Chapter I

REVIEW OF LITERATURE

1.1 Weed Research in India :

Weeds are the biggest competitors for the economic crops, lawn grass, and open places left for beautification. They cause tremendous losses to production. The most conservative estimate give 11.6% loss of production in the world, and upto 25% are commonly accepted in India. From these estimates it can be calculated that India alone loses more than 13 million tonnes of food grains annually, due to weeds.

In India uptill now extensive weed research had been done and is in progress, of which literature is available in diverse reports, numerous research articles, proceedings of seminars published in various journals and books. Some of the important books comprising the weed research study are -

"Weeds' By Walter C. Muenscher (1962)

"Weed Control As A Science, By Glenn C.Klingman (1978).

"Weeds of the World, By Lawrence J. King (1974).

'Crop Production and Field Experimentation' By Vaidya, Sahasrabuddhe and Khuspe (1978).

'Ecological Approaches to Indian Weeds, By David N. Sen (1981).

'Weed Science, By Kingman, Ashton and Noordhoff (1982).

'Principles of Weed Science, By V.S.Rao (1983).

'Bibliography of Indian Weeds, By Gupta and Mittal (1983).

Rao, (1979) reported on the currnt status of weed research in India. According to him all states of India, near about 42 weed research 'Units' in different universities and Research Institutions are engaged in study of -

- Weed Taxonomy
- Weed Biology and Competition
- Herbicide Screening

- Adjuvants and Antidotes
- Herbicides residue
- Mode of Action of Herbicides
- Integrated Weed Management
- Extension of Weed Research to Farmers
- Herbicide Certification and Registration
- Aquatic Weed Control
- Weed Control in Non-agric and Non-aquatic systems.
- Spraying and Spray Equipments.

Universities and Research Institutions in India, where work on weeds is in progress can be listed as

Andhra Pradesh Agri. University, Baptala.

Sri Venkateshwara University, Tirupati.

International Crop Research Institute for Semi Arid Tropics, Hyderabad.

Allahabad Agriculture Institute, Allahabad.

G.B.Pant Univ. of Agri. and Tech., Pantnagar.

Haryana Agri. Univ., Hissar.

Orissa Univ. of Agri. and Tech., Bhubaneswar.

University of Agri. Sci., Bangalore.

Visva-Bharati Univ., Santiniketan.

Calcutta University, Calcutta.

University of Jodhpur.

Central Rice Research Institute, Cuttak.

Indian Institute of Sugarcane Research, Lucknow.

Soil and Water Management Research Station,
Govt. of Rajastan, Kota.

In Maharashtra, Universities having weed research unit are -

Mahatma Phule Krishi Vishwa Vidyalaya, Rahuri.

Marathwada Agricultural University, Parbhani.

Marathwada University, Aurangabad.

Panjabrao Krishi Vidyapeeth, Akola.

Binswanger and Shetty (1977) from their village studies in the Akola, Mahbubnagar and Solapur districts concluded that weed control activity is clearly related to the quality of the resource base. The better the growth environment for the plants and weeds, the more and better weed control is undertaken by farmers. These authors also concluded that for dryland crops herbicides use cannot be advocated at present on the basis of cost consideration in the semi-arid tropics of India. Weed scientists have to look to the problems of poor and rich farmers.

In our Shivaji University, Kolhapur the weed research is also in progress. Various weeds are studied for their basic physiology and the data can finally add towards the basic information in control of the weeds. The weed research in Shivaji University Laboratory can be summarised as :

A notorious weed Parthenium hysterophorus was studied in detail with respect to its Autecology, Physiology and Chemical and Biological Control by Patil (1980).

Karadge (1981) has worked out Portulaca oleracea, a succulent weed for its Basic Physiology.

Photosynthesis and Senescence in Alternanthera ficoidea and Alternanthera paronychioides weeds have been studied in detail by Pathan (1982).

A grass Cymbopogon martinni was investigated for its eco-physiological aspects by Sabale (1983).

Upadhye (1986) has worked out Trianthema monogyna (a common C_4 succulent dicot weed) and Pennisetum purpureum (a C_4 monocot weed) for their physiological changes during leaf ontogeny.

1.2 Autecology of Weed :

Ecological study of individual species is referred to as autecology. Ecological life histories of individual species of a community give an understanding of adaptations and interrelationship between plant species and their home. Further autecology of a species and its populations reveals the kinds and the extent of plant responses at various stages of growth to stresses of environmental components. Such studies on individual species have been first conducted at the time when man started agricultural practices. Later on more emphasis on such studies was given on economically important plants. Uptill now near about 30,000 species of weeds have been recorded around the world, out of which nearly 18,000 cause serious damanage in different ways and remaining were found to be more or less useful to human beings (Sen, 1981). So it is extremely important for a weed-biologists to identify weeds in the field.

