CHAPTER I

Introduction

CHAPTER I

INTRODUCTION

History records many instances of massive decline in agriculture resulting from the salinization of farmlands and a breakdown of irrigation systems (Jacobsen and Adams, 1978). Salinization and alkalinization directly reduce soil fertility and may be caused by accumulation of acid, neutral or alkaline water-soluble salts. An unfavourable increase in salinity can occur naturally as a result of poor drainage due to evaporation, contamination from preexisting salt deposits or incursion of too much sea water. Excessive irrigation and poor drainage converted many times the fertile fields into saline and alkaline deserts and have especially affected the agriculture in Middle East, Iran, Pakistan, Bangladesh and India. Salinization and waterlogging are believed to be serious problems in 200,000 - 300,000 hectares of the world's best land each year (Eckholm, 1975; Worthington,1977).

In India the distribution of extensively affected areas of salinity and alkalinity is a total of 23,796 thousand hectares (Anonymous, 1972-1982). Northern states of India viz., Uttar Pradesh, Haryana, Rajasthan and Gujarat are severally affected by salinity. Other compact areas of saline-alkali soils are located in the central parts of Deccan of the Indian Peninsula (Patnaik, 1967; Ray Chaudhuri, 1964).

Paddy is the most important food crop of India and other parts of Asia. It occupies about 25 per cent of the cropped area and accounts for about 40 per cent of the total food grain production. The importance of paddy in the Indian economy is further emphasized by the fact that about 25 million farm families and 75 per cent of the landless labour depend upon paddy for their livelihood. India is only second to China in the world so far as the production of paddy are concerned (Ghose et al., 1959; George and Choukidar, 1973). Unfortunately, average rice yield per hectare in India is very low as compared with Japan and other major rice-growing countries in the world. It has been estimated that at present India has 40705.6 thousand hectares of area under rice cultivation with 53593.2 thousand tonnes of annual production amounting to 1317 kg. yield per hectare. Among these, Gujarat State has 499.1 thousand hectares of area under cultivation, 736.7 thousand tonnes annual production and 1476 kg. yield per hectare, which is lower than the other states like West Bengal, Assam, Bihar, Orissa and South India (Mahabal Ram, 1986). Salinity is one of the factors which decreases the rice productivity in the Gujarat State. Out of 195 lakh hectares of geographical area of Gujarat State, about 100 lakh hectares is under-agriculture. In this about 85% falls in the category of dry lands, 8% falls in the category of command areas and the remaining are either saline or alkaline. It has also been estimated that 7 lakh hectares of cultivated lands being affected by salinity due to tidal and sea ingress or by over irrigation (Shah, 1982). The main crops of Gujarat State are wheat, jowar, paddy, bajra, cotton and tobacco (Chopra, 1975). The annual rice production is low when compared to wheat and jowar. During the years 1962 to 1973 the Gujarat State received 6,65,000 tonnes of rice from other states viz., Andhra Pradesh, Maharashtra, Punjab, Tamil Nadu and Uttar Pradesh (George and Choukidar, 1973). Apart from the drylands and command areas, the increasing salinity has also become a major problem which decreases the crop productivity in many areas of Gujarat.

By considering all these factors, the rice crop has been chosen in the present study and several experiments to select the salt resistant varieties of rice for improvement of rice productivity in the Gujarat State has been carried out.

The loss of productivity by salinity is an acute problem in agriculture and it is essential to study and understand the nature of salt tolerance of crop plants while developing measures to increase the yield under saline conditions. It is important, therefore, to understand the interelationship between the plants and its sorrounding medium. Several studies have been conducted to understand the effect of salinity on the growth and development of plants. Such investigations may give an idea of the mechanism of action of salts on the plants at different stages of ontogenesis and also the reaction of plants to excessive ions. Differences between genera and species in their ability to tolerate saline conditions are well-known. The group of plants "Halophytes" have over a period of time evolved in a manner and developed certain characteristics by which they are able to live in sea water.

