CHAPTER - I

Review of Literature

1. INTRODUCTION :-

The *Sansevieria* is one of the important genus belonging to Agaraceae furnishing the fibers. Most well known "bow-stringhemo" fiber is obtained from *Sansevieria roxburghiana.* The *Sansevieria trifasciata* leaves also yields the fibers. Several other species are cultivated for good source of fibers. This fiber is not popular on the market as *Agave* fiber. But they are as good as Jute fiber. The *Sansevieria* is a perennial and monocarpic plant i.e. flowering is followed by death. The plant multiples by suckers. The *Sansevieria* species are wild as well as cultivated in garden, as in good indoor succulent plant. The leaves are rosette dark green in colour. fleshy concave, sharp pointed with golden edges. *Sansevieria* is one of most popular of all house plants. The basic species *Sansevieria trifasciata* is smaller, less popular but other verities are cultivated as evergreen indoor foliage plant.

2. TAXONOMIC POSITION :-

Earlier the genus *Sansevieria* was include in the family Lilliaceae, (Lawrence 1955). The Lilliaceae has been considered by botanist to represent the basic monocot stock of primitive and typical family having 240 genera and 400 species. (Lawrence 1955).

Dewit(1965), include the most allied species along with *Agave* in separate family Agavaceae rather than Amaryllidaceae. The genus *Sansevieria* is much more similar in vegetative and floral character to Agave was also classified in to the Agavaceae.

Datta (1988) has included the genus Sansevieria in Lilliaceae. However, the validity of this classification and particularly the delimitations of the individual families continuous to be a subject of controversy among taxonomist. The present research work is not dealing with taxonomic aspect of Sansevieria but it is only restricted to its physiological studies. The floral morphology show affinities of the genus to Agavaceae, hence for present studies the genus is considered to belongs Agavaceae rather than Lilliaceae, according to recent trends in classification of plants. (Ref)

Sansevieria trifasciata, (cv) lourentii was wrongly named as earlier as Zeylanica. It is commonly known as mother-in-low's tounge plant and cultivated as a garden succulent. as well as foliage house plant.

3. CULTIVATED SPECIES OF SANSEVIERIA:-

The genus is mainly cultivated as a garden succulent and indoor plant. Most of the species are bushy, up right succulent with beautiful appearance. In India as well as other warm and temperate countries several species are in cultivation. They are enlisted as follows.

i) Sansevieria trifasciata, (cv) Lourentii :-(Mother in-law's Tongue)

ii) Sansevieria trifasciata var. craigii (snake plant)

iii) Sansevieria trifasciata var. moonshine

iv) Sansevieria trifasciata var. Bentel's sensation

Tv) _Sansevieria cylindrical_.

vi) _Sansevieria zeylanica_

vii) _Sansevieria hanii_

viii) _Sansevieria golden hanii_

ix) _Sansevieria roxburghiana_. (Bow - string Hemp.)

In Maharashatra few above verities are cultivated in garden as succulents and also as indoor plants.

4. MORPHOLOGY :-

Sansevieria trifasciata (cv) Lourentii is a small genus of short stemed, bearing a rosette of leaves. The leaves are thick, fleshy long, narrow with a acute apex. The leaves are flat or with deep central groove running on the upper surface from base to apex. The leaves having length 70-100. cm. and breadth 5-10 cm. The width is more or less uniform through out and narrow only towards the pointed tip. The leaves are smooth, glabrous, green, having golden or yellow edges. The _Sansevieria_ plant flowers only once in a year. the inflorescence born at the bottom of plant and arise through the center of the leaf.

Inflorescence axis is about 2 ft. in length at maturity. It posses 8 to 15 flowers in fascicled racemose manner which arise in axile of large bract. About 40 to 50 such bract possesing flowers in alternate fashions are observed on a single stought rachis. Each flower is yellowish, white or greenish white in colour fragrant, trimerious, hypogynous, blooming in the evening.

Single flower consist of 6 perianth lobes connate at the base. Stamens are 6, filaments are free with two anther lobe, versatile and extrose. The pistil is superior, tricarpellary, with single style and capitate stigma.

5. PROPAGATION AND PLANTING :-

a) Propagation :- The Sansevieria are propagated by means of suckers.

Suckers :- The plants which are about 2-3 years old propagated themselves due to production of suckers from under ground rhizomes. The number of suckers formed and each develops in to new seedling or plantlets. These plantlets are removed and used as planting material. Propagation by seed germination is not convenient method.

b) Planting : A large number of Sansevieria are cultivated as indoor ornaments, as well as garden plant including e.g. Sansevieria trifasciata Lourentii, snake plant, Sansevieria hanii, They are popular through out the world mainly as house plant and are suitable for the hedge and fencing. They may be planted for checking soil erosion. The suckers are generally planted in nursery and raised for a year before they are put down in the plantation. Transplanting is done in month of August and September. When ground is soft enough to dig after the rain. the young plants receives the advantage of rain.