Autecological studies on weed helps in controlling the weeds to save precious crops from their devastations or it helps in bringing the economically important weed under cultivation. For controlling weeds in any habitat one must know all aspects in the life cycle of a particular weed, such as the types of seed, polymorphism in seeds, seed germination mechanism, seed dormancy, growth requirements, establishment of seedlings, root growth, flowering and

fruiting, perennation through rootstocks, rhizomes, etc. If the weakest link is the life of a weed is known then it is to be attacked at that particular stage for its control. In real sense the aim of such a study is not to study the environment. Autecology helps in understanding how that particular plant species flourishes in the environment.

Importance of autecological researches has been emphasized by Harper (1957), Whitehead (1957) and Misra (1958). Pelton (1951, 1953) regards that life cycle studies help to explain the structure and dynamics of communities themselves. Autecology forms the working basis for the study of the community and development of vegetation. Salisbury (1928) pointed out that the progress of study of plant communities is greatly limited due to the lack of information about the life histories and biotic relationships of the constituent species. Misra (1958) is of opinion that the ecological life cycle studies of important species of a community help to establish the relationship between plants and their environment. The importance of autecological information on applied plant sciences especially forestry, range management, soil conservation and weed control has also been emphasized by Sampson (1917), Olmasted (1941), Duncan (1952). Indeed, agriculture and silviculture are rightly regarded as extensions of autecology (Pandeya et al., 1968).

In India autecological studies were mainly initiated with forest trees of high economic importance (Nicholson, 1945; Chakrawarty, 1948 and Bhatia,1955) Autecological study of some Indian forest trees like Tectona grandis (Dhareshwar, 1939; Khan and Chatterjii, 1944); Boswellia serrata (Sharma, 1955), Dendrocalamus strictus and Dalbergia sissoides (Kadambi, 1949) has been carried out.

The beginning of such studies on herbs in India was made by Mukerji (1932) who studied the genus Artemisia, its species and ecads occurring in Kashmir. Panja and Kar (1932) studied the germination behaviour of water hyacinth. Misra and Rao (1948) worked out the ecology of Lindenbergia polyantha. By now a fund of information has accumulated on herbaceous species of grass land, marsh-land and fresh waters through the work of Misra (1944), Shrivastava and Tandon (1951), Ramakrishnan (1960, 1962), Tripathi (1965, 1968), Srivastava (1967), Das (1968), Shukla (1969), Sharma (1970), Sharma and Sen (1972), Gupta (1973), Lal (1976), Sen (1977), Shinfe (1978), Bartakke (1977), Sharma and Sen (1980), Patil (1980), Karadge (1981), Pathan (1982), Yadav (1983), Sabale (1983), and Upadhye (1986).

not listed in ref.

These studies have contributed a lot of information about distributional pattern, seed germination and growth behaviour of the weed species under different environmental parameters.

In light of literature referred, it was thought interesting to study the autecology of Euphorbia gniculata. Present work is a primary attempt towards understanding of basic eco-physiology of E. geniculata.

1.3 Seed Attributes :

Seed is a critical stage in the life cycle of plant. It is the primary means of survival mechanism of weeds. Successful establishment of weed depends upon its seed and seed attributes. Weeds through their seed reproduce, multiply, invades newer and newer areas and tide over extreme conditions of the environment.

In general weed seeds are, light in weight, with low seed index and moisture content, produced in enormous quantity, colour and size is well adapted to crop seeds, provided with special structures for ease dispersal, long lived, with high germination and viability percentage, better seed vigor and with wide ecological amplitude (Kozlowski 1972, Sen 1981, Kingman et al., 1982 and Rao 1983).

Ramakrishnan (1960, 1961) have investigated seed output, germination percentage and reproductive capacity of different species of Euphorbia e.g. Euphorbia hirta and Euphorbia thymifolia.

Seed vigor in terms of speed of germination was studied by Wanjura et al. (1969) in cotton, while the same aspect is worked out by Larson (1961) in Pinus ponderosa.

Portulaca quadrifida a common weed, was worked out for it's seed attributes by Shukla (1971). Ramakrishnan and Kumar (1971) have studied seed output of Cynodon dactylon grown in Maize crop. A comparative study of seven different weeds with respect to their seed output and reproductive capacity was made by Sen (1977). Viability and germination % of immature and mature seeds of Asphodelus tenuifolius was worked out by Tripathi (1977).

Bansal and Sen (1978) made a comparative study of two forms of Cucumis callosus with respect to their fruit and seed size, number of seeds per fruit and weight of 100 seeds. Seeds of Chenopodium album and Chenopodium murale were analysed for their dry weight by Bhati et al., (1979). Studies on germination percentage of seeds of Burleria articularis were carried out by Bansal (1978).

