CHAPTER-I

PHYTOCHEMICAL ANALYSIS AND GROWTH CHARACTERISTICS OF SOME MEDICINAL PLANTS OF FAMILY SOLANACEAE AT DISTRICT SAHARNAPUR

INTRODUCTION

Plants are one of the most important sources of medicine. The application of plants as medicines, perhaps dates back to prehistoric period. However, there is no such reference in record. The writings indicate that Chinese were the first to use the natural vegetation as medicine. The practice of application of plants, therefore, is as old as 4,000 to 5,000 B. C. Greeks like Aristotle, Theophrastus and others have given voluminous information about drug plants in their writings. Dioscorides, has given in details, authoritative references, in his invaluable book De Materia Medica, written in about 77 B. C. In centuries to follow', "Doctrine of Signatures" was advanced, which advocated that all plants useful for man possessed certain forms and shapes, that indicated their specific use, in the treatment of similarly shaped organs in the human body (for example, walnut. Akhrot, was a brain tonic). With the advance of knowledge, such superstitions were gradually lost and much useful remedies were discovered.
In India, earliest references of the curative properties of plants appear in *Rigveda*, which is said to be written between 3,500-1,600 B.C. Several plants have been referred in the *Suktas of Rigveda* viz. *simal, pithvan, palas, pipal*, etc. However, these references are brief. A later *production—Atharva-veda*, describes uses of large number of drugs. In *Ayurveda*, definite properties of drugs and their uses have been given in some details, It is a basic foundation of ancient medical science in India. Works of *Chorale* and *Susruta* namely *Charak-samhita*, were additions to the knowledge of medicine *Susruta samhita* which deals with about 700 drugs, a few of which were indigenous to India. Since this time, investigations have brought the number of drug plants to about 1,500. Today there are about 2,000 drugs in use. Out of these, large number are of plant Origin. Bendre & Kumar (2001).

Studies of medicinal-plants based on ancient literature and its investigation in the modern light is known as Ethnology which is rising as a specialised branch of Botany. A branch of medicine dealing with history, commerce, collection, selection, identification and preservation of crude drugs and raw materials is—Pharmacognosy, while the branch dealing with the study of action of drugs is Pharmacology. Most of the drug plants are wild. These occur in the wild state in nature, especially tropics. Only a few of them have been cultivated.

Medicinal plants have their values in the substance or substances present in various plant tissues. These produce specific physiological action in the human body. The important of these substances are alkaloids, compounds of carbon, hydrogen, oxygen
and nitrogen. Besides these, glucosides, essential and fatty oils, resins, gums, mucilages, tannins, etc. are also of large use. These active principles may be present in the storage organs of the plant viz. roots, seeds, leaves, bark, wood, etc.

According to Bible, the Lord had planted a garden in the east in Eden or the Garden of Paradise, the first residence of man, and there he put the man he had formed and the Lord made all kinds of trees grow out of the ground. Some contemporary scholars tend to regard the biblical descriptions as imaginary. So, endless controversy has revolved around the question of geographic location of Eden. The name Eden is probably connected with Edin (the Sumerian name for the plain of Babylon). The author of genesis might have had in mind the verdant landscape of Mesopotamia. The Eden is mentioned in old testament books as a place of extreme fertility and the name continues to connate an ideal setting. The reverend scholars may not accept the Indian subcontinent and archipelagos to be Eden the garden of paradise but certainly it is one of the richest floristic regions of the world with geologically recent but the highest mountains, the Himalayas; and the Aravalis, Khasi and Jantiya Hills, and the southern plateau extending in the north-east probably comprise the oldest rocky structures of the earth; with Cheerapunjee and Mausindrum the places of maximum rains. This all created climatic conditions leaving ample opportunity for origin, evolution, dispersal and speciation of plants, with available all sort of climates, tropical, subtropical, arid, temperate and alpine (Kaushik and Dhiman, 2000).
The drugs are chemical agents or the mixtures of agents employed for the cure or prevention of diseases or for alleviation of discomfort, pain or anxiety. The term is also used to designate narcotic and sleep producing agents. The drugs enhance, suppress or alter biological functions exerting their effects as a result of interaction with living systems. The drugs not only affect the host rather also the pathogenic microorganisms like bacteria, protozoans and fungi. There exists information regarding chemical analysis of naturally occurring drugs. The drugs bear harmful as well as beneficial effects and decisions about when and how to use them therapeutically depend on balancing of benefits and risks. Though our body is adapted for natural raw plant drugs but the drugs should always be taken under the supervision of a trained physician. According to Acharya Charak, the great Indian physician, “A medicine in the hands of an incompetent physician becomes a poison whilst in the hands of a gifted physician becomes a powerful medicine”. Indeed some raw plant drugs are deadly poisonous to prepare a balanced dose is most essential (Kaushik & Dhiman, 2000).