1. Effect of Salinity on Growth and Yield :

Varieties of crop plants were screened for their tolerance to salinity using different criteria based on their differences in their growth and yield parameters. In general a level of 6000 ppm salinity was critical for growth of most crop plants, except rice and cotton which showed some tolerance even upto 8000 ppm (Ramanujam and Sakharama Rao, 1969).

a. Effect of Salinity on the Germination

Paddy varieties differed in their capacity to tolerate salinity during germination stage (Pearson *et al*., 1966; Panchaksharaiah and Mahadevappa, 1971). Salinity affected the germination of paddy beyond EC 8.9 mmhos/cm (Narale *et al*., 1969). Similar studies conducted at IRRI (Anonymous, 1967) indicated that the germination of paddy seeds was not affected upto an EC. of 12,000 μ moles/cm and it was suggested that rice could tolerate salinity during germination stage but became susceptible in the subsequent growth stages. The germination of rice variety IR-8 was found to be inhibited with increasing levels of salinity and was reduced to about 56 per cent at a salinity of 6000 ppm in the water (Dixit and Lal, 1971). Gill and Dutt (1979) observed that there was no linear response of germination percentage in rice varieties to increasing salinity, but five different response curves were observed. The slopes of regression was found to have a closer correlation with salt tolerance. It was observed that germination of paddy varieties was delayed and decreased with the increase in salinity. Paddy variety 'SR-26B' was found to be highly salt tolerance and 'Rupsal' the least (Maliwal and Paliwal, 1971a). The relative salt tolerance of 14 rice varieties were tested during germination and suggested that the EC values associated with a 50 per cent reduction in germination one week after planting ranged from 21.2 to 30.5 m mhos/cm (Pearson *et al.*,1966). The relative tolerance of rice during germination were also tested in number of varieties (Paliwal and Gandhi, 1975; Seshagiri Rao *et al.*, 1970; Singh Lallan and Mehrotra,1971). The salinity affected the germination in various other crops such as wheat (Maliwal and Paliwal, 1967, 1969; Mathur, *et al.*,1967) and barley (Ayers, 1953; Donovan and Day, 1969).

b. Effect of Salinity on Early Seedling Growth

Varietal differences to tolerate salinity during early growth stage was observed in rice (Pearson et al., 1966; Panchaksharaiah and Mahadevappa, 1971). Kaddah and Fakahry (1961) reported that rice was moderately tolerant to salinity and was particularly sensitive to early stage of growth. Rice varieties TN-1, IR-49, NS-50 and IR-8 were highly affected by NaCl than the sulphate, nitrate, bicarbonate and carbonate during their early growth (Paliwal and Gandhi, 1975). Rice variety 'SR-26B' was more tolerant in dry matter production than the 'Getu' and 'Madhu' during the seedling stage to salinity treatment (Janardhan et al., 1976b). The salinity affected the seedling growth of wheat varieties (Khetawat et al., 1967; Mathur et al., 1967), barley, sorghum and sunflower (Iyengar et. al., 1977). In sorghum seedling, the growth was highly inhibited when exposed to more than EC8 mmhos/cm (Ogra and Baijal, 1978). Different varieties of castor differed in their capacity to tolerate salinity. It was observed that they were susceptible during seedling stage, but found to tolerate in the later stages of growth (Abdel-Rahman et al., 1975).

c. Preflowering Vegetative Growth as Affected by Salinity

Rice varieties considerably differed in their vegetative growth to salinity (Malek et al., 1961;

Venkateswarlu *et al.*, 1972; Giriraj *et al.*, 1976). Thus, the differences among the varieties in growth parameters was also used to screen varieties for saline tolerance (Janardhan and Murthy, 1972). Kaddah *et al.*, (1973) observed that salinity did not affect the total and productive tillers of rice varieties. The dry weight of rice shoot was not much affected until NaCl concentration exceeded 0.4 per cent (Iwaki *et al.*, 1959). However, salinity significantly affected the vegetative growth such as plant height, shoot weight, number of tillers and weight of tillers of rice varieties (Agarwal *et al.*, 1964; Datta, 1972; Ehrler, 1960; Farah and Anter, 1978; Javed and Khan, 1975; Kaddah and Fakahry, 1961; Paricha *et al.*, 1975; Shimose, 1958, 1963).