Argemone mexicana, a troublesome weed was evaluated for its seed output by Sharma and Sen (1980). Dagar et al. (1976) and Patil (1980) studied a notorius weed Parthenium hysterophorus with respect to its seed attributes.

Seed and seed germination study of Psoralea corylifolia, Tephrosia purpurea and Withania somnifera was done by Yadav (1983). Recently Mulik and Bhosale (1985) have studied seed attributes and autecology of Acanthus ilicifolius.

Considering the importance of seed attributes Narchoo et al., (1986) have worked out the seed and fruit characteristics of hundred different weeds in Kashmir region. Present dissertation work - "Eco-physiology of E. geniculata" is strengthened by the study of the seed attributes of E. geniculata.

1.4 Leaf Architecture :

Leaf has got a paramount importance in the plant body because it is directly concerned with photosynthesis and thereby all living world. It is a well established fact that there is a close relationship between leaf architure and photosynthetic path. The internal morphology of the leaf is complex and varies considerably from species to species.

Now a days on the basis of path of carbon assimilation and associated characters all higher plants are broadly divided into three types as C_3, C_4 and CAM plants (Downton and Treguna, 1968; Kluge and Ting, 1978). Each group is characterised by its own leaf architecture.

Majority of the higher plants follow C_3 pathway. In general C_3 plants are characterised by dorsiventral leaves. In it mesophyll is differentiated into pallisade and spongy. One or more compact layers of palisade parenchyma lie

next to the upper epidermis of leaf. The cells of palisade parenchyma are elongated and regularly oriented with their long axes at the right angles to the leaf surface. The spongy paranchyma lie in the lower part of the leaf. Cells are irregular in shape, arranged much less compactly with numerous inter cellular spaces (Monson et al. 1984). Further interveinal distance in C_3 plants is much more when compared with C_4 plants (Crookston and Mass, 1974).

Of the approximately 3,00,000 species of flowering plants about 1000 have been reported to be C_4 plants (Noggle and Fritz, 1986). The different families representing C_4 plants are listed by Raghvendra and Das (1978). The different families are : Acanthaceae, Aizoaceae, Amarantaceae, Asclepladaceae Asteraceae, Boraginaceae, Capparidaceae Caryophyllaceae, Chenopadiaceae, Cyperaceae, Euphorbiaceae, Liliaceae, Nyctaginaceae, Poaceae, Polygalaceae, Portulacaceae, Scrophuloriaceae and Zygophyllaceae. It is possible that this list will keep on increasing and more plants and families will be added from time to time.

The C_4 plants are characterised by a wreath-like or 'Kranz' leaf anatomy (Rathnam and Chollet, 1980). In 'Kranz' leaf anatomy there are two functionally distinct chloroplast containing photosynthetic cell types. These two cell types are generally arranged in two concentric layers around the vascular bundles. The outer layer of the cells is termed as mesophyll and the cells that surrounds the vascular bundle are termed as bundle sheath cells. In C_4 plants the distance between the leaf substomatal cavities and vascular bundles is relatively short, and the presence of a less extensive leaf-air space system implies a greater tissue density per unit leaf volume than in the C_3 leaves.

Non-succulent higher plants have been classified either as C_3 or C_4, with 'Kranz' considering as a reliable indicator of C_4 syndrome (Ellis, 1977; Laetsch, 1974). All available evidence indicates that species with C_4 photosynthesis have evolved from C_3 plants (Laetsch,1974; Bjorkman, 1976). Recent attempts to find naturally occuring C_3-C_4 intermediate species have met with some success

There are few C_3 - C_4 intermetiate plant species. Panicum milicides is one of them. In general C_3 - C_4 intermediates have an obvious chloroplast containing layer of bundle sheath cells, but the bundle sheath cells are not thickned as in C_4 plants. In C_3-C_4 intermediate numerous chloroplasts are arranged in a centripetal position in bundle sheath cells (Morgan and Brown, 1979; Holaday et al., 1981; Winter et al., 1982). The interveinal distance and the number of mesophyll cells between veins in C_3-C_4 intermediate plants is in the range of intermediate between C_3 and C_4 plants (Morgan and Brown, 1979)

Succulence i.e. thickness of the leaf is also a parameter to judge whether there is occurrance of Crassulacean Acid Metabolism (CAM) as discovered by Kluge and Ting (1978). CAM leaves are characterised by presence of water storage tissue and thin walled large photosynthetic cells with large vaccuoles.