The man since antiquity had to depend on nature and plants for sustainance and survival. Man as savage must have known by experience how to relieve his sufferings by the use of plants growing around him. The ancient civilization records show that a number of drugs used today were already in use in ancient times. The history of medicinal plants dates back to vedic period about 4500-1600 B.C. After that, the Egyptians, Babylonians, Greeks, Romans, Chinese and Indians developed their characteristic
materia medica respectively. According to Wahid and Siddiqui (1961) modern medicine is supposed to be derived from Greek medicine which was taken over by Romans and Arabs from whom after its enrichment with Chinese and Indian medicine, was taken over by Europeans. However. Kaushik & Dhiman (2000) also gave some relevant ancient details as follows -

**Egyptian materia medica**: Ebers Papyrus is believed to be written about 1500 B.C. which contains a collection of preparations and formulae covering a wide range of uses. The important drugs mentioned in it includes oil, wine, beer, yeast, vinegar, turpentine, figs, castor oil, myrrh, mastic, frankincense, worm wood, aloes, opium, cumin, peppermint, anise, fennel, saffron, lotus, linseed, juniper fruits, henbane, mandragora, poppy, gentian, colchicum, squill, cedar, elder berries, honey, grapes, onion, garlic, acacia and date blossoms.

**Assyrian and babylonian pharmacy**: In the library of Sardana-palus at Ashurbanipal which dates back from 650 B.C. have been found clay tablets belonging to Assyrians and Babylonians, relating to medical and pharmaceutical subjects. Their list of drugs possesses 250 herbs of which important ones include, cassia, cinnamon, costus, orris root, anise, jasmine, oleander, allamander, cathartica, mint, henbane, liquorice, alcohol, fats, oil, wax, turpentine and alum.

**Chinese medicine**: Pun taso, a pharmocopoeia like compilation consisting of 40 volumes contains several thousand prescriptions. The origin is attributed to the mythical god of medicine believed to have flourished about 2735 B.C. About 265
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inspect them not once or twice but frequently, for though twins look alike to strangers, they are easily distinguished by friends”. His works were also translated into Arabic languages.

**Arab Medicine:** After the decline of Galen medicine in Rome, the work of earlier Greek physician were forsaken and work of Galen gradually assumed the position of greatest authority in medicine. Greek medicine found its votaries among Arabs who caused as much literature as could be found to be translated into Arabic.

**Indian medicine:** The history of medicine in India can be traced to the remote past in the vedic period. The Rigveda, perhaps the oldest repositories of human knowledge having been written about 4500-1600 B.C., claims about 99 medicinal plants. Yajurveda listed 82 plants and in Sam veda, various plants already mentioned in Rig veda and in particular, Soma plant has been described. Atharva veda, which is considered important among all four vedas, deals with 288 plants (129 according to Dr. Udupa), almost all have medicinal ingredients and were used to cure deadly diseases. The later production from vedas, the Brahmans deal with 129 plants and Kalpa sutras describe some about 519 plants. Those plants which have not been dealt with in detail in the earlier work like the Rig veda, Atharva veda and Brahmans have been vividly described in later sanskrit texts like Kalpa sutras.

