evapotranspiration in all the months excluding July. This utilization was maximum in June and minimum in January. As a result of this process, water deficiency was recorded in most part of the year. In the month of July when precipitation exceeds potential evapotranspiration, the excess of water was totally spent in soil moisture recharge. It is worth noting that there was no water surplus during the study year. According to Thornthwait system, based on soil moisture index value (-16.86) the present study area can be classified as dry sub-humid (C₃) which can be further classified on the basis of thermal efficiency, i.e. PE (=1435.42 mm) as micro-thremal (0-3 C₃). The value of summer concentration of thermal efficiency (S C T E = 40.57) comes to a symbol which clearly indicates that lower S C T E value means, high temperature uniformly month after month. Thus, ecoclimatic
formula of the study area comes to $C_1 C_2 a_3 d$ where small $d$ indicates no water surplus.

The various climatic indices worked out are:

Potential Evapotranspiration (PE) = 1435.42 mm

Humidity Index

$I_h = \frac{S}{PE} \times 100 = 00$

Aridity Index

$I_a = \frac{D}{PE} \times 100 = 28.10$

Moisture Index

$I_m = I_h - 0.6 (I_a) = -16.86$

Summer Concentration of Thermal Efficiency (SCTE) = 40.57

**Soil**

Soil is an useful resource to the man and is a component of environmental system. Thus it can be studied in terms of link between soil properties and process and other environmental components such as air, water, rock and life. In addition, the soil properties and processes which affect the use of soils by man are important topics for study. Soil develops when rock at the surface of the earth is changed by a series of processes, collectively known by the terms weathering. The rock is weathered and broken down by the combined action of water, gases and living matter. The formation of soil is not just a matter of the disintegration of rock:
while the rock is disintegrating it is exchanging material with its immediate environment. A true soil is, therefore, a rock which has exchanged some material with its environment and the soil now incorporates not only rock but also water, gases both living and dead organic matter.

Soil conditions have a considerable influence on plant growth but often plant growth can not be thought of solely in terms of soil conditions. Other factors are also involved, such as genetic constitution of the plant, the climate, competition between different plants and infestation by viruses and fungi. Any one of these factors may limit the growth of plants. It follows that maximising plant productivity, in an agricultural context, or understanding plant distributions, in an ecological context, involves the study of many factors, not simply soil factors. Indeed, for many semi-natural vegetation types man has been the dominant influence. On the occurrence of plant species rather than environmental factors. Soil conditions should, therefore, be seen as one of many contributing factors influencing agricultural crop production and influencing plant ecology.

Plants may also have a significant influence upon soil characteristics. In particular, the nature and acidity of leaf litter can strongly influence the nature of the humus layers in soils which act to influence soil properties such as infiltration capacity. Plants may
also influence the nutrient status of a soil, depleting it by nutrient uptake at the roots. Soil of the study site presents a mature profile development. It is an old alluvial deposit. Agrawal and Mehrotra (1952) classified it as soil type III.

**MATERIALS AND METHODS**

Soil samples were collected from studied grassland at the depth of 0-30 cm at each sampling dates of study period. Composite soil samples of each sample were taken for the analysis of all physical and chemical parameters of soils of grassland. All the analysis were done at air dried basis, i.e. room temperature. The soil samples were passed through a sieve having 2mm holes in order to avoid the rootlets and stones.

**Soil Colour**

It was estimated with the Munsell soil colour chart. Nomenclature for soil colour was expressed in colour names and Munsell notation recommended in the chart.

**Soil Moisture**

Fresh soil samples were taken in the beaker and dried at 105°C for 24 hours. The loss of moisture in fresh weight was calculated on the dry weight of soil (Misra, 1968).
Soil Texture

It was performed by International Pipette Method as described by Piper (1966).

Field Capacity, Water Holding Capacity, Bulk Density and Porosity

It was estimated by methods described by Misra (1968).

pH

It was made by pH meter having glass-electrodes in a 1:5 soil water suspension (Misra, 1968).

Organic Carbon

It was estimated by Walkley and Black's rapid titration method as described by Piper (1966).

Nitrogen

It was analysed by Micro-Kjeldahl method as described by Jackson (1958).

Available Phosphorus

It was estimated photometrically by the molybdophosphoric acid blue colour method as given by Jackson (1958).

Exchangeable Cations

Exchangeable cations, i.e., potassium, calcium, acid sodium
were extracted by leaching the soil with the adequate amount of
neutral ammonium acetate solution. The concentration of the
nutrients was estimated by Flame-photometer using different filters.
i.e., potassium, calcium and sodium as described by Jackson (1958).