Hegde and Patil (1981) have studied a weed, Parthenium hysterophorus for its eco-physiology. They have shown 'Kranz' leaf architecture in 'Parthenium which is basically a C_3 plant. The development of 'Kranz' in Parthenium seems to be an indication of evolutionary nature towards C_4 path which is refelected in Asteraceae. These results show that Kranz leaf architecture can appear in C_3 plants also. Simultaneously there are some examples which show C_4 plants without 'Kranz' e.g. Suaeda monecia (Shomer Ilan et al.,1975), Ipomoea pes-caprae (Joshi et al., 1982).

In light of the litereature cited above it was very interesting to study the leaf architecture of Euphorbia geniculata along with other parameters.

1.5 Stomatal Studies :

Stomata are minute pores of an elliptical shape. They are present in the epidermis, and especially abundant on the lower epidermis of the leaf. Typically every stoma is surrounded by two specialised epidermal cells called guard cells. The guard cells are kidney shaped in dicotyledons and dumbell shaped in Gramineae. Each guard cell has cytoplasm with nucleus, chloroplast and a central vacuole. The wall of the guard cell bordering the opening is thick and inelastic called ventral wall and the wall away from the opening is thin and elastic, called dorsal wall.

The position and distribution of stomata on the two surfaces of the leaf varies from plant to plant. In most of Angiosperm tree and shrubs the leaves have stomata restricted to the lower surface (hypostomatous leaves). In few water plants with floating leaves stomata are restricted to the upper surface (epistomatous leaf). While in most of herbaceous plants they are found on both the surfaces of leaf (Amphistomatous leaf) (Wilkins, 1969).

In general, stomata show a diurnal periodicity, closing at night and opening during the day. The opening and closing of stomata is chiefly controlled by the changes in the osmotic pressure and turgor pressure within the guard cells. When the guard cells are turgid the stomata open and when they are flaccid the stomata are closed.

On the basis of opening and closing behaviour of stomata Loftfield (1921) has classified stomata into three main groups as follows :

1) Alfaalfa Type : The stomata are open throughout the day and night.

2) Potato Type : The stomata are open throughout day and night except for a few hours in the evening.

3) Barley Type : The stomata in this case are open only for a few hours during the day.

Stomata plays very important role in plant metabolism. It regulates exchange of respiratory and photosynthetic gases like Co_2 and O_2 between leaves and the external atmosphere and loss of water vapour in transpiration.

It is well known that there is a positive correlation between the stomatal behaviour and path of photosynthesis (Joshi, 1976; Das and Santakumari,1977 Wardley and Simpkins, 1980; Solarova et al., 1981).

Joshi (1976) has showed that in most of plants stomata tend to open during the day and closes at night.

However in CAM plants stomata opens at night and usually are closed during most of day (Klug and Ting, 1978).

Plants growing in hot climates have wide stomatal opening in the morning and partial or even complete closure sometimes after midday followed by reopening in the afternoon (Davies and Kozlowski, 1974).

Now a days stomatal behaviour is co-related with the photosynthetic path Das and Santakumari (1977) have observed maximum stomatal opening at 10.00 a.m. in C_3 plants while in C_4 plants it occurs at 12.00 p.m. It is further concluded that stomatal frequency can also be used as a guide in determining the pattern of photosynthesis.

However stomatal frequency varies among plant species, from leaf to leaf of the same plant and even in different parts of same leaf. Location, number and distribution of stomata on upper and lower epidermis of leaf also varies (Noggle and Fritz, 1986).

It is generalized fact that there is a correlation between diurnal variations in stomatal behaviour and rate of transpiration, relative humidity, diffusive resistance for water vapour and Co_2, light quantum and leaf temperature (Noggle and Fritz 1986, Hegde and Patil 1985, Upadhye 1986, Chavan 1987, Mulik and Bhosale 1988, Ishihara et al., 1987).

In order to understand the basic physiology of weed under investigation, we have added one more parameter under the title stomatal studies.

1.6 Nitrogen Metabolism :

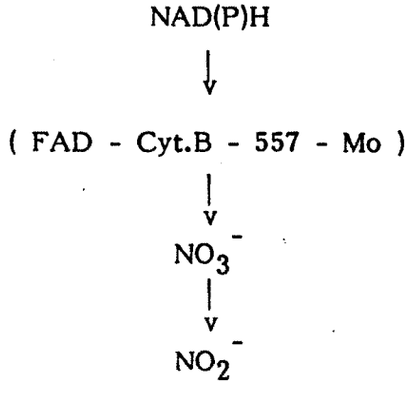
As E. geniculata is a nitrophilous, shade loving weed and more emphasis is given on the nitrogen metabolism, a brief idea of basic nature of nitrogen metabolism in plants has been reviewed.

