CHAPTER - II
TOPOGRAPHY OF THE REGION AND ABOUT THE PLANTS

The state of Maharashtra (Map I) forms a major part of peninsular India with the sea coast on the western side. The state extends from latitude 16.4° to 22.1’ North and longitude 72.6° to 80.9’ east. It has total area of 308000 sq. km.

The percentage of land area falling in Marathwada region is 20.4 % of the total area. The Maharashtra received 82 % of the total rain during the months of June to September and remaining in part between the months of November to January and part in the hot weather months of April and May. The agricultural food crops are cereals (maize, wheat, rice) millets (Jowar, Bajra), Pulses (Pigeon pea, horse gram, cowpea, black gram, green gram), sugarcane, sunflower, soyabean, fruit and vegetables are cultivated as a cash crops. The non-food crops include the fodder crops like lucerne, hybrid Napier etc.

The Marathwada Region

Marathwada region of the state of Maharashtra comprises of eight districts – Aurangabad, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani. The region falls within North latitude 17°35’ and 20°40’ and East longitude 74°40’ and 78°15’. Marathwada region forms the part of the
West Deccan Plateau of India and is one of the divisions of Maharashtra State.

The entire region is situated at an average height of about 300 – 600 m above the mean sea level gradually sloping from west to east. The region is traversed by hill ranges originating from the Sahayadris ranges, derive their names from local source, the northern being Ajanta, Satmala ranges and the southern the Balaghat ranges. In addition to these, there are scattered hillocks of varying heights throughout the region, the highest peak Surpalnath (960 m above m.s.l.) being situated near Kannad in Aurangabad district.

The main river Godavari flows west to east collecting water on its way from several large and small tributaries like the Dudhana, Manjra, Penganga, Kayadhu, Purna, Tavarja, Terna and others. It enters Andhra Pradesh in South and ultimately merges into the bay of Bengal. Most of the tributaries are seasonal and dry up soon after the monsoon. In addition to this principal source of water, the region has few lakes and ponds formed between the hillocks. Some of these collect enormous amount of water drained down along the river banks. Most of the hill tops are bare or covered by course gravel, while the low land areas accumulate clay and loam. Chemically the soils are rich in calcium and magnesium carbonates and are deficient in nitrogen and phosphorus. This chemical composition is mainly responsible for the cracking of the soil during summer.
Climate and rainfall

Marathwada has the typical tropical hot and dry climate. The average day temperature ranges from 27.7 to 38°C while it falls from 26.9 to 10.4°C during night. Similarly summer and winter temperatures also vary greatly. Of the three seasons, summer is very warm with maximum temperature as high as 46°C during May. Winter (October to February) is pleasant with the temperature falling as low as 2.2°C. Relative humidity is extremely low for major part of the year ranging from 14.2 to 68.1% and reaching over 93.2% during monsoon.

The rainy season is considered from middle of June to the end of September. It is followed by sultry period from the end of September to the middle of November. The winter season commences from the middle of November and end in February, which is followed by a dry hot summer from March to the middle of June.

The region receives rain from the south west monsoon like rest of the Deccan plateau. The rain starts by the middle of June, become intense in July and August and cease by the end of September. The normal average rainfall is about 900 mm but is rather variable from year to year. During this period, Nanded district receives the maximum rainfall while Osmanabad district the least. It is decreased considerably in the recent years. The major amount of the south west monsoon precipitation was received on the west coast of India due to the Sahayadri and only a small amount escapes
through high hills which is received by the Deccan plateau. The region thus falls in the rain shadow of the Sahayadris.

The climate of the region supports the vegetation that can be conveniently divided into tropical dry deciduous forests, the open scrub jungles and vast tracts of grassland.

The district of Aurangabad

The district of Aurangabad extends over an area of 9172 sq. km and is situated in the upper Godavari basin to the extreme north west of the Marathwada. In general the district slopes down towards the south east, the district lies between the parallels of 19°20’ and 20°40’ 1°10 north and between 74°40’ and 75°50’ east. The general elevation above sea level varies between 665 and 735 m on the north and between 565 and 635 m towards the south.

