Chapter IV

SUMMARY AND CONCLUSIONS

Salinity has become one of the problems in modern agricultural systems. It has posed a problem to crops either on salt affected soils or under saline water irrigation. Some 15.4% of arid and semi-arid land, which comprises approximately 46.5% of the total land area of the earth, is salt affected and salinity affects one third of all irrigated land. In India there are about 12-15 million hectares of saline land distributed in the states of Punjab, Rajasthan, U.P. and Deccan and Costal areas. About one third of irrigated land in India, amounting to almost 77 million hectares are said to be sufficiently affected by salinity so as to adversely affect crop growth. Unfortunately no cheaper methods of desalination of soil or water have been achieved to overcome the salinity hazards. According to Epstein et al. (1980) besides an engineering approach, the development of crops tolerant to salinity is a better strategy for meeting the challenge of salinity problem. To achieve this objective, it is of prime importance to understand the performance and the physiology of plant species and the cultivars under saline conditions.

Salinity puts various problems to plants at the population, the individual, the physiological and molecular level. The overall reflection of all these problems occurs in the reduction of growth. The work on salinity for the last several decades has lead to the formation of two different schools of thoughts regarding the nature of salt injuries. The champions of osmotic school (Bernstein and Hayward, 1958) claim that most of the adverse effects of salinity are related to the decreased osmotic potential of saline root media. On the contrary the champions of specific ion school (Eaton, 1942; Strogonov, 1964) propose that the adverse effects of salinity are caused mostly by the specific effects of individual ions.

Salinity has far reaching effects on the plant metabolism which ultimately results in impairment of growth and loss in overall productivity. This is true in most of the crop species. At the same time it can be noticed that at salt concentrations injurious to conventional strains, certain plants perform well. Survey made by Maas and Hoffman (1977) indicated that the crop plants differ in their tolerance capacity and broadly be classified into sensitive, moderately sensitive, moderately tolerant and tolerant groups. The varietal differences are also noticed by a number of workers with respect to salt tolerance potential.

The plant species exhibit varying degrees of salt tolerance with respect to the stage of development. It is generally believed that the plants are more sensitive to salinity at germination than at later stages of growth. However, according to West and Taylor (1981) generally there is a poor correlation between salt tolerance at germination and that at later stages of growth.

The first phase of plant growth and seed germination and seedling growth is critical under saline conditions. The ability of a given variety to germinate and establish the seedling is frequently the limiting factor in crop production. This process being the first and the most important phase, it is of utmost importance to study the effect of salts on this process.

Salinity causes several metabolic disorders in the germinating seeds which can be immediately recognised by changes in the pattern of key enzymes and metabolites. The disorders ultimately reflect in growth retardation and failure of emergence of normal seedlings. The literature on metabolic process taking place during germination is voluminous. Yet it is not possible to explain all the aspects of this process. Considerable work has been done on pulse crops by various research centres throughtout the world. It is noteworthy that most of the germination studies are centred around the cereal crops. There are intensive investigations on the metabolic processes of rice, wheat, maize barley, jowar, etc. Among the cereals relatively little attention has been paid to sorghum hybrid CSH-9 and var. SPV-462 so far their salt tolerance ability is considered. In the present investigation, therefore, an attempt has been made to have preliminary idea about the response of these sorghum cultivars under the salt stressed conditions during germination.

For the present studies the seeds of sorghum hybrid CSH-9 and var. SPV-462 were subjected to various concentrations of NaCl and Na_2SO_4. Salt treatment was given through Hoagland nutrient medium (1:10 dilution). The concentrations of salts used were 25,50,100 and 200mM. Control was maintained under non-saline conditions (distilled water). The seedlings were grown in petridishes under sterilized conditions. The treatments were continued for 120hours. The effect of salts on germination percentage was studied by making the observations after every 24 hours. The seedlings were analysed for their linear growth and biomass (fresh wt) after 120 hours of growth. Inorganic constituents, total nitrogen and protein contents and carbohydrates were estimated in the seedlings after 120 hours of germination. The significant findings of the present investigation can be summerised as follows :

1) GERMINATION :

The process of germination is relatively delayed in sorghum var. SPV-462 as compared to that in hybrid CSH-9 due to NaCl salinity. The germination is maximum in control, 25 and 50mM NaCl, but it decreases with increase in NaCl medium beyond 50mM in 24 hours in hybrid CSH-9. It can be seen that the germination in var. SPV-462 is maximum in control only and it is improved at higher NaCl salinity (200mM) after 96 hours. The higher concentration of NaCl (200mM) has a noted effect on germination after 24 hours, both in hybrid CSH-9 and var. SPV-462. It is observed that in hybrid CSH-9 there is maximum germination in control and 25mM Na_2SO_4 and it decreases with increasing salt concentration of Na_2SO_4. However, in var. SPV-462 there is maximum germination upto 100mM Na_2SO_4 even at the period of 48 hours. When performance of both the cultivars in Na_2SO_4 salinity is compared with that in NaCl salinity, it appears that Na_2SO_4 is more toxic than NaCl during germination.