Most of the higher plants prefer NO_3^- as a nitrogen source. Assimilation of NO_3^- is a continuous process beginning with uptake of NO_3^- by the roots. The NO_3^- absorbed must be reduced to ammonia which is then assimilated into organic compounds mostly amino acids and then proteins.

Reduction of NO_3^- to NH_4^+ takes place both in the leaves as well as in roots which is achieved in two stages involving enzymes nitrate reductase and nitrite reductase. Nitrate reductase -NR (EC 1.6.6.2) catalyses reduction of NO_3^- to NO_2^-. The enzyme was originally isolated from Neurospora (Nason and Evans, 1953). The enzyme from higher plants shows a specific requirement

for NADH (Beevers and Hageman, 1969). For reduction catalysed by NADPH, NADPH is 1st converted into NADH and actually NADH donates electrons. $FMNH_2$ and $FADH_2$ can also act as electron donors. Essentiality of molybdenum for NO_3^- reduction has been demonstrated by Aparicio et al.,(1971) and Notton and Hewitt (1971). The enzyme is present both in the leaves as well as in roots. In roots it is present in the cytoplasm. While in the leaves it is present either in cytoplasm or loosely attached with outer membrane of chloroplast. In the leaves of C_4 plants nitrate reduction occurs in mesophyll cells (Moore and Black, 1979; Losada et al. 1981).

Nitrate reductase is a complex, oligomeric enzyme having molecular weight 197 to 460 K daltons (KD) and is composed of a variable number of apparently identical sub-units. FAD, cytochrome b-557 and Mo are ubiquitous prosthetic groups. The enzyme consists of two subunits, one flavin and second flavo-protein with molybdenum. Flavin component accepts electrons first, then transferred to FAD and flavoprotein components and Mo is essential for this transfer. Finally electrons are accepted by NO_3^- which itself gets reduced to NO_2^-. The reaction is summarised as,



The NO_2^- thus produced is further reduced to NH_3^+ and this reduction is catalysed by another important enzyme system, nitrite reductase - NiR (EC 1.6.6.4)

In the leaves this enzyme is present in chloroplast probably in thylakoids, while in roots it is present in protoplastids. NiR presents a marked specificity for ferridoxin as electron donor (Vega et al., 1980). Flavodoxin can substitute ferridoxin. The molecular weight of ferridoxin NiR is between 60-70 Kg. Reduced ferridoxin which is a result of noncyclic photophosphorylation provides reducing power. The enzyme possesses iron porphyrin prosthetic group, 'siroheme'. Iron-sulphur centre of this enzyme plays an important role in NO_2^- reduction. Electrons from reduced ferridoxin are transferred to iron sulphur centre first and then to siroheme and finally electrons are accepted by NO_2^- which is reduced to NH_4. The overall reaction can be represented as,

Ferridoxin reduced

↓

|(4Fe - 4S) - Siroheme|

↓

NO_2^-

↓

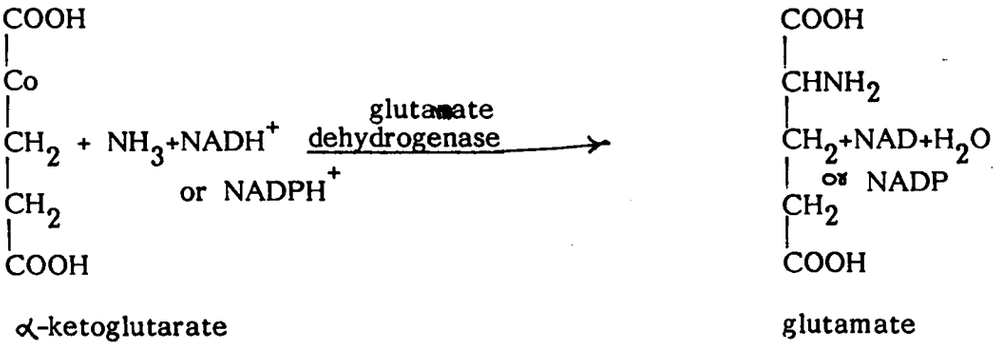
NH_4^+

Nitrite, the substrate of the enzyme is bound to the siroheme centre of NiR.

In roots the enzyme is associated with proplastids which are rich in enzymes of pentose phosphate pathway, which in turn can produce NADPH. But NADPH transfers the electrons via some intermediate to NO_2^-. However, such intermediate is not demionstrated.