Soils

Soils of Aurangabad district are medium to deep black and contain large quantities of calcium and magnesium carbonate. They are deficient in nitrogen and phosphorus and crack heavily in summer. The soils are quite fertile and particularly suitable for cultivation of wheat, cotton, soybean, tobacco, chillies and jowar.

Climate

The climate of Aurangabad is pleasant and agreeable during the greater part of the year. The climatic year may be divided into three short season.
a) Moderately warm, wet season from June to September.

b) A cool and dry season from October to February.

c) A hot dry season from March to May.

During the rainy season the temperature does not fall below 17°C and normally ranges between 21 to 36°C. The winter season is comparatively dry. January is the coldest month of the year. The maximum temperature in the month of May rises as high as 40.1°C. In summer the days are hot though nights are fairly cool.

**About the University Botanic garden**

Dr. Babasaheb Ambedkar Marathwada University campus is located on the north western fringe of the city. The botanical garden is situated E 75°18' 46.69' east and altitude 1908 ft from the mean sea level (Google earth, 2006). The botanical garden extends in the centre of the University campus. It occupies an area of about 08 hectares and is developed as an experimental wing of the department. The garden was taken up for development in June 1965. The garden is surrounded by a nallah almost on three sides. A road of 5 m width passing through the garden from east to west divides it into two parts. The garden is provided with adequate lift irrigation facilities. During the last thirty five years a number of crops such as cowpea, lucerne, maize, jowar, Napier, bajra, carrot, tomato, raddish, soyabean, winged bean, oat, coix etc. were cultivated for research purposes.
About the plants

Maize

Maize (Zea mays L.) is a cereals crop. The plant is native of America but the views on the date of its introduction in India differ. It was introduced in India by the Portuguese during the seventeenth century is often quoted, but the more recent evidences supports the possibilities of its pre-combian introduction through the Atlantic Arabian trade route (ICAR, 1980). However, the historical records regarding the cultivation of maize in India date back only to the Maratha empire.

Maize is one of the most important cereals of the world, with its world average yield of 27.8 / ha. Maize rank first among the cereals and is followed by rice, wheat and millets.

Maize requires fertile, deep and well drained soils. It can be grown on any type of soil ranging from deep heavy clays to light sandy one. The pH of the soil does not deviate from the range of 7.5 to 8.5 and is highly susceptible to salinity and water logging. Maize is essentially a warm weather crop. It is grown under extremely diverse climatic conditions in different parts of the world.

It is grown in two years rotation with cotton and sugarcane. It is usually grown as a pure crop, but occasionally along with legumes such as mung, tur or beans. In central India under rainfed conditions, however, cotton and tur are grown mixed with maize. It is cultivated as a kharif crops for obtaining high yields. The maize crop require heavy doze of manure
(25–30 kg of FYM). For hybrid varieties of maize 100 – 120 kg of nitrogen is applied with 60 kg of P₂O₅ and 40 kg of K₂O per hectare. The maize is sown in rows, 60 – 75 cm apart whereas the plants in the rows are spaced at 20 – 25 cm. Sowing is done with drill or by dropping 17 to 20 kg of seed for grain crop and 35 – 40 kg per hectare for the fodder crop. Weeding may be done between the rows by hand. Two to three weeding may be necessary.

The maize crop grown for grain is harvested when the grains are nearly dry and do not contain more than 20 percent moisture. Maize grown for fodder should be harvested at the milk to early dough stage, the earlier harvested crop was likely to yield less and have a lower protein content.

Maize is consumed directly as a food in various forms like the chapattis roasted ears, popcorn and porridge. The use of maize in animal feed, particularly for poultry, and in starch industry is increasing. Green maize plants also furnish a very succulent fodder during spring and monsoon.