Salinity affected the growth through its effect on Osmotic potential, and thus by imposing water stress (Nieman, 1965). Salinity affected the production of matter by the vegetative parts of barley beyond 12 m mhos/cm (Nouri *et al.*, 1970) and beyond 10 m mhos/cm in wheat (Dhir *et al.*, 1975). Freijsen and Van Dijk (1975) observed the interspecific differences in the growth rate of four varieties of *Centaurium littoral*. It was found that the fresh weight, shoot-root ratio and dry matter was reduced at 3.51 atm NaCl. NaCl 0.15 M was found to reduce the leaf area of castor varieties, and also varieties differed in their capacity to tolerate salinity (El-shourbagy and Missak, 1975). Soyabeans and sesame were also found to be susceptible to salinity.

Even the lowest salinity of 2.0 atm reduced the growth of Soyabean and 2.8 atm reduced the growth of sesame. The growth of Cabbage was also found to be reduced under a salinity level of 3-18 m mhos/cm (Paliwal and Maliwal, 1975). Large differences among sugarcane varieties in their tolerance to salinity were observed. The major differences observed were mainly in growth, formation of joints, levels of stored sucrose and flowering (Tanimota, 1969).

d. Effect of Salinity on Yield Components

Various investigators screened rice varieties for their tolerance to salinity using the criteria based on their differences in their yield components (Malek et al.,1961; Venkateswarlu et al., 1972; Giriraj et al., 1976; Janardhan and Murthy, 1972). Murthy and Narasinga Rao (1965) observed that the reduced yield of rice under saline condition was caused by the reduction in the number of fertile tillers, grain number per panicle and an increased percentage of sterile spikelets. These effects were less pronounced in a salt tolerant variety, SR-26B, compared to a salt susceptible variety, T-90. In a test with four varieties, Jhona 349 was found to be resistant showing no reduction in panicle weight, mature tillers, seed number and seed set and Mongolia showed resistance in terms of straw weight, and number of primary branches per panicle (Akbar et al., 1972). Kaddah and others (1973) observed that salinity did not affect the total productive tillers in rice though the grain yield was drastically affected. Studies at IRRI (Anonymous, 1968) also indicated that rice was more sensitive to salt during the reproductive stage of the crop as shown by drastic reduction in the weight of the panicle. Venkateswaralu et al., (1972) observed that two dwarf (Hansa and T(N) I) and two tall (MCM2 and MR-12) varieties of rice could tolerate a salt concentration upto 3 m mhos/cm. At 4.5 m mhos/cm level there was reduction in yield from 25 to 35 per cent. The per cent sterility increased to a tune of 66 per cent with increase in salinity upto 10 m mhos/cm. Similar study conducted by Giriraj et al., (1976) indicated that salinity reduced the panicle number, length of main panicle and grain number per panicle. The grain yield was more seriously affected than other characters. Fifty per cent reduction in grain yield in salt susceptible varieties was observed at a salinity level of 8 m mhos/cm compared to salt tolerant varieties.

Korkor and Abdel-Aal (1974) observed that the grain yield of rice was more drastically affected than the vegetative growth. Murthy and Narasinga Rao (1965, 1967) reported that salinity increased spikelet-sterility and decreased the number of ear bearing tillers per plant, number of grain per panicle, 1000 grain weight and grain yield of rice varieties. Balasubramanian and Rao (1977) concluded that the yield reduction by salinity was mainly due to decreases in the number of panicle per plant in the rice varieties. Rice could tolerate a concentration of 0.2% of NaCl in irrigation water (Desai _et al._, 1957). The tiller and panicle counts decline progressively with increased concentration over 0.2% to 0.5%. The yield reduction was linear with the increased salinity. A concentration of 1.0% was fatal to rice. These limits were in respect of the crop grown in rainy season. Concentrations over 0.3% seem to be highly injurious to rice grown in summer season. Pearson and Berntein (1959) observed in their field trial a 50 per cent decrease in grain yield, associated with a EC of 8 m mhos/cm in soil solution in the active root zone during the growing season. Several other investigators too reported the reduction in the yield components of rice varieties to salinity (Ehrencorn, 1965; Ehrler, 1960; Kathirgamaraj _et al._, 1969; Maskima _et al._, 1979; Pajanissamy and Dhanapalamosi, 1973; Pan, 1964; Strickland, 1968).