6. ECOLOGICAL FACTORS AFFECTING GROWTH :-

a) Rainfall : *Sansevieria* stand with drought when most of plants would suffer. This thing some time gives rise to misconception that *Sansevieria* need low rain fall, but the xerophytic nature of *Sansevieria* is unconnected with the way of the growth. There is no specific range of rain fall is required. Moderate rain favours the growth

b) Temperature :- Maximum temperature should preferable range between 27-32^{o}C. while minimum temperature should not fall below 16^{o}C. Diurnal range not more than 710^{o}C. Their growth is slowing down as a result the life cycle of this indoor plant.

c) Light :- *Sansevieria* not need the plenty of light but they prefer the shade and show good & healthy growth.

d) Soil :- *Sansevieria* is tolerant verity to any kind of soil like sandy, loamy, freely drained and to be acidic or low in nutrients. However water lodging and salinity are fatal to *Sansevieria*.

7. PEST AND DISEASES :-

Sansevieria is not sensitive to serious pests and diseases infection. The spots are not occurring on the leaf. However during the senescence leaves becomes yellow and then detiorated, So no special pesticides or fungicides are required, suggested.

8. ECONOMIC IMPORTANCE :-

a) Fibers :- Botanically speaking the term fibers refered to wood fibers Wood fiber is the mass of wood cells, tapering at both the ends and having very thick wall with simple pites, in the secondary walls, (Schery, 1954) According to him fibers are composed of mainly cellulose with ligninİng, hemicellulose and occasionally other substances from chemical point of view.

The fibers of Sansevieria are obtained from the leaves. The Sansevieria fiber is not hard. Sharma and Muckergy (1982) investigated the structure of the hemicellulose obtained from the fiber of Sansevieria trifasciata leaves. They isolated two acidic, two neutral oligosachrides, fractions from the same. According to them the fiber of Sansevieria trifasciata and jute (Corchourus capsuluris) are almost identical under infra red spectra. In addition their earlier studies revived the structural features of hemicellulose in the same fiber.

b) Indoor and garden succulent :- In the modern civilization, cultivations of indoor plants is increased day by day. Sansevieria is a most popular indoor foliage plants. Several species enlisted earlier are used for indoor and garden cultivation. The Lourentii, moonshine, snake plant and also rosette forms of Sansevieria are economically important.

9. CYTOLOGY :-

The cytological studies revealed that the chromosome number of Sansevieria is 2n=20. About 14 sp. are showing same genome constitution. It indicates stability of genome in the genus.

10. ANATOMICAL STUDIES :-

Gopal *et. al.* (1981) studied epidermal structure; and his to chemistry of five succulents, monocot plants like *Alove vera*, *Sansevieria roxburghiana*, *Agave varacruz*, *Furecres gigantea*, and *Tradescantia* sp. They observed that all plants except *Tradescantia* sp. show similarities several epidermal characters like presence of a thick cuticle, sunken stomata, low stomatal frequency and mostly closed stomata during day. In most of the epidermal cell they have a preponderance of lipids over starch, protein and insoluble polysaccharides. The *Sansevieria* shows typical xerophytic characters likes, thick epidermis, sunken stomata on lower epidermis, thick cuticle on upper epidermis and fibers tissue storing water.

11) PHYSIOLOGICAL STUDIES :-

a) Growth :- *Sansevieria* belongs to a category of succulents acid metabolism (CAM). Plants that have relative low growth rate which probably due to the fact that CAM is more a survival mechanism. It has been observed by Black (1973) that maximum growth rate (g-dry wt. $dm-2d^{-1}$) in CAM plants is 0.015 to 0.018. They are adequate for the succulence growth.

b) CAM :- perhaps in the most of the studied, physiological aspects in *Sansevieria* species is the CAM. (Kluge & Ting 1978).

