INTRODUCTION

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Salinity is a major and ever present threat to the permanance of irrigation agriculture. This problem in agriculture is becoming very serious year after year. About 3/4 area of the Earth's surface is occupied by saline soils.

History reveals that civilization began in an environment of agriculture.

In 1958, about 31 million acres of land was under irrigation in the 17 western states of USA and Hawaii and appropriately 27% of this land was salt affected soils and saline waters, qualified conventially as wastelands and waters, . If attention is not given to this problem it may cause a dangerous cause to the environment.

During the decade 1929 to 1939 over 1 million acres of irrigation land in the 17 western states of USA were abandoned because of the accumulation of salt and sodium.

Salinity problem exists in several other countries such as Egypt, Sudan, USSR, North China, Holland, India and Pakistan.

The studies undertaken in 1963 by planning commission of the government of India reveal that about 15 million acres of originally fertile land in India has been rendered unproductive due to development of salinity or alkalinity or rise in subsoil layer.

In Punjab and Uttar Pradesh three and two million acres of land respectively are affected by salts (Vaidya and Shastrabuddhe, 1970).

Central Soil salinity Research Institute of India has reported that in Haryana 3 lakhs 40 thousand acres of land is salty. Along the East Coast of Tamilnadu and in the states of Bihar and Orissa there are vast areas of saline and alkali soils. Further large areas are getting saline every year on account of adoption of improper irrigation and agricultural practice and absence of effective drainage.

In Maharashtra under the Deccan canal system the saline lands are increased from 29,000 acres in 1944 to 86,000 in 1952. The acreage under these lands is more than one Lakh acre in the coastal districts of Thane, Kolaba and Ratnagiri. In Sangli district the problem of salinity has become severe in recent years. Hundreds of acres of land has developed salinity and lost its productivity.

For the effective approach to reclaim these abandoned area a Knowledge regarding the physiology of salt tolerance of plants is needed.

The saline soils were developed in India rapidly because of the irrigation system. Saline soils occures more in regions of semiarid climate. In arid regions leaching and transport of soluble salts to the ocean is not effective or complete check as in humid regions.

The favourable conditions for the formation of saline soils are :

1. High water table with fairly salt concentration
2. High Temperature
3. Low Rainfall (Tamhane etal, 1966)

4. The Saline and sodic soils have developed due to conditions-

   a. When the irrigation water has high salt content.

   b. When poor drainage keeps the salts in the surface. soil and prevents the leaching of salts.

   c. When the use of irrigation water is erratic i.e. flooding at one time followed by intense drought. When the total supply water is limited, this would also leave the salts in the roof zone.

   d. When seepage from leaky canals and lateral channels which run at a higher level has resulted in a high H_2O table and saline or sodic soils

1. EFFECT OF SALINITY ON GROWTH

The most common and conspicuous effect of salinity is growth retardation. According to Allison (1964) about 27% of the land in 17 western states of USA and Hawaii is salt affected to some degree. If salinity is not controlled, the productivity decreases and land values drop. In severe cases, such lands are completely abandoned.

Salinity affects various stages of plant growth. It affects germination (Bernstein and Haywards, 1958) it affects the seedling growth (Pearson, 1966). The plants expose to salt stress show retarded growth. Strongonov (1964) stated that property of salt tolerance changes with the development of plant.

Many investigators working on salt tolerance in rice have observed that there are great differences in response depending upon stage of the life cycle at which the salinity is introduced. This is well illustrated by the work in Japan by Iwaki (1956) Shimose (1972 and 1973) and others.

With increase in soil salt concentration, over all plant growth decreases. Plant height, leaf number, leaf area along with root and shoot dry weight are some of the attributes of growth known to be reduced by salinity.

Lunin *et al.*, (1963) showed with the help of simple glasshouse experiments that five of six vegetable crops (tomatoes, broccoli, spinach, beets, peppers and onions) tested were especially sensitive to salinity during their early development stage. Yields of onion bulbs and beet roots were actually increased by mild salinity stress imposed at the later stages of plant development.

2. CLASSIFICATION OF PLANT (SENSITIVE, MODERATELY TOLERANT)

The plants which show toxicity at the very low concentration of salts are not able to grow on salty soils. Hence they are called glycophytes or non halophytes. These plants do not grow in high concentrations of salts in the soil. The cereal crops belong to the group of glycophytes. Less chloride content can some times be favourable for the growth of glycophytes.