**Sorghum**

*Sorghum (Sorghum vulgare Pers.)* popularly known as jowar is the most important food and fodder crop of dry land agriculture. The annual area under its cultivation ranges between 17 and 18 million hectares and the production between 8 and 10 million tonnes. Medium and deep black soils are suitable for growing *Sorghum*, whereas the *rabi* season *Sorghum* is confined to black cotton soils, the *kharif Sorghum* is grown on light soils.
*Sorghum* is grown during both *kharif* (July – November) and *rabi* (October – February) seasons. The preparation of land with ploughs or harrows with least application of FYM line, sowing with seed drill in rows 12 – 18 in apart. A two year rotation of jowar cotton is most common during *kharif*. During *rabi*, jowar + cotton, jowar + gram rotations are common. It is also cultivated in intercropping systems, *Sorghum* + pigeonpea, *Sorghum* + soyabean, *Sorghum* + groundnut and a few other mixtures have been found to be remunerative.

The *Sorghum* grain is used primarily as human food in the form of roti. *Sorghum* is also malted popped for several local preparations. Green and dried fodder is the most important roughage for feeding cattle throughout the country. The grains are also used as cattle feed, in poultry ration and for various industrial uses.

For fodder purpose the crop should be cut immediately after flowering or upto 50 % flowering. Delay in harvesting increases the content of crude fibre in foliage and results in sharp decline in crude protein contents and digestibility of nutrients. On an average the crop yields 400 to 450 quintals of fodder per hectare with excellent management. The yield as high as 850 quintals have been reported from 3 to 4 cuttings (Relwani, 1979). The crop is toxic to the animals in the young stage as it contains a glycoside which break down into hydrocyanic acid in the stomach of the animal. The recommended varieties for Maharashtra are MP chari,
Maldandi, Nilwa S 1049 and M -35-1. The hay and silage, however are generally safe when prepared from Sorghum.

**Bajra**

Pearl millet or bajra (*Pennisetum typhoides* (Burm.f.) S & H) is cultivated for grain as well as for fodder. In India, the crop is grown on over 12 million hectares. It is grown mostly during June to October and as a winter crop from November to February or as a summer crop from March to June. It is grown on a wide range of soils, such as sandy loams, heavy clays and very light soils. It is grown as a pure or mixed crop and is rotated with cotton *Sorghum, Niger*, wheat and in *rabi* with pulses as a mixed crop. It is grown along with a wide variety of oil seeds and pulses.

It is not grown solely for the purpose of fodder, but can also serve as a quick growing forage crop under irrigation. It is usually sown for grain in *kharif* season. If rainfall and type of soil are very poor, it is cut and fed to the cattle. If it is harvested before flowering, two or more cuts can be taken in the same season. It is a drought resistant crop and hence is grown on light type of soils in low rainfall areas. The sowing is done by drill, in 30 cm apart rows, with the seed rate of 10 kg / ha after the first shower of rain.

The yield of green fodder varies from 7000 to 12000 kg/ha with an application of a basal dose of 25 kg N, P$_2$O$_5$ and K$_2$O per hectare (Deore *et al.*, 1982). The crude protein content in green foliage of bajra varies from 8 to 11 % on dry matter basis. On an average the fodder contain 10.56 % crude protein, 50.15 % carbohydrate, 2.12 % fat, 27.96 % crude fiber and
9.21% ash (Rahudkar, 1965). The fodder is of low palatability as compared to maize and *Sorghum*.

On this farm Tifl 23 – A variety of this crop was cultivated by Mungikar (1974) during February to July, 1973. The crop yielded 8828 kg dry matter and 1286 kg crude protein per hectare after receiving 240 kg N / ha when it was harvested 5 times in 150 days (Mungikar *et al.*, 1976a).

**Wheat**

Wheat (*Triticum* spp.) in the past comprised of four species, namely *Triticum aestivum* L., *T. durum* Desf., *T. dicoccum* Schuble and *T. sphaerococcum* were under cultivation in India. Wheat requires cool winters and hot summer climate which are very conductive to a good crop. The annual average rainfall ranging from 125 to 1000 mm is required to get good yield, irrigation is essential, 4 – 6 irrigations are needed. Well drained loam and clayey loam soils are considered to be good for wheat. For crop rotation maize, jowar, bajra, cotton and tur are included. Sometimes, some of the green manure crops such as mung, guar lobia are sown to enrich the soil. Gram, linseed safflower and mustered are also included in mixed or intercropping.