Salinity beyond 12 m mhos/cm affected the production of dry matter by the grain heads of barley (Nouri _et al._, 1970). The osmotic potential at which 50% reduction in grain weight of wheat occurred, was found to be -7.3 bars (Everardo _et al._, 1975). Salinity caused a significant reduction of total number of bolls matured, weight of both seed and lint per boll and fiber length in cotton (Longnecker, 1973; El-Saidi, 1974). Huges _et al._ (1975) observed a reduction in the grass yield of five species under saline conditions ranging from 0-20,000 ppm. Ruf (1970) observed the difference in the grain yield in wheat varieties, C-273 and Mexipak. Increase in salinity from 4.0 to 15.0 m mhos/cm decreased the yield from 55.3 to 19.3 maunds per acre in C-273. The decrease in straw yield also was more in C-273 than in Maxipak. Greenway (1962a) observed the reduction in 1000 grain weight in a susceptible barley variety to a greater extend than in a resistant variety.

2. Effect of Salinity on the Endogenous Status of Inorganic and Organic Compounds :

a. Uptake and Transport of Inorganic Ions Under Saline Conditions

Evidences indicated to the possibility of the plants preventing the entry of some ions into the xylem eventhough they were present at considerable concentration in the root environment (Atkinson *et al.*, 1967), reflecting the diversion of ions entering the cytoplasm of the root cells to the vacuoles of these cells. Alternatively, the permeability of the root cells might be low or they might be re-exported to the roots rather than allowing them to enter into the xylem (Scholander *et al.*,1966). When barley plants were subjected to a salinity level of 100 meq/l of NaCl there was an increase in the sodium content and a decrease in pottasium content from all parts of the plants (Greenway, 1962b). Further increase in the salinity level to 150 meq/l brought about an increase in sodium content with a further decrease in the potassium levels from the barley shoots. The increased uptake of sodium and a decreased uptake of potassium due to salinity was also found in other plants like cabbage (Paliwal and Maliwal, 1975), Soyabean (Shere _et al._,1974), Castor (El-Shourbagy and Missak, 1975), halophyte _Salicornia europaea_ (Austenfeld and Fraz-Arnold, 1974) and some grass (Hughes _et al._, 1975).