Ramachandra and Datta (1982) have studied ten CAM plants for the enzymes studies. They observed that in Bryophyllum calycinum, B. tubeflora. Agave americana, and Sansevieria roxburghiana NADP - Malic enzymes and NAD malic enzyme as well as pyruvate-pi-dikanase were present and they have a regulatory role. These plants with different decarboxylating system. Attempt is were also made by Chen and Black (1983) to study diuranal changes in volume and specific tissue weight of CAM plants including Sansevieria trifasciata. (cv). There observation indicate that diuranal variation occurred in the volume increased early in the light period. reaching a maximum about mid day. Then volume decrease to minimum near mid-night. The maximum volume increase each day was about 2.7% of total volume. They concluded that the specific weight of green CAM tissue should increased at night due to net fixation of CO_2 and it is incontrast to C_3 and C_4 plants studied. Further they state that the increase in leaf weight at night is based in the carbohydrate available for net CO_2 fixation. Since first report of occurrence of dark CO_2 fixation in Aloe by Desaussure (1804). Considerable advances have been made regrading the operation and significance of this metabolic path way. It is now vary well established that these plants have an ability to close these stomata during day time and to fix CO_2 during night hours. Thus checking the rate of transpiration. The key enzyme of carboxylation in these plants is phosphoenol pyruvate carboxylase (PEP-Carboxylase) and the malate is the first stable product of CO_2 fixation during dark. The malic acid accumulate in the vacuoles during dark hours. During day time malic acid is decarboxylated and CO_2 entered the reductive pentose phosphate cycle. As a result of this peculiar type of metabolic behaviour, well defined diurnal flactuacation in organic acid and carbohydrate contains occur in CAM plants. Berry and Koehelar (1986), studied carbohydrate contents in the nector of Sansevieria trifasciata members of Agavaceae they analysed simple carbohydrate like fructose glucose & sucrose between floral and extra floral nector among 17 taxa of Sansevieria. The comparative study indicate that the dominance of sucrose in floral nectories than extra floral nectories. This study are helpful to relate the acid contents & Carbohydrate contents in this taxa.

The CAM is now recoganised as a special kind of physiological adaptation to crops with arid environment. Sansevieria is plant growing luxuriantly in low. rainfall areas, due to the presence of CAM in this plants.

The stomatal behaviour is an important future of CAM plants and the first report about opening of stomata at night in CAM plant independently by Nealls *et al.* (1968). and Ehalar (1969). Nobel - (1976). Extended these finding by investigating the water relation of CAM succulents under field condition.

According Neals (1975) their can be regarded two categories of CAM plant, weak CAM plant and full CAM plants or super CAM plants. He further explain that type of gas exchange patterns i.e. most typical of CAM plants were dark assimilation of CO_2 contributes Significantly to the carbon balance of plants. According to him the full CAM pattern is shown quite typically in Agave Americana.

Isotopes discrimination ratio (delta C^{13}) have provided an useful technique for the separation of C_4 - C_3 and CAM on the basis of their carboxylation reaction through variation in delta C^{13} value can occur within plants and in aquatic environments (Tronghton, 1971 and 1979). This ratio arises from the fractions of carbon isotopes during carboxylation and is caused by proportionally utilization of $^{12}CO_2$ and partial exclusion of $^{13}CO_2$ the plants. A greater discrimination in C_3 plants results in lower ratio than for C_4 plants; while the variability in C^{13} ratio in CAM plant is evidence for shift between C_4 - C_3 photosynthesis. According to environmental condition, Thus in C_3 plants C^{13} values range from -12 to -34, in C_4 plant -11 to -19 while in CAM plants they are in the range of -13 to -34. Neales (1975) reported that in Agave americana C^{13} value ranges from -14 to -14.5 in case of Agave verginica.

Ulrich et.al (1985) have studied isotope ratio of nector in comprisions to tissue in C_3 and CAM plants. They found that SC^{13} values in Kalanochoe diagremontian, Aloe vera and Sansevieria species were within the typical ranges known for these plants. In Sansevieria and Aloe the nector was relatively richer in ^{13}C, suggesting that isotopes effects may occur during the secreation process. The lipids may also absent while the tissue dry matter was much poorer.

Kluge and Tinge (1978) have shown that the succulent plants have fewers stomata distributed over exposed surfaces then most of the mesophytic non-succulent plants. This is quite understandable in view of drought resistance potential of these plants. They observe that the number of stomata per cm^2 on abaxial leaf surfaces of Agave americana and Agave deserti were 2100 - 2000 respectively.

Generally in most of CAM plants the product of dark carbon assimilation is malic acid. Besides malic acids in some other CAM species the organic acids like iso-citric and citric acid also accumulate. (Pacher et al, 1949, Vickery, 1954) an interesting observation made by Nordal and Ogner 1964 and Beruateak et al (1963), Kluge and Ting (1978), have reported that the fleshy leaf xerophytic members like Aloe gasteria, Hawarthia and Sansevieria have been shown to be CAM species. Dark CO_2 fixation was shown in these species by Nuernbergk (1961) Holdsworth, (1971) Denius and Homann 1972, Bartakke (1978) Milburn et al. (1968)

The levels of pyruvate dikinase, NADP malic enzyme, NAD malic enzyme and phosphoenol pyruvate, carboxykinase have been estimated in ten different CAM plants.(Reddy et al, 1982). CAM behavior is influenced number of factors, The temp. has been recognised to one of the most important factor in this respect. Eickmeier and Adams (1978) observed that high night temp. (35^{o}C) eliminated high CO_2 uptake, reduced net 24 hours. uptake was associated with minimal night acidification and deletion acidity values. and increased both night and 24 hours transpiration.