Ayurveda, the science of life is considered upveda (about 2500 B.C.) contains a more detailed account of many drugs and their uses. Ayurveda in fact, is the foundation stone of the ancient medical science of life and art of healing. The eight divisions of
Ayurveda were followed by the comprehensive works of Charaka (1000 B.C.) and of Sushruta (800 B.C.), which gave a detailed description of the materia medica as it was known to ancients. Charak samhita, the first recorded treatise on Ayurveda is the edited version of the old scientific treatise by Agnivesha who wrote the first treatise on Ayurvedic medicine.

**Table 1**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>1.</td>
<td>Shalyatantra</td>
<td>(Major surgery): art of extracting extraneous things from the body.</td>
</tr>
<tr>
<td>2.</td>
<td>Shalakyatantra</td>
<td>(Minor surgery): treatment of external organic affections or diseases of ear, nose, throat, oral cavities and eye.</td>
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<tr>
<td>5.</td>
<td>Kaumarabhritiya</td>
<td>Paediatrics: comprehensive management of infants and treatment of disorders of mother both prior to and after pregnancy.</td>
</tr>
<tr>
<td>6.</td>
<td>Agadatantra</td>
<td>Toxicology including environment and water pollution; administration of antidotes and treatment of poisonous bites.</td>
</tr>
<tr>
<td>7.</td>
<td>Rasayantantra</td>
<td>Chemistry of drugs including purification of blood; knowledge of physical and mental decay and medicines promoting health and longevity.</td>
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</table>

The above three works are known as ‘Vriddha tray,’ of Ayurveda and the period of their creativity i.e., the period from 800-1000 B.C. is considered as the golden era in the Indian system of medicine. Another, triad known as ‘Laghu trayi’ of Ayurveda
are compilations by Madhavakar (12th century), who wrote Madhavanidana, concerned mainly with diagnosis Sharangadhara (14th century), who wrote Sharangadhara Samhita, a systematic ayurvedic materia medica; and Acharya Bhava Mishra (15th century), a native of Benaras who wrote Bhavprakasha which contains more than 600 drugs including some foreign drugs. Besides, a large number of Nighantus or pharmacy lexicons on medicinal herbs were written. (Kaushik & Dhiman, 2000).

After independence, Bhandari (1993), published Vanoushdhi chandrodaya (an encyclopedia of Indian botany and herbs) which in addition gives information on important preparations made from the plants besides their medicinal uses. Singh (1948), prepared a guide book ‘Vanoushdhi darshika’ for the students of botany and forestry and later in (1955), he surveyed the forests of Bihar and published his work under the title ‘Bihar Ki vanaspatiyan’. Singh (1969), published ‘Vanoushdhi nirdeshika (Ayurvediya pharmacopoeia) which was revised later in 1983. This provided much information about the adulteration of the drugs including main preparations made from the plant products. In 1962, Government of India constituted Ayurveda committee with a view to maintain the uniform standards in preparation of drugs and to prescribe working standards for compound formulations including tests for identifying purity and quality of the drugs. Central Institute of Medicinal and Aromatic Plants at Lucknow also is serving in this field. Phanacopoeial Laboratory for Indian Medicines established at Ghaziabad is serving as a centre for standard setting cum-drug testing laboratory for Indian medicine
including Ayurveda, Siddha and Unani system of medicines. Under this centre, Amchi research unit has been set up also to carry out clinicalresearches and survey of local drug potentials of Tibetan system of medicine (Amchi system) which is in vogue in Ladakh, Lahul and in some other regions. Similarly, Central council of Indian medicine was established for working in Ayurvedic, Siddha and Unani system of medicines. National Institute of Ayurveda was established is 1976 at Jaipur (Rajasthan) in collaboration with Government of Rajasthan which is working as a national centre for promoting Ayurveda. Besides Central council for research in Ayurveda and Siddha was constituted in 1978 to develop and coordinate scientific research in different aspects of fundamental Ayurvedic and Siddha system of medicine. Institute of History of Medicine and Medical Research, Delhi and Central Council for Research on Unani Medicine established in 1979 are working for the coordination and scientific research in Unani Medicine which in fact indirectly incorporate Ayurveda (Kaushik & Dhiman, 2000).