Seeds are sown by drilling at a uniform depth. A seed rate of 100–125 kg / ha is recommended. It is desirable to add 2 or 3 tonnes of FYM per hectare. The fertilizer requirement of the irrigated wheat crop is Nitrogen 80–120 kg / ha, phosphorus (P2O5) 40 – 60 kg / ha and potash (K2O) 40 kg / ha. The crop is harvested when the grains harden and the
straw become dry and brittle. Wheat is consumed mostly in the form of chapatee or bread. Wheat straw is used for preparation of paper and for feeding the cattle.

**Cowpea**

Cowpea (*Vigna sinensis* (L.) Savi ex Hassk.) is a leguminous forage crops mainly cultivated in northern and central India. It gives protein rich green fodder for cattle apart from its other uses as green manure, cover vegetable or pulse crop. This crop is free from every type of toxicity.

It can be grown on variety of soils and it thrives best between 21 to 35°C. The crop is more tolerant to heavy rainfall. In India the crop is raised as a dry land *kharif* crop. It is rarely grown as a sole crop and is cultivated with maize, *Sorghum*, bajra, sunflower, hybrid Napier grass, sudan grass and Guinea grass.

Cowpea is grown with moderate manuring at a seed rate of 40 kg/ha. Sowing is usually done in rows with 30 to 40 cm row to row distance. It gets ready for cut as fodder after about 60 to 70 days. At this stage it has more than 50 % leaf fall ness with broad, dark green and smooth leaves. In a two cut management, the first cut can be taken about 50 days followed by second cut (regrowth) after 30 to 40 days. The average yield of cowpea fodder do not exceed 275 to 300 quintal per hectare. However, a yield of 350 to 400 quintals per hectare can be obtained with better management and multicut system (Relwani, 1979). On this farm Deshmukh (1972) reported
yield of 42460 kg/ha green fodder from this crop in 80 days during monsoon.

Cowpea makes an excellent hay. However, while conserving cowpea as silage, it is desirable to mix it with carbohydrate rich fodder like *Sorghum* or maize before ensilaging (Kasture *et al*., 1984).

**Dolichos**

*Dolichos* or *Lablab niger* Medicus syn. (*Dolichos lablab* L.) is an important leguminous crop. It is widely grown in southeast Asia, Egypt and Sudan and have been introduced in other tropical zones including India. It is known as “Dhorwal” or “Walpapadi” in this region and is cultivated for vegetable pods. It is also cultivated for green fodder around sugarcane fields and is also popular as a green manuring crop.

The plant can grow on variety of soil. It is drought resistant and cannot tolerate water logging. The plant is twinner giving a dark green cover over the soil even during the dry season. In this region, it is cultivated either for green manuring or for fodder.

On this farm it was cultivated by Deshmukh (1972) during summer in 1967, it yielded about 70 quintals of green fodder per hectare. Kasture (1982) recorded its yield upto 90 quintals per hectare when cultivated in 1981. The foliage of this crop contains 18 to 25 % protein on dry matter basis. On this farm it was identified as the most suitable leguminous crop for intercropping with maize and *Sorghum*.
Phaseolus

*Phaseolus aureus* Roxb. or mung is spread all over the country, with a production of about 0.8 million tonnes (ICAR, 1980). Green gram is grown almost throughout India. It is cultivated mainly as a *kharif* crop. It can be grown on a variety of soil but it prefers medium loamy soils. A well distributed annual rainfall of 60 – 90 cm is the most suitable for the crop. Ploughing and manuring are needed before the seeds are sown by broadcasting. It is grown both as a pure and mixed crop. The crop responds well to 25 – 40 kg / ha of *P*₂*O*₅ and 10 kg / ha of N with increased yield (ICAR, 1980). As a *kharif* crop it is usually sown in June / July while as a *rabi* crop in the month of October. It takes about three months for maturation.