The plants which can grow in higher concentration of Na^+ salts are called halophytes. The term halophyte means salt plant. Greenway and Munns (1980), adopted the ecological defination of Jennings (1976) i.e. "the native flora of saline soils" and have assumed the salt concentration with osmotic pressure of at least 3.3 bars.

Because of wide range of resistance, found among halophytes they have been subdivided into the extreme euhalophytes and the moderate oligohalophytes (Takada, 1954). Many halophytes are able to grow perfectly normally in low or non saline environments

(Unger *et al.*, 1969) and are therefore facultative halophytes.

The growth of these plants is favourably affected by NaCl, Na can be substituted by K^+. Eg. *Aster tripolium*, *Artemisia maritima*, *Plantago maritima*.) Others cannot grow without NaCl and are favourably affected by NaCl alone, and are therefore called obligate halophytes eg. *Salicornia herbacea* and *Atriplex Vensicaria* (Weissenback, 1969) plants that live and thrive in the sea, and grow in coastal environments are the examples of extreme halophytes.

Chapman (1966) grouped the halophytes according to the salinities in which they usually grow well they are :-

1. Mio halophytes
2. Meso halophytes
3. Meso euhalophytes
4. Eueuhalophytes

3. SALT TOLERANCE IN HALOPHYTES :-

Although halophytes are tolerant to salinity, it has been observed that at germination stage they are less tolerant to the salinity level than under which the adult plant grows. Under natural conditions, seeds of halophytes may remain dormant till the onset of rains. From the halophytes, mangroves can be treated as a special group of plants because of their extreme environment conditions of growth.

Schmiper (1891) was the first ecologist who has noted that the physiology of halophytes is a problem as they show close resemblence with xerophytic leaves.

In India, the credit of initiating the work on salt tolerance on mangroves goes to Bultter (1905). He has studied the anatomy and morphology of mangroves from Bombay. There are many earlier investigators in this field who have done considerable work on mangroves. The prominant among them are warming (1909), Keller (1925) Bharucha and Navalkar (1942) Londegordh (1954) Ashby and Beadle (1957) Beadle and co-workers (1957) Adriani (1958); Black (1960); Walter (1955, 1961), Osmond (1966).

4 **SALT TOLERANCE IN GLYCOPHYTES :-**

Salt tolerance means the ability of plants to tolerate in presence of soluble salts in the root medium. Salinity affects the metabolism in plants, hence many investigators have done extensive work to find out the effect of salinity on non-saline plants. The studies on plant growth relationship on saline soils have been reviewed by Magistad (1945 Hayward and Wadleigh (1949) Hayward and Bernstein (1958). The salt tolerance of a crop may be appraised according to 2 criteria -

1) The ability of the crop to survive on saline soils.
2) The yield of the crop on saline soils.

Glycophytes are salt sensitive plants. Most of the crop plants are glycophytes. In the view of importance of crop plants the influence of salts on them is discussed in detail.

The most common effect is supressed growth. Strogonov (1964) stated that property of salt tolerance of plants increases during their growth and development. Garg and Garg (1980) reported a shift sensitivity to the same union with a change in the stage of plant growth in pea. Semushina (1970) reported that NaCl was more inhibitory to stem and leaf weight in maize than Na_2SO_4 at 7 atm. where as at 10 atm Na_2SO_4 decreased the leaf weight more than NaCl in barley, Lunin etal. (1963) showed with the help of simple glass house experiment that 5 of 6 vegetable crops (tomatoes broccoli, spinach, beets, peppers and onions.) tested were especially sensitive to salinity during their early development stage. In same instance salt increase soluble solids and improves the quality of fruit crop such as tomato or melon (Shannon, 1985) Hoffman and Rawlins 1971; Bernstein and Ayers, 1953, whereas in other cases, salinity reduces fruit size or shelf life or inhibits quality characteristics like head formation in lettuce (Shannon, 1980)

For crops that may produce either vegetative or seed yields eg. alfa alfa, corn etc, it is advisable to measure both responses to salinity. Too often vegetative responses are unreliable for predicting effects of salt on fruit or seed production (Mass and Hoffman, 1977)

5. EFFECT OF SALINITY ON PLANT METABOLISM:MINERAL NUTRITION

Mineral nutrition of plant is a subject of tremendous interest and importance. They play key roles in regulating the sequences and network of many reactions in plants. Hence the knowledge of inorganic element, which are indispensable for the growth of plants is of fundamental importance. At least 16 chemical elements are essential for the growth of plants (Epstein, 1969).