Frans worth (1990) stated that the herbal medicines of ancient times was practiced by the large number of workers like Assyrians (4000 BC), Sumerians (3500 BC), Indians (3500 BC), Chinese (3000 BC) and Egyptians (2500 BC). He further reported that in due time these herbal medicines were subdued under the impact of modern medicine. However, again a comeback of ‘herbal renaissance’ is taking place all over the world. It is estimated that 80 percent people of the world rely on traditional medicine for primary healthcare needs. And of the 119 plant-based drugs used
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today by modern medicine, about 74 percent are from plants traditionally used as herbal cures (Frans worth, 1990).

We have historical evidence that ancient people like the descendants of the Sumerians as early as 3500 BC used deadly nightshade (*Atropa belladonna*) and henbane (*Hyoscyamus niger*) against pain and sickness. The Assyrian midwives around 4000 BC made crude preparations from the ergot fungus (*Claviceps purpurea*) to control bleeding after childbirth. The Egyptians pressed mouldy bread on purulent wounds and swallowed it as internal medicine. They also used senna leaves (*Cassia angustifolia*) for proper bowel movement (Trivedi, 2006).

Medicinal plants have been known to human being since civilization started. Nowadays, several drugs are obtained from plants. For example in “Indian Materia Medica” 2500 items of drugs are listed from plants sources and thus, India is endowed with the real wealth of medicinal plants. However, the urbanization and industrialization led to reduction in the nature heritage, including the ethnic medicines of the Indian subcontinent (Rajaram, 2004).

The Chinese herbalists, around 2000 BC, used *Ephedra gerardiana* locally called as ‘ma-huang’ and used it against respiratory infections. They also used hemp (*Cannabis sativa*) resin to ease pain, gout and absent mindness. The aboriginal people of India knew the present *Rauwolfia serpentina* as ‘snake root’ plant as early as 3000 years ago and used it to treat several diseases from mental disorders to insomnia and snakebite. The Peruvians and Bolivians of the 17th century used *Cinchona officinalis* as a wonder
drug to control malaria. Likewise, foxglove (*Digitalis purpurea*) was used by the English people for external application (Trivedi, 2006).

The poppy juice 'opium' (*Papaver somniferum*) was used in the 18th century to relieve pain and anxiety and the periwinkle (*Catharanthus roseus*) used in diabetes. The willow tree (*Salix purpurea*) was used for thousands of years to ease pains, aches and rheumatism; coca shrub (*Erythroxylum coca*) to relieve pain; ginseng root (*Panax ginseng*) as a stimulant and cure for all ailments. Ancient literature of the world on medicines suggests that the primitive people of antiquity and of earlier centuries had been using several kinds of food and medicinal plants for healthcare (Trivedi, 2006).

Herbal medicine, today, owes its existence much to the skill and painstaking labour of ancient traditional folk healers of India and the world, who were pioneers in discovering the curative effects of several herbs, often at the risk of the lives of their own fellowmen. Folklore medicine is as old as any other traditional medicine in India and can be called the parental body. All other branches of traditional medicine such as Ayurveda, Unani and Siddha have been greatly benefited from folk medicine. Several of the herbal drugs used by the traditional folk healers since long have proved to be of great biological significance, and modern research has convincingly established their medicinal properties and restorted their credibility which was eroded with the coming of modern synthetic medicines (Trivedi, 2006).
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Plants use to cure human ailments are a tradition as old as human civilization. Ancient traditions of Indian medicines viz. Ayurveda, unani and Sidha and now, even, allopathy derives many of their curative tools from plants. Tomer (2007) stated that the Indian system of medicine has played an important role in our country in providing medical care since antiquity. This system of medicine is as old as the Indian history itself, because it formed an integral part of the Indian traditions since time immemorial. Some of our popular ancient literature such as Atharveda, Charak-Samhita, Sushruta Samhita etc. indicates role of plants in curing ailments.