RESULTS

The physical properties of grassland soil is given in the
Table 2.3. The colour of the soil was light gray on dry but olive
brown on wet. The texture of the soil was sandy loam. The
percentage of sand, silt and clay were estimated 55.08, 27.10 and
17.81, respectively. The percentage of the sand was comparatively
higher than silt and clay. The moisture content, bulk density, porosity,
water holding capacity and field capacity are tabulated in the Table 2.3.
The chemical properties of grassland soil, i.e., organic carbon, C/N
ratio, pH, exchangeable cations are tabulated in the Table 2.4.

DISCUSSION

The physical and chemical parameters of grassland soil
are greatly affected by growth and development of vegetation.
However, the significant effect of physical parameter of soil can be
seen after longer period of time. Moisture content of the soil is
dependent on the rainfall (Table 2.1). The bulk density was
Table 2.3: Soil colour, texture class, mechanical composition, moisture, bulk density, porosity, water holding capacity and field capacity of soils of grassland.

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Colour</td>
<td>Light gray 2.5 Y. 7 2 dry Olive brown 2.5 Y. 4/4 wet</td>
</tr>
<tr>
<td>2. Texture class</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>3. Mechanical composition</td>
<td></td>
</tr>
<tr>
<td>(a) Sand (%)</td>
<td>55.08 ± 1.09</td>
</tr>
<tr>
<td>(b) Silt (%)</td>
<td>27.10 ± 0.48</td>
</tr>
<tr>
<td>(c) Clay (%)</td>
<td>17.81 ± 0.33</td>
</tr>
<tr>
<td>4. Moisture content (%)</td>
<td>10.36 ± 0.42</td>
</tr>
<tr>
<td>5. Bulk density (g/cc)</td>
<td>1.37 ± 0.05</td>
</tr>
<tr>
<td>6. Porosity (%)</td>
<td>47.31 ± 1.88</td>
</tr>
<tr>
<td>7. Water holding capacity (%)</td>
<td>46.09 ± 1.85</td>
</tr>
<tr>
<td>8. Field capacity (%)</td>
<td>29.03 ± 1.17</td>
</tr>
</tbody>
</table>
**Table 2.4**: Organic carbon, total nitrogen, C/N ratio, pH, exchangeable potassium, calcium, sodium and available phosphorus of soils of grassland.

<table>
<thead>
<tr>
<th>Chemical Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Organic carbon (‰)</td>
<td>0.39 ± 0.02</td>
</tr>
<tr>
<td>2. Total nitrogen (‰)</td>
<td>0.03 ± 0.001</td>
</tr>
<tr>
<td>3. C/N ratio</td>
<td>13.00 ± 1.46</td>
</tr>
<tr>
<td>4. pH</td>
<td>7.30 ± 0.28</td>
</tr>
<tr>
<td>5. Exchangeable potassium (m.e.‰)</td>
<td>0.42 ± 0.03</td>
</tr>
<tr>
<td>6. Exchangeable calcium (m.e.‰)</td>
<td>3.31 ± 0.20</td>
</tr>
<tr>
<td>7. Exchangeable sodium (m.e.‰)</td>
<td>0.16 ± 0.01</td>
</tr>
<tr>
<td>8. Available phosphorus (ppm)</td>
<td>126.00± 6.17</td>
</tr>
</tbody>
</table>
recorded 1.37 g/cc and as a general rule porosity is found to be inversely related to bulk density. The clay particle of the soil is more or less related to water holding capacity and field capacity (Sant, 1966; Pandey and Sant, 1979). Man and Biosphere programme sponsored by UNESCO has given much importance on the carbon, nitrogen status of the soils. The main source of carbon and nitrogen in the soil is litter and decaying roots. Therefore, high amount of organic carbon was recorded on the soil due to low decomposition in the soil having more moisture liberating much amount of nitrogen which was lowered the C:N ratio indicating slow rate of decomposition (Foth and Turk, 1972). The pH of the soil was found neutral on the soil. It may be due to faster decomposition of litter and formation of humic and fulvic acid. Most of the nutrients exist in minerals and organic matter and as such are insoluble so unavailable to plants. Nutrients become available through mineral weathering, organic matter decomposition and precipitation. The nutrients are absorbed from the soil solution or from collooidal surfaces as cations and anions. All the exchangeable cations were in high concentration because of addition of elements released by litter decomposition. The soil contained least amount of phosphorus as compared to other major nutrients. Less amount of phosphorus is required in the plants in comparison to other macro nutrients.