The end product of nitrate reduction is NH_4^+. It is further incorporated into organic compounds. For many years it was thought that the most likely pathway of ammonia incorporation was through the reaction known as reductive amination catalyzed by enzyme glutanate dehydrogenase. In the presence of

glutamate dehydrogenase, ammonia combines with α-ketoglutarate in a reductive amination to produce glutamate. This was assumed primarily on the careful kinetic experiments with $^{15}NH_3$ with the yeast, Candida utilis (Smis, et al.,1968). The reactioin in reductive amination is as,



α-ketoglutarate glutamate

The bulk of the enzyme is located in the mitochondria and utilizes $NADH^+$ preferentially. Additionally, there have been reports of an $NADPH^+$ glutamic dehydrogenase (Givan, et al., 1970) located in the chloroplasts and the enzyme has been suggested to function extensively in ammonia incorporation in leaves. Since the enzyme glutamate dehydrogenase was found to be localized in mitochondria it is now believed that the enzyme plays a catabolic role rather than anabolic one. Tempest et al., (1970) demonstrated a new enzyme from Aerobacter aerogenes (now Enterobacter aerogenes) called glutamate synthase which, when preceded by glutamine synthetase would allow an alternative route with net synthesis of glutamate as follows,

Glutamine synthetase / glutamate synthase pathway :

1. NH_4^+ + ATP + glutamate
   ↓ glutamine synthetase
   Glutamine + ADP + Pi

2. Glutamine + α-oxoglutarate + $NAD(P)H^+$
   ↓ glutamate synthase
   2 glutamate + $NAD(P)^+$

Studies on both glutamine synthetase and glutamate synthase from bacterial sources suggested that on kinetic grounds this might be more effective pathway of ammonia incorporation than glutamate dehydrogenase, particularly in a "scavenging" situation where ammonia concentrations are very low.

Subsequently glutamate synthase has been observed in a wide range of non-photosynthetic plant cells (Dougall and Bloch, 1976), in pea roots (Miflin and Lea, 1975) and in developing pea cotyledons (Beevers and Storey, 1976). Miflin and Lea (1974) showed that both glutamine synthetase and glutamate synthase are localized in chloroplast. Which indicate that the ammonial assimilation is coupled with photosynthetic process in the leaf tissue.

Once assimilated into an amino-group, nitrogen may be subsequently be distributed among the variety of metabolites in plant cells during transamination reactions. Transamination catalyzed by an aminotransferase is dependent upon the formation of a Schief base between enzyme-bound pyridoxal phosphate and an amino donor. The derived enzyme-pyridoximine complex reacts in turn with a keto acid to form a new aminoacid and to regenerate pyridoxal phosphate. The sum of these partial reactions is as -

$$R_1 . CH (NH_3^+) COO^- + R_2 . CO. COO^-$$

$$\downarrow\uparrow$$

$$R_1 . CO. COO^- + R_2 . CH (NH_3^+) COO^-$$

Aminotransferases are located in the cytoplasm, chloroplates, mitochondria and microbodies. They play a key role in the biosynthesis of various protein and non protein amino acids and the process in many instances hinges upon the

capacity to form the appropriate precursor. The carbon skeletons of the lower amino acids are derived from very few metabolic intermediates, each of which is associated with a central metabolic pathway. These pathways include reactions of photosynthetic carbon metabolism, glycolatic pathway, pentose phosphate pathway and the tricarboxylic acid cycle. Bryan (1976) has summarised the path ways and intermediates of amino acid biosynthesis and according to him about 89 different enzymes participate in this process.

Amino acids in addition to their function as precursors in protein synthesis, serve as intermediates in the synthesis of other cellular constituents and are also capable of undergoing extensive interconversions. Thus, variety of organic compounds such as purines, pyrimidines, porphyrins, vitamins, coenzymes, alkaloids, glycosides, polyamises and plant growth regulators receive their nitrogen component through these complex reactions.

Study of key enzymes of nitrogen metabolism will add towards understanding the metabolic process. Hence enzymes nitrate and nitrite eductase are worked out.

1.7 Seasonal Variatiions in Physico-Chemical Constituents :

It is a generalized fact that environmental conditions created due to climatic and edaphic factors varies from month to month or from season to season. This variation in environmental condition exert an influence upon the life processes of plants. To cope up with this changed environment, metabolic processes of plants alter and as a result physico-chemical constituents of plant varies from season to season.

Patil and Joshi (1967) and Joshi and Gowda (1975) have studied seasonal variations in the inorganic constituents of the sea water from Bombay and Ratnagiri.

Seasonal variations in inorganic constituents have been studied from different plants by different workers. They can be listed as -

- Young and Langille (1958) in Chondrus crispus.
- Patil (1967) in Ulva lactuca.
- Gowda (1971) in Sargassum ilicifolium.
- Mishra (1967) in Clerodendrum inerme.
- Bhosale (1974) in Aegiceras majus, Acanthus ilicifolius and Avicennia officinalis.
- Joshi (1970-1975) in eight mangrove species.
- Jamale (1975) in four species of mangrove namely Sonneratia acida, Rhizophora mucronata, Avicennia alba and Excoecaria agallocha.
- Shinde (1981) in Aegiceras corniculatum and Sesuvium portulacastrum.
- Kotmire and Bhosale (1979) in estuarine plants.
- Waghmode and Joshi (1982) from Aeluropus lagopoides.
- Sabale (1983) from Cymbopogon martinni.