The revival of interest in natural drugs, especially those derived from plants, started in the last few decades mainly because of the widespread belief that ‘green medicines’ are healthier and safer than the synthetic ones. Herbs are staging a comeback and a ‘herbal renaissance’ is blooming across the world. The WHO took note of the role that Traditional Medicine (TM) can play role in the extension of health services particularly in the remote rural areas (Trivedi, 2006).

Tiwari et al. (2007) stated that central Himalayas have a great wealth of medicinal plants and traditional medicinal knowledge.

Indian civilization, with the antiquity and continuity, ever recognized the importance of maintaining ecological balance by avoiding under exploitation of natural resources. Time tested techniques were discovered by sages and seers, and practiced by craftsman and householders for preservation of healthy
environment for ever past 5000 years. Indian culture has little to learn from 20th century western mind regarding environment and sustainable development or living harmony with plants and its environment.

India is a country of contrasts and diversities. The climate ranges from the tropical to alpine types. Rainfall shows variation that is widest in the world. This great diversity of soil and climate is well reflected in our flora and fauna. India has about 2.2% of world's land area, having nearly 10% of total world plants. Man's dependence on forest for the medicinal plant essential for his existence has been of paramount importance in his life since the human race began. Primitive man probably had few needs other than food and shelter; civilization has, however, brought with it an even increasing complexity, and has increased man's requirements to an amazing degree.

Along with mineral resources medicinal plants (flora) too constitute the national wealth. The love and interest for plants is a part of inheritance of our cultural life on aesthetic heritage.

As a whole, medicinal plants of the country have not been intensively explored. It has been suggested that the flora of all the big cities and their environs be work out. Therefore, it was of interest to take up a study on the medicinal plants of Lamiaceae at Saharanpur. The climate and the soil are favourable for good vegetation in district Saharanpur. Ganges is the major river of north India which flowing through this region, beside small rivers (radiation and photoperiod), slope, plants and animal population, range of interference etc.
Medicinal Plants:

Medicinal plants includes all species of plants related to microorganisms and the ecosystems and ecological processes of which they are parts (OTA, 1987). It is an umbrella term for the degree of nature's variety, including both the number and frequency of ecosystems, species or genus in a given assemblage (Sai & Mishra, 1986). It is usually considered at three different levels, genetic diversity, species diversity and ecosystem diversity. Genetic diversity is the sum total of genetic information contained in the genes of individuals of plants, animals and microorganisms that inhabit the earth. Species diversity refers to the variety of living organisms of the earth. Ecosystem diversity relates to the variety of habitats, biotic communities and ecological processes in the biosphere (Baltimore, 1993).

There are two main functions of plants. First, it creates the stability of the biosphere, which in turn leads to stability in climate, water, soil, chemistry of air and over all health of biosphere. Secondly, it is the source of plant species on which human race depends for food, fodder, fibre, shelter, medicine etc. these by and large exist in the twelve Vavilovian centers of diversity. Thus, medicinal plant is not only an important resource but also strength of developing countries.

Medicinal plants mean the diversity of life-forms found in different parts of the world. According to an estimate the life exists on the earth in more than thirty million different forms. For practical purposes life-forms have been grouped into 'species'. The
existence of different species of plant, therefore, means the availability of different alternatives to making for utilizing their environment in the best possible manner. (Appanah, 2001).

The member of same species growing or living in different climatic and geographic regions sometimes evolve certain specific genetical properties that distinguish them as a “VARIETY” of the same species. For example Shisham trees of hilly district of India grow in better shape and size as compared to those in other parts of India. It is therefore, a genetically superior variety of Shisham (Dalbergia sissoo) species. The medicinal plants study programme therefore, undertaken with aim not only at the conservation of species diversity but also at the genetic diversity existing within the range of the species. These varieties will certainly help us in the selection of the better parent material for higher yield per unit area and also higher resistance against diseases and environmental pressures like drought, water logging and excessive soil salinity.