The ability of a plant to maintain a high level of potassium and low level of sodium could be one of the factors in determining the salt tolerance of the plant. When barley varieties were exposed to 150 meq/l of NaCl, the resistant varieties had a higher level of potassium than the susceptible varieties leading to the conclusion that barley varieties differed in regulating their ion content under saline conditions based on their genotypic difference (Greenway, 1962b, 1965). The capacity of the rice variety, Kala Rata to withstand salinity was also attributed to its ability to maintain a high level of potassium in its system (Hegde and Joshi, 1974). Genotypic difference in the absorption of sodium and potassium was also found in citrus (El-Gazzar _et al._, 1965), sugarcane (Tanimota, 1969), wheat (Calos Torres Bernal _et al._,1974), castor (El-shourbagy and Missak, 1975) and cotton (Janardhan et al.,1976a). Ion antagonism is also another aspect of salt tolerance. Presence of high level of potassium in the ambient medium inhibited the entry of sodium into the plant (Tariq et al., 1972; Wignarajah et al.,1975). Resistant varieties of rice had a lower level of sodium compared to a sensitive variety (Hegde and Joshi, 1974; Paricha et al., 1975; Giriraj et al., 1976). Resistant varieties like MR-18 and Getu had sodium 6.43 and 3.71 meq/100 gm dry weight respectively compared to susceptible varieties which had 13.92 and 19.93 meq/100 gm dry weight when exposed to a growing medium of 12 m mhos/cm (Giriraj et al.,1976). Janardhan and Murthy (1970) developed a method to screen varieties of paddy for saline tolerance based on the survival of the seedlings and also the leaf injury due to salts. Salinity also caused a decrease in the uptake of various nutrients like N, P, K, Ca, Fe, Mn, and Zn in rice (Palfi, 1965), barley (Nouri et al., 1970), tomato and Soyabean (Mass et al., 1972). Mass and others (1972) suggested that eventhough salinity reduced the growth by 40 per cent, the concentration of micronutrients in the tissue remained within the physiological limits necessary for plant growth. Salinity caused an unfavourable balance between various ions like K^+ and Ca^{2+}. Due to excess absorption of non-essential nutrients from the soils, apart from salt poisoning, the plant could also suffer from the hunger of essential nutrients. However, a variety, adopted to saline condition, could make use of the absorbed non-essential nutrients for osmotic adjustments or even exclude the salt in order to escape from salt damage.

b. Salinity and its Effects on Enzymes

Since ion accumulation due to ion compartmentation could not be a reliable indicator for tolerance of crop plants in general, metabolic interactions seemed to be effective physiological mechanisms to survive under saline condition (Maas and Nieman, 1978). Increased ionic concentrations and the lower osmotic potential increased the activity of many enzymes such as peroxidase in rice (Aleshin *et al.*, 1971), cotton, maize, lucerne (Azizbekove, 1964) and other plants (Strogonov *et al.*, 1956), polyphenolase and ascorbic acid oxidase in cotton, maize and lucerne (Azizbekova, 1964), amylase, invertase and phosphorylase in wheat (El-Fouly and Jung, 1970), tomato, beans and spinach (Latzko, 1954). Acid phosphatase activity was found to increase by salinity in wheat (El-Fouly and Jung, 1970; El-Fouly, 1972) and barley (Dzhanibekova, 1972). Salinity promoted the ATPase activity in the cotyledons of *Phaseolus vulgaris* (Lai and Thompson, 1972) and in the leaves of *Avicennia nitida* (Kylin and Gee, 1970).

Protein breakdown and turnover was delayed by the sodium chloride treatment in *Vigna sinensis* (Prisco and Vieira, 1976). Sodium chloride decreased the protein synthesis and increased its hydrolysis in many crop plants, for instance in pea roots (Klyshev and Rakova, 1964) and grape leaves (Saakyan and Petrosyan, 1964). Nitrate reductase activity was decreased in many plants (Heimer, 1973; Abdul-Kadir and Paulsen, 1982). Salinity resulting from chloride inihibited the activity of dehydrogenases related to tricarboxylic acid cycle in barley, sunflower and tomato (Zhukovskaya and Lyakhova, 1969). Contrary to this, Gupta and Parmil Kaur (1970b) observed a direct correlation between salt tolerance and total dehydrogenases in pea. Greenway and Osmond (1972) suggested that the different species had been known to regulate the ionic environment and of the cytoplasm to protect the enzymes within the different compartment.