The *rabi* crop is generally grown unmixed, whereas the *kharif* crop may be sown alone or mixed with millets, maize, bajra, cotton and tur. The availability of early erect varieties makes intercropping possible without in any manner affecting the major crop.

The dried seed of green gram contains 23.6 % protein, 58.2 % carbohydrates, 1.2 % fat, 3.5 % fibre and 4 % minerals. Tender pods are consumed as a vegetable and ripe seeds are used as a pulse seeds are perched and make into porridge. They are often fried and used as snack. Sprouted seeds are also eaten. The herb is valued as a feed for cattle and horses.
Gram

Bengal gram (*Cicer arietinum* L.) or Chickpea is the important pulse crop in India. The average annual area and production are about 7 – 8 million hectares yielding about 4 – 5 million tonnes of grain (ICAR, 1980).

In India, gram is grown as a *rabi* crop. It is well adopted to arid and semiarid regions with low to moderate rainfall and a cool and dry climate. It is usually grown as a mixed crop with *Sorghum*, safflower, pea, wheat, barley, linseed and mustard.

The crop is sown in October / November and is ready for harvest in February / March. Seed are sown by broadcasting or drilled in rows. The seed rate varies, depending on the seed size from 58 – 100 kg / ha. The crop matures in about 150 days. The harvesting is done by cutting plants close to the ground by hand sickles or they are pulled out when the leaves turn reddish brown. The plants are dried completely before threshing and winnowing. The seed are threshed by trampling or beating with wooxon flairs. The average yield of the rain fed crop is 500 – 600 kg of dry fodder per hectare (ICA.R, 1980).

Chickpea is very nutritive and used as protein adjunct to starchy diets. The seeds are widely consumed as pulse in many preparations: Dal, besan (flour), crushed or whole gram, boiled or parched, roasted or cooked, salted or unsalted or sweet preparations, green foliage and grain as vegetable, are the important forms in which it is consumed by the people. The young leaves are used as vegetable Malic and oxalic acids are collected
from green leaves. Soaked grain and husk are fed to horses and cattle. Leaves and stalks are dried and used as fodder for cattle.

**Hybrid Napier grass**

In the year 1953, cross was made in India between bajra and Napier grass resulting into hybrid Napier grass (Pennisetum typhoides x P. purpureum). This crop proved successful and became popular as fodder crop under the name hybrid Napier grass, elephant grass or gajraj. Now it is an important cultivated fodder grass in India. It is more juicy, succulent, palatable and nutritious than common Napier (Dabaghao, 1969). It yields from 2,10,000 to over 2,50,000 kg green fodder per hectare per year (Patel et al., 1968, Patel, 1968).

Several varieties of hybrid Napier have been raised by IARI, New Delhi, PAU Ludhiana and other Research Station. A hybrid variety NB – 21 has an universal acceptance due to excellent performance in most parts of India. Although it grows better under moist conditions, it is remarkably drought resistant.

The plant is propagated by stem cuttings or the tillers. The crop is planted in rows, 61 cm apart with plant to plant distance, within the row of 30.5 cm. After establishment, with the increase in number of tillers, the crop exhibits thick canopy structure. Mostly it is cultivated alone, however, its cultivation along with legumes is also practiced for higher yields. The crop is most suitable for soils which are sandy loam to clay loam in nature. From 10,000 to 25,000 rooted slips are planted per hectare. Being a perennial
crop the first cut is taken 75 days after plantation and subsequently it is cut at an interval of 45 days. The crop can be harvested for green fodder for 8 – 10 times in a year.

Being a grass, the crop responds well to nitrogen fertilization producing dark green, soft fodder. The foliage contains high proportion of oxalic acid, which interfere with utilization of calcium in animals (Relwani, 1979), and hence calcium supplementation is essential, while feeding this fodder to animals. Application of 40 – 60 kg N/ha, 20 days before each harvest is recommended for higher production of fodder. Application of N in excess, may result in accumulation of nitrate in the foliage, particularly in summer (Mungikar, 1974). Proper crop management is thus essential to obtain large amount of fodder from this highly productive grass which should be free from toxic components i.e. oxalate and nitrates.