In the recent years, the alarming rate of loss of some medicinal plants has become a matter of great concern to everyone. However, systematic efforts to conserve medicinal plants biodiversity have been negligible as far as Uttar Pradesh is concerned as compared to such efforts in other states, specially, Tamil Nadu, Kerala, Karnataka, Maharashtra and Gujrat.

*Homo sapiens* (human beings) have traditionally been directly as well as indirectly dependent on diversity in medicinal plants to larger extent. Increasing population pressure, along with related concomitant development like urbanization and industrialization, however, have led to our dependence on these
natural medicinal plants. Certain strategies of development have also resulted in shrinkage as well as erosion of ecosystem, ultimately leading to loss of plants. Coupled with these in appropriate agriculture methods discriminate and injudicious harvest of natural resources, fragmented population of species and introduction of Alien species have also lead to both quantitative as well as qualitative depletion of diversity of medicinal plants (Appanah, 2001).

Medicinal plants is a vast subject. Its understanding and conservation are further complex, but certainly not formidable. All the great variety that exists in living organisms – plants and animals and human being on earth reflects biodiversity in medicinal plants. The basic requirements to study Medicinal plant is a good knowledge of our abiotic factors, vegetational composition, soil characteristics and knowledge of impacts of developmental activities (Simpson and Bugna, 2001).

The district Saharanpur belt in the past was ignored in respect of developing a scientific understanding of the dynamics of the natural ecosystem and its floral diversity. The old religious traditions which associated foothills with dangers, catastrophes, supernatural events and poor accessibility impeded the process of building on the scientific knowledge. On account of pre-existing low level economic growth coupled with lack of infrastructural facilities needed for expanding the market economy, mountain areas were considered peripheral to core resource use area in lowlands. This apparent lack of attention left this ecosystem with a
paucity of data, and sketchy and scattered literature (Lacy, 1987), (Baltimore, 1993 and Sah et al., 1999).

India is recognized as one of the mega rich flora center in the world as its different climatic conditions provide it with a high variety of ecosystem rich with myriad types of biodiversity. The study of the forest ecosystem is not only interesting, but has also attracted a worldwide attention at present, due to environmental degradation and rapid decline in the wild life. The status of forest is depleting rapidly due to urbanization, industrialization and various other developmental activities. It is not only making the impact on human beings but also on wild flora and fauna (Agrawal et al., 1997, Kadavul and Parthsarthy, 1998).

The various species of plants and animals are becoming extinct or on the verge of extinction, mainly due to loss of their natural habitat and thereby leading to imbalance in the food chain with in their respective ecosystem. Apart from the loss of biodiversity the abiotic components are also under great change. This has made us concerned towards the importance of biodiversity not only for the sake of the ambience but because of the fact that existence of human race is under threat. India is very rich in flora diversity at ecosystem and species level and ranks sixth among twelve mega diversity areas of the world, as it holds two biodiversity hot spots out of 1.7 million globally described species, India posses 49219 species of flora 81251 species of fauna which represents 7% of the world’s species (Kumar and Asija, 2004).
GEOGRAPHICAL LOCATIONS OF THE AREA

The district Saharanpur lies between 29° 24' and 30° 30' North latitude and 77° 15' and 77° 55' East latitude. The altitude above the sea level varies from 270–900 meters. It is about 64 Kms in length from East to West and about 60 Kms in width from North to South district lies in the foothills of Shiwalik ranges. It is separated in the North from Haridwar and Dehradun district by the Shiwalik ranges; in the East from Muzaffarnagar district and in west with Haryana district and in south again district Muzaffarnagar present Saharanpur district touches two districts of Haryana i.e. Karnal and Yamuna nagar (fig. 1).