Anne M. Borbland and her group of British Scientist recently (1994) studied the carbon isotopes composition and carbon balance in C_3 – CAM intermediate Clusia minor(l) growing in Trinidad. During wet and dry seasons CAM activities are increased in response to decrease availability of water, sunlight. The organic acids and soluble sugar were increased in dry season about 4% to the plant sampled during wet season. The induction of CAM was accompanied by doubling in size of reserve carbohydrate pools. The utilization of carbon for organic acid & carbohydrate production was derived only from C_3 – Carbo-oxylation during wet and dry seasons.

The physiological studies in CAM succulent was not under taken in detail during last three years. However induction of CAM in Mesembryanthum crystalinum was studied by Schmitt and Prepenbrock in 1991 – 1992 and Chu *et al.* in 1990. Their work indicated that the stress conditions as well as salt induced cultures expresses CAM IN the above plant, due to increasing enzyme activities like PEP. Carboxylase, Malic enzymes etc.

c) Water relation :- The process of transpiration is of almost importance in CAM plants like *Sansevieria* because the evolution in CAM is mainly for the purpose of maintaining water status and checking the transpirational water loss. Transpiration ratio have been estiminated for variety of CAM plant CAM plants have low TR values with minima often in the range of 50 - 55 (Black 1973).

d) Temperature tolerance :- To understand the tolerance of desert succulents to extremely high temp. (60^{o}C) the effect of growth temp. on fatty acid composition to various member fraction has been investigated by Chuan and Noble (1985) from *Agave deserti*. They observe that day/night air temp. of 30^{oC}/20$_{oC}$ were maintained, chlorenchyma, fatty acid composition were similar to those of mesophytic leaves except that desert succulent lenolanic acid 18:3 and more olic acid (18:1) and hence greater fatty acid saturation on the succulents particularly in chloroplast fraction. Tolerances increases, as the air temp. is increased. Thus, according them, high temperature acclimitilation in desert succulents need not be direct corelated with major changes in fatty acid composition or the saturation of the membrane lipid. The *Sansevieria* is very allied to *Agave* and possible showing the temperature tolerance like *Agave* ,

E) MINERAL NUTRITION :-

Sansevieria trifasciata (cv) is crassulacean succulent as it exhibit diurnal variation in the acid contents of the leaves, the CAM is governed by numerous factors like environmental conditions, the rate of organic acid synthesis, Carbohydrate Reserve and the nitrogen metabolism, The inorganic ions acts as co factor for the metabolic reactions in the succulent.

The taxa Sansevieria is of commercial importants as fiber plant and indoor succulent. This nutrient responses not yet been studied in detailed. It is member of Agavaceae and its possible that the mineral nutrition on this species may be similar like Agave.

Nible and Barry (1988) have studied seedling responses of Agave deserties to high concentration of various elements for monitoring both 12 days growth in hydrophonic solution and six months growth in sand culture. They observes that nocturnal acid accumulation by Agave sp. was related to element level in their chlorenchyma. According to them acid accumulation was positively corelated with levels of ten elements in the chlorenchyma, especially N(r^2 = 0.46) More over they found a low Na and high Ca level compaired with agranomic crops. In contrast nocturnal acid accumulation was weekly corelated with chlorenchyma Na (r^2 = 0.13) consist with the deletorius effect of salinity on the growth of seeding. They further found that Agave deserti also tolerated high levels of the heavy metals like Cu and Zn.

Nobel and Harbstock (1980) observed that Agave deserti seedling in hydrophonic show enhanced growth by increasing potassium phosphate and Nitrate levels. There study suggest the N application level could increase the productivity for Agave species.

The mineral nutrition studies in Agave cantala (Landge 1988) throws light on the role of sodium, potassium, calcium, magnesium and Iron in this CAM. According to him low levels of sodium is probably due to the inactive role in the Agave. The potassium level was recorded highest in winter season than in rainy season. Calcium was found to be most prominent cation than other elements. It shows significant corelation between nocturnal acid metabolism and the calcium status of leaves of Agave Cantala. The Mg contents is found to rather low than Ca. The Fe contents in Agave Cantala are also low but above the optimum values.