c. Accumulation of Free Amino Acids in Response to Stress

An attempt has been made to screen genotypes for saline tolerance based on their capacity to accumulate free proline under a given stress. Palfi *et al*., (1974) observed differential accumulation of proline in 27 species. Some species were found to accumulate high proline than others. Stewart and Lee (1974) observed differential accumulation of proline in the coastal and inland species of Triglochin maritima and suggested that the capacity to accumulate proline was correlated with salt tolerance. Genotypic differences in the accumulation of proline was also observed in sorghum (Sinha and Rajgopal, 1975; Blum and Adelina Ebercon, 1976). It was found that proline accumulation in sorghum ranged from 2.56 to 4.26 µg in different cultivars, whereas in barley proline accumulated from 9 to 15 mg per gm dry weight in different cultivars (Singh et al., 1973). Hence, accumulation of proline was also used as a criterion for the assessment of genotypes for stress conditions. Proline accumulation in plants as a response to saline environment was reported by other workers like Palifi and Juhasz (1970), Stewart and Lee (1974), Ball (1975) and Chu et al., (1976a), suggesting that proline acted as an endogenous osmotic regulant in halophytes and also served as a source of energy for growth and survival in rice (Ball, 1975).

Proline also accumulated when crops were exposed to drought conditions (Singh et al., 1972). The relationship between proline accumulation and drought resistance indicated the possibility that proline might also be implicated in resistance to physiological drought under saline conditions. Thus, Stewart and Lee (1974) observed that accumulation of proline in halophytes and the level of proline was low under non-saline conditions and increased with increase in salinity.

Hence, it was suggested that the capacity to accumulate proline was correlated with salt tolerance and possibly proline served as a source of solute for intracellular osmotic adjustment under saline conditions. Chu _et al_. (1976b) suggested that the accumulation of proline during both water and saline stress followed as a consequences of a reduction in cell osmotic potential but with an increase in the internal sodium content there was a decrease in the accumulation of proline. Among the differences in the ability of genotypes for accumulation of proline under saline conditions, the higher magnitude of free proline accumulating genotypes could be considered as salt tolerant varieties.

d. Effect of Salinity on Nucleic Acids and Protein Metabolism

Salinity increased the DNA content in pea (Kabanov and Erakov, 1969) and tomato (Tsenov _et al_.,1973). Alternatively, salinization decreased the synthesis of RNA and DNA in okra, spongegourd (Maliwal and Paliwal, 1972a), bean (Nieman, 1965) and Tomato (Tal, 1977).

Salinity decreased the protein synthesis and increased its hydrolysis as observed in grape leaves (Saakyan and Petrosyan, 1964) and bean leaves (Nieman, 1965). However, protein breakdown and turnover was delayed by salinity in _Vigna_ (Prisco and Vieira, 1976). On the other hand salinity increased protein content in wheat seed (Singh and Vijayakumar, 1974) and in particular, acid proteins in pea roots (Rakova et al., 1969). There was an increase in total nitrogen content in desert fodder plants (Abd-El-Rahman et al., 1974) and rice (Shimose, 1957, 1969), but the observation on wheat reported a decrease in total nitrogen (Abdul-Kadir and Paulsen, 1982).

e. Carbohydrate Changes in Response to Salinity

Salinity decreased the reducing sugars, non-reducing sugars and total soluble sugars in Potatoes, beet, bushbeans, buckwheat, lapins, sunflower, barley, wheat, rape (Buchner, 1951), tomato (Maliwal, 1975), wheat (Maliwal and Paliwal, 1972b), brinjal (Maliwal and Nanawati, 1974), maize (Paliwal and Maliwal, 1971), millet, clover (Ravikovitch and Yoles, 1971) and groundnut (Reddy and Das, 1978). Alternatively starch content decreased under salinity in oats, millet (Boiko and Matukhin, 1964), rice (Shimose, 1963), tomato, celery and vines (Siegel and Bjarsch, 1962). The reduced carbohydrate utilization as a result of salt stress might possibly initiated feed-back effects where photosynthesis was diminished and thereby could result in reduced starch content (Hall and Milthorpe, 1978). Rathert (1982) suggested that the genotypically high sugar content particularly in the roots could be evidenced an additional mechanism to prevent salt injury. On the other hand, a restricted utilization of carbohydrate under salinity might result in a lack of energy for growth (Rathert and Doering, 1983). In addition, osmotic adjustments via accumulation of reducing sugars to a certain extent in the leaves seemed to be a typical cytoplasmic status for salt tolerant plants such as barley (Gauch and Eaton, 1942). Such ion regulation of the carbohydrate metabolism was also proved in cotton (Rathert 1983a).