The district can be divided into three physical tracts namely Ghar, Khadar and the Bangar. The Ghar is sub mountainous belt below Shiwaliks covered with sand and soil accumulated from the mountains which have formed blackish layer. The Khadar is the hinterland – of the river of Ganges and other rivers. The Bangar slopes are from north to south with upper limits roughly running parallel to the Shiwaliks. The river Ganga passes through the area in north south direction. (Fig. 2a, 2b)

The area is mostly plain except the low hills in the north – west to north and north - east portion namely Shiwalik range which are covered by forest and a forest patch at the middle of area. The river Ganga passes through the area in north – south direction. The lands (plain area) are fertile and well irrigated. Wheat, rice, barley, gram, bajra and arhar are the main crops.
GEOLOGY OF SAHARANPUR

The district has rich fertile alluvial and well irrigated soil in its southern part or Bangar tract where as the northern part or sub mountain tract i.e., an area lying below the Shiwalik hills is less fertile. In the Khadar and sub mountain, areas there are many seasonal rivulets. The land being stony and sandy is unfit for agriculture.

Saharanpur region forms the beginning as well as northern part of the Ganga Yamuna “Doab” (do=two and ab=water). It presents many varieties of feature and is complex in itself. It has plain area as well as sub mountain area. The complexity of relief has influenced the distribution of plants in this region.

The region could be divided into: (i) The Shiwaliks; (ii) The sub mountain tract (Ghar); (iii) the Bangar and (iv) The Khadar.

(i) The Shiwaliks:

The water shed line of the Shiwaliks forms the northern boundary of this region. These hills are only 9 to 12 km broad in this district and are characterized by extremely rugged and serrated outline a feature which is continually exaggerated owing to the destructibility of the material of which the hills are composed. The Shiwaliks have remarkable even create between 700-940 meter. The highest peak is Amost crest (942 M) which now goes in Haridwar district.
(ii) **The Ghar or the Sub-Mountain Belt:**

Topographically Ghar is the most significant and complex part of the region running at the foot of the Shiwalik from West to East across the area on the northern boarder consisting of the two parallel strips.

(iii) **The Bangar:**

Below the Ghar tract, Bangar lands are found on the inter fluvial areas above the general flood limits. It occupies nearly 50% of the total land of Haridwar. Bangar lands are the old alluvium and are seldom liable to inundation. Topographically these plains are quite similar.

(iv) **Khadar:**

Khadar occupies the flood plains and grades in the slits of the most recent times. This strip is confined to the vicinity of the present channels viz. Ganga rivers have broad belts of Khadar land. These occupy nearly 25% of the area of the Saharanpur.

**TOPOGRAPHY**

Except for the Northern region which is occupied by the steep Shiwalik hills, the rest of the Saharanpur district shows even topography (Nevill, 1909 and JRC, 2003).

Chiefly topography of Saharanpur depends on Shiwalik ranges, rivers, canals and tanks. The river Ganga runs from north to south and the Shiwalik ranges forms hilly belt in the north. There is
a gradual slope of the district from north to south and hence all rivers run from north to south.

Apart from the main river Ganga and Yamuna which originate from Gangotri and Yamunotri respectively pass into Muzaffarnagar district through Saharanpur. Most of the other small rivers originating from Shiwalik ranges are Hindone, Solani, Pathari, Dhamola, Bhoori Ganga and Paon Dhoi etc. All these rivers drain through the north and later joins Hindone which further joins Yamuna or Ganga. River Kali and Bhoori Ganga which originate Khadar bases of Ganga during rainy season enter into Muzaffarnagar district.

To meet irrigation demand three important canals are developed from the Ganga and Yamuna water. These are Eastern Yamuna canal, Ganga canal and branch Ganga canal. From these canals certain small canals named as Rajbahe, have been constructed for irrigation purposes.

Besides river and canal irrigation is also done by tube wells, tanks, ponds and ditches etc. Ponds and tanks are usually full of water in rainy season and provide water for irrigation purposes.

District Saharanpur is one of the developed districts in the state of Uttar Pradesh with few large scale industries and some small scale units, along with sugar mill. Effluents of these industries also enter into streams which are also used for irrigation purposes at some places. The area of the forest has declined in this district in the last 10-20 years. At present forest area is
approximately 1100 hectares. This also has influenced topography of the area.

**SOIL**

Garg (1968) has divided the soils of this northern region into 5 categories. Based on settlement reports and Gazetteers he proposed following soils. This work done prior to Uttarakhal/Uttarakhand state formation.