Recently Joshi and Anjaiah (1985) have investigated seasonal variations in proteins and mineral constituents in various parts of Atriplex griffithii.

Euphorbia geniculata Orteg. is a common weed and found to be rich in its proteins and 'Geniculatin', a triterpenoid saponin (Tripathi and Tiwari 1980). It germinates and flowers throughout the year which leads to the prediction that it has a wide ecological amplitude.

However, seasonal variations in physico-chemical components will also add towards the knowledg of basic eco-physiology of E. geniculata and hence attempted in present investigation.

1.8 Pathophysiology :

Plant pathology is the study of the diseases of plants and covers the entire field of biological and scientific activity, concerned with the understanding of this complex phenomenon. Pathology is thus the study of the nature, development and control of plant diseases. Disease, is a complex phenomenon and is difficult to define in a few words. Stakman and Harrar (1957) defined plant disease as a physiological disorder or structural abnormality that is harmful to the plant or to any of its part or products that reduces the economic values.

In recent years, much of the earlier symptomological approach to the problems of plant disease has given way to an integrated study of cause and effect. It is now becoming increasingly clear that a sufficient knowledge of plant physiology and biochemistry is essential for interpreting the metabolic changes in diseased plant.

The physiology and plant pathology represents those specialities within plant pathology which focus on the physiological and biochemical activities of pathogens (which causes disease) and on the response of host plant (diseased plant). A study of pathogenesis (metabolic events that bring about the disease in plant) involves not only an understanding of the alteration in normal metabolism of plant, but also a knowledge of those factors used by pathogens in attack of host tissues. Thus such a physiological plant pathology mainly deals

w ith the activities of toxins, enzymes and growth regulators as factors involved in pathogenesis and changes in metabolic pathways in the diseased plants.

It is generalized fact that, pathogen from fungi, Bacteria, viruses etc. causes diseases in the plants. Pathogen during its establishment in the host tissues, disturbs or alters the normal metabolism of host plant. It affects the process of photosynthesis by destructing chloroplast and chlorophyll. Reduced chlorophyll content and increased chlorophyllase activity has been reported by Peterson and Mackinney (1938) for mosaic diseases caused by four viruses. Montematini (1904) claimed for some Uredinales and later Grecusnikow (1936) for oat rust, that photosynthesis is raised for a short time after infection and then drops rapidly.

McCombs and Winstead (1964) Hasija (1968), Vidhyasekaran et al. (1974) and Sasikumaran et al., (1979) have studied the effect of infection on carbohydrate status of the host tissue. They have observed that infections modify the carbohydrate metabolism of the host plant.

Increased respiration is known to be general phenomenon in the physiology of diseased plants. This has been demonstrated in several host plant infected by fungi, bacteria and viruses. Fischer and Gaumann (1929) showed that there is a more or less steep increase in respiratory rate, in early phases of disease to a peak followed by a decline. Allen (1954) suggested that stimulation of anabolic process in infected tissues could also cause an enhancement in respiration. Now it is well known that pathogen enhances respiration in host plants by acceleration of ATP utilizing system, induction of respiratory enzyme systems not involving phosphorylation, and uncoupling of oxidative phosphorylation.

As amino acids are good nutritional source for pathogen, pathogen decom poses proteins of the host plant and thereby affect the nitrogen metabolism of plant. Infected plants show change in the quality and quantity of their proteins. Some proteins are also formed by the pathogens themselves in the infected cells. Several workers have reported changes in protein synthesis of the host cells due to fungus infection (Pozsar et al. 1966, Kiraly et al.,1966, Izawa, 1974, Arjunan, 1976).

According to Benoit et al., (1978) infections modify the normal inorganic metabolism of the host. They further state that host nutrition influences plant diseases and relationship between the two is quite complex. The role of particular element in various hosts remain more or less similar but different hosts responds differently to nutrients and their response differs against the attack of plant pathogens.

Uptill now number of plants have been worked out for its pathophysiological studies by different workers. Some of them can be listed as,

- Scott and Smillie (1966) have worked out pathophysiology of barley plant infected with powdery mildew.
- Sivaprakasam et al (1974), of bringal plants infected by Verticillium dahliae.
- Izawa Koichi (1974) of Italian rye grass infected by Puccinia coronata.
- Montalbini et al., (1975) of Peach plant infected by Taphrina deformans.
- Gupta (1975) of Coriander infected by stem gall disease.
- Srinivasan and Jeyarajan (1976) of Grape infected by downy mildew.
- Patil and Kulkarni (1977) of sunflower infected by Puccinia helianthi.
- Sarkar and Joshi (1977) of brinjal plant infected by little leaf disease.
- Hegde and Karande (1978), of Pennisetum typhoides infected by green ear disease.