Apart from carbon, hydrogen and oxygen all green plants require potassium, Ca, Magnesium, Nitrogen, Phosphorus, Sulphur ions, Iron, Manganese, Zinc, Copper, Boron, and Molybedenum, Cobalt is also included in this list by wilson and Nicholas (1967).

The plant absorb and accumulate these elements. But the absorption and accumulation differs in plants considerably. Obviously the mineral elements are absorbed by plants in different forms and they are accumulated in different parts in different crops. Salinity effects the mineral nutrition of the plants.

High salt concentration decreases or lowers, the dissociations of nutrients which decreases high osmotic potential and reduction of root growth. The NaCl absorbed compete with K^+ Ca^{2+}, Fe^{2+} Mn^{2+} etc ions resulting a decrease in uptake of such ions. As a result the Na^+, Cl^-, $SO4^{2-}$ accumulate in the tissues with the reduction in intake or K^+ and Ca^{2+}.

Strongonov (1964) stated that plant has to maintain a suitable internal environment, in presence of high concentration of potentially harmful salts under conditions of adverse water relations as expressed in a saline enviornment.

K^+ plays a important role in the mechanism of salt tolerance in plants, Ca^{2+} has long been known to have an emeliorating effect on the growth of plants, under saline condition (Epstein, 1972). Induction of salt tolerance by Ca^{2+} is fairly well known (La-Haye and Epstein 1969) Most of the plants absorb Na^+ as well as Cl^- grown under NaCl salinity.

Govnberg (1959) pointed out that excess of chloride inhibits P^{5+} uptake. A suppression of P^{5+} uptake due to salt stress has been recorded by strogonov (1962). There are controvarsial reports regarding the Mg uptake under saline condition. Bernstein (1975) has claimed that the tolerance of species for a particular salt reflect the ability of species to absorb nutritionally adequate levels of Ca and Mg from the soil.

Very little attention has been paid to the effect of Salinity on uptake and distribution of micronutrients. Strogonov (1964) has reported a decrease in Fe^{3+} content due to NaCl salinity. Maas *et al*., (1972) however, found that roots and tops of NaCl treated tomato, Squash and soyabean were richer in fe^{3+}. Further they found Mn^{3+} content increases in tops of tomato and soyabean while decreases on tops of squash due to NaCl salinization. Reports on effects of salinity on uptake and distribution of other micronutrients such as Cu, Mo and Co and Zn are scanty.

6 EFFECT of SALINITY ON CHLOROPHYLL (LEAF PIGMENT)

Increase as well as decrease in content of chlorophyll have been reported by different workers. According to some authors salinity decreases the chlorophyll content of plants (Sivtsev 1973), Arnold, 1965 and Udovenko, 1964) whereas other studies reveal that salinization increases the chlorophyll content habitants has been established for tomatoes (Koval's Kaya, 1945) cotton (IL- yasova, 1948) and various glycophytes (Pokrovskaya 1958).

Strongonov (1974) reported that salinity causes a marked increase in the chlorophyll content of plant compared to the control. Both chlorophyll 'a' and chlorophyll 'b' accumulate. Strogonov and Ivanits-Kaya (1954) stated that plants from saline and normal soils differ in the extractability of their chlorophylls.

7. EFFECT OF SALINITY ON CARBOHYDRATES

Carbohydrate motabolism is affected by the increase in salinity level as well as by the type of salinity. Bhardwaj (1959) reported that both NaCl and Na_2 Co_3 resulted in a decline in sugars at the seedling stage as well as in the grains produced soluble sugars contents also declined.

El-shourbagy and Kishk (1975) observed a decline is bound sugars whereas total sugars fell only slightly in a halophyte. Shimose reported no effect on the total carbohydrate content of barley leaves and stems, but those of wheat ears decreased with increasing NaCl concentration. Starch was not affected by NaCl and constituted about 10% of the ethanol insolu ble dry weight in all the treatments.