(i) **Mountain Forest Soils:**

   It is found in Shiwalik forests and is of residual type. These are pod solized soils. The hill sides support thick forest of pine *(Pinus sp.* and Sal *(Shorea robusta)*).

(ii) **Sandy or Gravelly soils of Ghar Orb Sub Mountain Tracts**

   These soils are generally sandy or gravelly resulting into a deep substratum of stone and boulders which frequently rise to the surface. These soils are very important for the cultivation of groundnuts.

(iii) **Loam Clay or Soils and sands of Bangar:**

   Loam are the most important soils of the region and covers most of the North tract. Light loam, locally known as ‘Rausu’ varies in texture and ranges from light literite soil with a considerable admixture of sand to the softer kind of clay in which all crops can be grown with equal fertility at both harvest. The surface soil is yellow to brown in colour with a brownish yellow sub soil indicating good drainage. Heavy clay, locally called as
'Dakar' is found, here, in the depression of upper Doab and matches with the 'Motiyar' of other district.

Light sandy soil, is locally known as 'Shur' is found here on the higher levels. In Manglaur and Deoband parganas it is found in the form of long ridges and is called 'Ghar'.

(iv) Sandy soils of Khadar:

The river Ganga, Yamuna have the sandy soils in their near by areas. It improves in texture with an increase in the percentage of silt, away from the rivers. Yamuna and Ganga khadar sands are used for the cultivation of potato, onion and to some extent millets also. The sandy soils of upper Yamuna Khadar are used for the cultivation of groundnuts.

(v) The swampy soils of Pathari Forest:

The presence of tall grass, forest and bad drainage have made the soils of this part as swampy. It is liable to water logging during rainy season and sun baking during summers.

SOIL EROSION

Saharanpur region is seriously affected by the problem of soil erosion near foothills. Though the problem exists more or less everywhere in the catchment areas of the various rivers yet the more seriously affected area is the upper half of the region which is lying in the North of Dehradun-Haridwar Road and Chakrota road. South of these roads, the problems of soil erosion is of mild nature.
CLIMATE

The climate affects much on the biodiversity in a particular region. The climate of Saharanpur resembles a mixed average climate of Uttarkhand and U. P. in general, but its Northern position and its proximity to the hills give its own peculiarity. Though the region lies well outside the tropics yet its climate, like that of the rest of North India, is essentially tropical because of the Himalayan chain in the north.

The climate is typically monsoon with three distinct seasons i.e., summer (March to June), rainy season (July to October) and winter (November to February). The climate data (minimum and maximum temperature - °C, average rainfall - mm and relative humidity - %) has been worked out.

SUMMER SEASON

The average values for last thirty years shows that maximum and minimum temperature fluctuates from 29°C to 38.4°C and 12.9°C to 25°C respectively. The rainfall is low ranging between 6.3 to 136.7mm and relative humidity varies from 58.4% to 74.5%.

RAINY SEASON

The average values for last thirty years shows that maximum and minimum temperature fluctuates from 32.6°C TO 32.9°C and 16°C to 25°C respectively. Average monthly rainfall varies from 51.6-to 488 mm. During rainy season approximately 75 % of the total annual rainfall (1958.3 mm) is received. Relative humidity ranges from 85 to 89 %.
WINTER SEASON

Average maximum and minimum temperature recorded in the last thirty years ranges from 20.5°C to 26.4°C and 6°C to 8.8°C respectively. Rainfall fluctuates between 7.8 to 54.7 mm and relative humidity is very high ranging between 84 to 93.2 % being maximum in December and January. Due to very low temperature the plants are severely affected during the season.

WIND

Wind influences much to the climate of Saharanpur. The reversal of the prevailing winds occur twice in a year. In one part of the year the continental winds produce dry season, while Oceano winds in the other parts give wet season. The dry season prevails from November to middle of June, and divided into two periods-the cold and the hot season. The wet season, commonly known as the rainy season extents from the middle of the June to middle or end of October.