- Kulkarni and Kulkarni (1978) of mango infected by Capnodium ramosum.
- Ryzhikova (1979) of sugarbeets infected with powdery mildews.
- Sankpal and Nimbalkar (1980) of sugarcane var. Co-740 infected by smut.
- Thite et al. (1980) of teak plant infected with powdery mildew fungus.

Recently Gharge (1984) has worked out pathophysiology of Arachis hypogaea, Ricinus communis and Cassia sophora infected by rust Puccinia arachidis, Melampsora ricini and Uromyces cassiae respectively.

Euphorbia geniculata Orteg. under present investigation is found to be infected with rust, Melampsora. Further it is thought that, E. geniculata may act as a vector for spread of disease in cultivated fields of maize, cotton, sugarcane etc. So by considering above literature on pathophysiology, an attempt has been made to study the effect of Melampsora infection on the basic physiological process of E. geniculata.

1.9 Genus Euphorbia :

In the family Euphorbiaceae, the genus Euphorbia is the largest one represented by more than 1600 species (Lawrence, 1973). All species are almost cosmopolitan in distribution but majority confined to the tropics (Kerner 1904, Good 1964).

Genus is distinguished by various habit like herbs, shrubs or small trees with milky juice, stem slender and leafy or thick and fleshy and sometimes leafless or nearly so. Leaves opposite or less commonly alternate. Flowers monoecious, combined in a cyathium inflorescence of many male florets surrounding a solitary female, arranged in a common 4-5 lobed perianth-like involucre with thick glands at the mouth, each gland often bearing a petaloid spread-

-ing white or colored limb. Male flower a stalked stamen without floral envelope. Female flower : ovary 3 celled on an ultimately exserted stalk in the centre of the involucre, ovule solitary styles 3, free or connected. Fruit a capsule of three 2 valved cocci. Seeds albuminous (Cooke, 1908).

In India, genus Euphorbia is represented by more than 40 common species (Cooke 1908, Vasishta, 1984). Out of these majority of Euphorbia species are recorded as weeds of cultivated fields and gardens (Muenscher, 1962 and Sutaria 1966, Reddi and Reddi 1962). Common weed species of Euphorbia are - E. corollata, E. cyparissias, E. dentata, E. esula, E. helioscopia, E. lucida, E. naculata, E. marginata, E. peplus, E. supina, E. vermiculata, E. hirta, E. heterophylla, E. microphylla, E. geniculata.

The early work on Euphorbia species was found to be related with its taxonomy, distribution, weed control, cyto-taxonomy, reproductive biology, pollination ecology, and biochemistry.

Good (1964) reviewed geographical distribution of Euphorbia species, while taxonomy of genus was studied by Croizat (1936). Cytotaxonomical studies were carried out on eighteen species of the genus Euphorbia by Mehra and Choda (1978). Ehrenfeld (1976, 1979) have worked out reproductive biology of three species of Euphorbia subgenus Chamaesyce.

Hammouda et al. (1984) investigated constituents of the latex of E. royleana. Epicuticular waxes from leaves of five Euphorbia species were analysed by Hemmers and Guelz (1986). Lynn and Clevette (1986) studied lectins from latices of Euphorbia and Elaeophorbia species.

Latex sera from 18 Euphorbia species (E. characias, E. cyparissiae, E. esula, E. helioscopia, E. lathyris, E. platyphylla, E. coerulescence,

E. cylindrifolia, E. globosa, E. hermentiana, E. lactea, E. lactea cristath, E. mammillaris, E. splendens, E. stapelioides, E. tirucalli, E. trigona, Elaeuphorbia drupifera) were analysed for protein, carbohydrate and total solid content (Lynn and Clevette, 1987). Groeneveld et al. (1987) studied sites of in-vitro triterpene synthesis in Euphorbia latex. Ramakrishanan (1960, 1962) studied autecology of euphorbia hirta and ecological life history of Euphorbia thymipolia.

Euphorbia geniculata Orteg. under investigation was worked out early for its cyto-taxonomical studies (Mehra and Choda, 1978), biochemistry (Tripathi and Tiwari, 1980), pollination ecology (Reddi and Reddi 1984), control in cultivated field of Maize (Rao, 1983). However, information about its autecology, basic physiology and pathophysiology etc. is scanty.

Considering this literature it was thought worthwhile to study and compile the various parameters of eco-physiology of E. geniculata.