Rathert and coworkers (1981) pointed to a low carbohydrate content due to stimulated respiratory rate, accompanied by reduced growth rates under high salinity stress. Evidences indicated that these carbohydrate changes were regulated by the absorbed ions, mainly K^+ and Cl^-, directly or indirectly via synthetic and degradative enzymes connected with the carbohydrate metabolism (Rathert, 1982).

f. Salinity Effect on Ascorbic Acid and Titrable Acid Number

Sodium chloride at moderate doses increased ascorbic acid content in pea (Gupta and Parmil Kaur, 1970a) and Sorghum (Garcia and Morard, 1979). On the contrary, salinity decreased the ascorbic acid content in cabbage and radish (Kim, 1958). Gupta and Parmil Kaur (1970a) reported that the salt tolerant variety of pea accumulated high level of ascorbic acid than the salt sensitive variety. They observed the existance of close relationship between salt tolerance and ascorbic acid content in the varieties of pea. The treatment with sodium chloride resulted in an increase in the titrable acid number in Bryophyllum (Karmarkar and Joshi, 1969), Saccharum (Nimbalkar, 1973) and Phaseolus (Khot, 1978).

g. Chlorophyll Breakdown in Response to Salinity

Rice is a salt sensitive crop which exhibits high uptake of sodium and chloride from quite moderate external concentrations (John *et al.*, 1977; Flower and Yeo, 1981). Rice also under saline conditions exhibited considerable variability in chlorophyll breakdown by the excessive entry of sodium and chloride ions (Yeo and Flower, 1983). Such decrease in the chlorophyll content as a response to salinity was observed by several other workers in radish, lettuce (Kim, 1958), spinach, beet (Nieman, 1962), tomato, celery, vines (Siegel and Biarsch, 1962) and some glycophytes (Prokrovskaya, 1958; Sivtsev, 1973). However, surprisingly enough the findings of Dostanova (1966) on cabbage evidenced that an increase in pigments content under saline treatment was possible. At high osmotic pressure as high as 11.3 atm increased chlorophyll a and to a lesser extent chlorophyll b in necrotic areas.

Objectives of the Present Study

In the present study nine rice varieties differing in their response to salinity were chosen and the experiments were carried out by subjecting them to sodium chloride salinity. On the basis of the inorganic status, growth and yield parameters, the salt resistant and sensitive varieties were screened and also published earlier (Krishnamurthy *et al.*, 1986). An attempt have been made to evaluate the salt tolerance of genotypes at germination, early seedling growth, preflowering vegetative growth and yield. The salt tolerance or salt sensitiveness of genotypes were assessed using the percentage of survival to sodium chloride absorption. The positive effect of sodium and chloride absorption on the other inorganic status were studied at the various stages of vegetative parts and harvested filled and unfilled grains.

During these investigations, several metabolisms were studied at different stages of growth to relate the changes to the degree of susceptibility or tolerance. Proline, ascorbic acid and titrable acid number were used for the assessment of genotypes to salinity tolerance. Genotype differences in the protein, amino acid, nucleic acid and carbohydrate metabolism were also investigated at different times of salt treatment. Salt effect on the response of different enzymes were studied as an indicator of metabolic reaction to salinity. Among the pigments, the level of the chlorophyll was also studied as an indicator to saline injury due to its ease of measurements in extensive replications dictated by the intravarietal variability of rice in saline conditions and also because of the prominence of chlorophyll in any visual assessment of damage. Finally an attempt has been made to bring out the salt tolerance of genotypes using germination performance and nutritional status of harvested grains from the saline exposed crop.

Correlation of yield components under saline conditions to the changes in the physiological characters was attempted with an object to develop a criterion for evaluation of salt tolerance. The evaluation of genotypes for tolerance to salinity would help in not only understanding the mechanism of salt tolerance but also in recommending such tolerant types for cultivation in salt affected areas of Gujarat State.