8. NITROGEN METABOLISM

Amino Acids and other soluble nitrogenous compounds play essential roles in plant metabolism. Nitrogen metabolism is affected differently by type of salinity and the responses differ in different plant species and inspite of large number of investigations very few common inference are there.

Nitrogen metabolism in plants is characterised by 3 main steps. The first step consists of the conversion of inorganic N into organic N compounds of low molecular weight. In higher plant this step is irreversible. This means that once the N has been converted in organic form it remains in this form in the plant.

Saline conditions are known to influence all these pathways in one way or the other and thus have tremendous effect on plant metabolism.

Disruption of plant nitrogen metabolism by salinity was attributed to decreased nitrate uptake (Rush and Epstein, 1975) decreased nitrate reductase activity (Heimer, 1973; Sharma and Garg, 1983) other studies however reported that salinity induced accumulation of nitrate nitrogen (Langdale <u>et al</u>., 1973) and had no effect on the activity of nitrate reductase (Heimer, 1973). Salinity effects on nitrogen metabolism start right at the level of uptake of inorganic form itself. Nitrate – reductase enzyme, which is involved in the reduction of NO_3^- to NO_2^- is known to be highly sensitive to all types of stresses, particularly salt and osmotic stress.

9. <u>PROLINE</u>

The physiological significance of changes in nitrogen compounds, in particular, the accumulation of proline range from the view that it is a symptom of injury (Hanson <u>et al</u>.,1977) to the suggestion that is of adaptive role of proline is related to survival rather than to maintainance of growth. Nearly all salt-sensitive and salt tolerant species contain substantial concentrations.

Accumulation of proline is widespread in plants subjected to low water potentials and is not unique to plants growing in saline environment.

10. <u>APPROACHES TO SOLVE THE PROBLEM</u>

There is always a need for technological and biological solution to help us overcome the physiological limitations that restrict plant productivity.

Technological approach include cultural practice to help seed and seedling estabilishment, agronomic practice and treatment with chemicals.

a) CHEMICAL TREATMENT

Nutrient deficiency of one or more elements in plants is one of the possible adverse effect of salinity. Calcium is one of the important cation for growth of the plant during salinity. It prevents the uptake of Na^+ ions (Hyder and Greenway 1965) Deo and Kanwar, 1969; Epstein, 1972).

Two approaches for increasing crop production on saline soils are possible.

i) Technological approach - changing environment to improve condition for the plant i.e. better soils for crop we have.

ii) Biological approach - changing the plant genetically to better tolerate the saline environment i.e. better crop for soil we have i.e. the crop which can grow better in the soils we have. The first approach is not used now because of rising cost of energy and scarcity of non saline water. Even in more developed countries the technological approach is not possible Instead a promising approach to improve crop production on such soils is to breed plants which can be suitably grown in these environment.

The immediate goal are to increase total food production by breeding crops that can withstand salinity and increase the yield. It is a challenge for the present scientist. They must develope varieties of plants that are capable of using saline water as their only water source.

Chilli is an important spice crop and India is the largest producer of chillies in the world (Patil 1980) chilli both green and ripe is very important, from chilli oleoresin is incorporated into a number of pharmaceutical formulations like sloans balm etc. Chillies are also a good source of vitamin 'A' and 'C'

Chilli crop is a important cash crop. In India the total area under chilli cultivation is about 826.3 thousand hectares with a production of 510.9 thousand tons per annum (Hosmani, 1982).

11. PHYSIOLOGICAL STUDIES IN *Capsicum annuum*

The knowledge regarding the physiology of chilli under saline conditions is very inadequate.

We have developed some new hybrid varieties of chillies by carrying out a breeding programme in our experimental fields. In the present investigations two most promising hydrid varieties PC1xDB and LxDB are selected and an attempt is made to study their physiology.

The increase in salinity is a very common problem which is increasing due to faulty irrigation. It will be interesting to study the response of the 2 selected hybrid varieties of chillies to salinity. It is worthwhile to study the effect of salinity or growth and development and mineral metabolism, proline, polyphenols and carbohydrates.

The results will help in assessing the newly developed hybrid varieties of chillies under salt stress. It will help new hybrid varieties selected (PCI x DB and L x DB) Pant C1 and Deonur Baidge and Lavangix deonur Baidge.