2) SEEDLING GROWTH :

It is found that in both the cultivars there is inhibition in seedling growth as salinity increases. It is also observed that salt (NaCl) concentrations beyond 50mM in hybrid CSH-9 and beyond 25mM in var. SPV-462 strongly affect the seedling growth. The seedling growth and development in salt (Na_2SO_4) concentrations beyond 25mM in sorghum hybrid CSH-9 and beyond control itself in var. SPV-462 are inhibited. When the results of effect of NaCl salinity are compared with those of Na_2SO_4, it appears, that Na_2SO_4 effect is more detrimental than that of NaCl.

Shoot growth is almost retarded in the seedlings of both the cultivars at 200mM concentration of NaCl as well as Na_2SO_4. Fresh weight in both the cultivars decreases with increase in salt concentrations of NaCl and Na_2SO_4.

3) <u>INORGANIC CONSTITUENTS</u> :

The salt stress on sodium and potassium contents in the seedlings after 120 hours of germination in both the cultivars indicate that along with increase in salt concentrations of NaCl and Na_2SO_4 there is a continuous increase in Na and K content in both the sorghum cultivars. The K/Na ratio in both the cultivars decrease with increasing salinity, suggesting the inhibition of seedling growth in salt stress. The calcium and phosphorus also increase with increasing salt concentrations. Amongst the micronutrients iron decreases with increasing salt concentration, while magnesium and manganese increase with increasing salt stress. Thus chloride as well as sulphate salinities disturb the mineral nutrition in the germinating seeds of both the sorghum hybrid CSH-9 and var. SPV-462.

4) <u>ORGANIC CONSTITUENTS</u> :

A) <u>Carbohydrates</u> :

Carbohydrate content decreases very rapidly during germination. This indicates rapid breakdown of food reserve during germination. Under saline conditions of NaCl and Na_2SO_4 there is increase in carbohydrate content with increasing salinity, suggesting inhibition of hydrolyzing enzymes by salinity in both hybrid CSH-9 and var. SPV-462. Starch is rapidly degraded during germination. This rapid depletion of starch, however, is inhibited by the salt concentrations. Higher the salinity more is the starch in both the sorghum cultivars. Total sugars are fairly low in the dry seeds of both cultivars and they decrease in non-saline conditions during germination. While there is increase in total sugars with increase in salt concentrations, suggesting their unutilization in salt stress.

It is suggested that both the sorghum cultivars respond in the similar manner to the salinity stress. However, the carbohydrate (starch) content of var. SPV-462 seedlings increase with increasing NaCl and Na_2SO_4 salinity than that in hybrid CSH-9 suggesting that CSH-9 has a better tolerance capacity than var. SPV-462.

B) <u>Nitrogen And Protein Contents</u> :

Nitrogen and protein contents decrease with increasing salinity in both the sorghum cultivars. It indicates that protein synthesis is inhibited in salt stress. Presence of more protein content in hybrid CSH-9 than that in var. SPV-462 under saline conditions suggests that it has a better salt tolerance capacity than sorghum var. SPV-462. When results of effect of NaCl salinity are compared with those of Na_2SO_4 salinity, it appears that nitrogen and protein contents are more in NaCl treated seedlings than those grown in Na_2SO_4 salinity. It indicates that Na_2SO_4 is more harmful than NaCl.

It is concluded that the salinity effect on the physiology of germinating seeds varies from salt to salt as well as in same species- hybrid or variety. The salt Na_2SO_4 seems to be more toxic than NaCl. Salinity affects the seedling growth variously in sorghum hybrid CSH-9 and sorghum var. SPV-462 and from over all performance and the changes in the physiology of seedlings under saline conditions, sorghum hybrid CSH-9 appears to be a salt tolerant cultivar than sorghum var. SPV-462.