Chapter 1

Introduction
Humans are active agents of changes in the environment - physical, chemical, biological, political, cultural etc. In nature, all organisms are tightly bound together by a strong network of relationships. Primitive humans considered all these natural controls as bondage and tried to break away from them. They could not understand the significance and intricacies of natural balance. Their quest to conquer the nature led to massive destruction of ecological balance. Such activities disregarding their catastrophic influence on ecosystems led to ill-ecological and non-sustainable progress that is now considered as a regress. Ecology enables humans to conserve crucial relations and continuously apply technology for sustainable welfare and progress (Ray, 2001).

Only a holistic understanding of environmental relations to the flora and fauna can enable us to be agents of sound and progressive growth and development. Agriculture is the most important area of natural modification for human progress on earth. Chemicalised “Green revolution agriculture” permitted higher food stability and security for a constantly growing world population (Plunkett, 1993) and it is now considered as a product of fragmented science (Gosh, 1996). In order to make agriculture a sustainable activity for constant progress, investigations into each and every aspect of environmental impacts on crop plants in all different field conditions are essential.

In the past century, agricultural environments in most part of the world have undergone enormous transformations. The two guiding themes of agriculture today are: the pursuit of increased production and the desire to prevent environmental degradation. Many of the environment packages suggested at present are costly for a country like India. Therefore, researches on different morphological and physiological characteristics of high yielding varieties in relation to their ecological stress are rewarding. Investigations on each and every aspect of ecological, chemical, physical and biological success of local varieties will help farmers to keep on increasing the production without costly inputs.

### 1.1 Significance of Research on Cultivation of Rice

Rice is a cereal grain, staple food crop for millions, cultivated all over the world, in a range of natural and human influenced ecosystem that we live amidst, is probably a native of the deltas of great Asian rivers, the Gangas, the Chang (Yangtze) the Tigris and the Euphrates. It is an annual with a height of 2 to 6 feet with round and jointed stem, pointed long leaves and
edible seeds borne in a dense head of separate stalks. It has a life span ranging from 90 to 140 days, depending on the breed, while producing new varieties attains the reduction in life span. It comes under Poaceae family.

There are two species of cultivated rice- Oryza sativa and Oryza glaberrima. Oryza sativa is the rice cultivated in majority of rice growing countries. Rice is diploid (2n = 24) short day plant and normally self-fertilizing. It is believed that cultivated rice has evolved from one wild species-Oryza rufipogon through long-term domestication. The existing subspecies of cultivated rice include indica, japonica and javanica. The indica type accounts for nearly 80% of the cultivated rice and forms staple food for millions of people (Blankett, 1943; Khan et al., 1993). Rice is the principal component of the human diet in most of the tropical countries and about 90% of population in Asia (Peter et al., 2001).

Rice being one of the most important cereal crops in the world, it accounts for more than 70% of caloric intake. Hence many agronomic studies have been done mainly on the growth and development of shoot and root with direct and indirect relations to yield. (Abe and Morita 1997) Achieving self sufficiency in rice production and ensuring market stability are considered to be the important political objectives in many developing countries as rice is providing food security and generating employment (Hassia, 1995). Most of the Asian countries have done remarkably well in meeting the food needs of the growing population over the last quarter century. The future is much more challenging posed with the problems of producing 350 million tones more than that is produced in 1992, involving less labour and water (Singh et al., 2000). Diversity and variability of environment in different rice growing countries and regions would make the development of an appropriate technology difficult. Baker (1988 a) has listed a set of environmental factors such as drought, temperature salinity, soil conditions etc., which varies across sites, seasons and years. Understanding the response of plants to their environment in terms of adaptability and performance is of paramount importance. Sustainable agriculture in harsh environments requires an understanding of the ways that plant genes respond to both biotic and abiotic factors (Swami et al., 1999).

The plant breeders at International Rice Research Institute in Philippines have developed hybrid breeds of improved varieties of rice that increases the yield in short periods to meet the burgeoning demands of the world population. In India, a lot of work had been conducted to produce improved varieties of local paddy so as to make it resistant to pests as well as to suit local conditions (Abe et al., 1997). Different varieties of rice are grown in two ways. Aquatic rice is cultivated in watered fields. The low yielding hill grown rice can be grown in
almost tropical and subtropical regions. Rice is commercially classified by its size, long, medium or short grain. There are both brown and white varieties. Brown rice is the entire grain with only the inedible outer husk removed. The nutritious, high fibre bran coating gives it a light brown colour with nut-like flavour and chewy texture.

Creation of new varieties as well as hybrids through research enhanced the production of rice. The green revolution strategies for enhancing the cereal production in India and other Asian countries was mostly based on massive investment in crop research and development of other infrastructure for cultivation. As a result, the rice output growth rate got increased several times and surpassed the annual population growth rate during 1970s. Even under highly extensive farming also, the rice yield has started showing signals of decline. The important reasons for the recent failure of green revolution technologies are basically ecological consequences of the lack of a holistic approach in crop improvement strategies as well as that in their cultivation procedures. Green revolution fields have started showing signs of induced degradation, reduced soil nitrogen supplying capacity, impairment of soil fertility, nutrient depletion, salinity stress, long term changes in soil physical properties, emergence of micronutrient deficiencies, lack of pure water for irrigation, water logging, increased incidence of pests and diseases and the like. The grain yield in rice is affected by a number of environmental factors, amongst which salinity and high temperature are considered agronomically significant (Yoshida et al., 1981; Singla et al., 1997a). Hence researches aimed at better understanding of total environmental relations of rice are most significant in modern times. The present work aims at finding the response of two high yielding varieties of rice towards salinity stress.

1.2 Significance of Researches on Morphology and Biochemistry in relation to Salinity

As mentioned by Singh et al., (2000) it is understood beyond doubt that the tiller number, shoot weight, shoot height, shoot diameter, leaf length and leaf width are strongly influenced by the growth of root system. Cessation of growth leads to terminal stress that, results in fewer grain number and poor grain filling (Krupp et al., 1972). Only a limited field scale information on root and shoot characteristics of wetland rice is available. However reports are available on significant difference in tiller number and shoot weight due to stress, difference in soil types as well as water regimes (Sorte et al., 1992).

Many agronomic studies have been done mainly on the growth and development of shoot with direct or indirect relations to yield. Information on root system, on the other hand is
relatively limited, partly because root research under field conditions is not always clear. However, the most important management practices in rice cultivation, for example fertilization and water management, are artificial actions to root systems through soil. In fact, good rice farmers know from their experiences that improvement of soil conditions for better root growth is at least a certain way to establish sustainable high yield. Therefore, it is essential to have a complete understanding on the growth and development of root systems of high yielding varieties of rice under different environmental conditions.

Rice is adapted to grow in aquatic and marshy habitats. Rice plant has two types of roots - the seminal roots and the nodal roots. The seminal root is quite temporary and soon. secondary fibrous roots (nodal roots) are produced in whorls from the underground body of plants. Nodal roots are highly branched with many rootlets and plenty of root hairs on each rootlet. Nodal roots are continuously produced from the lower nodes till the plant attains full maturity.

Various ecological groups of rice varieties have characteristic root systems. Roots in wetland rice help them in buoyancy and in drawing nutrients from water. If we could know the ideal root system in rice cultivation, we will be able to control root system development to maximize the yield (Abe et al., 1997). Response of roots and other biochemical characteristics of plants towards stress conditions in their seedling stage give a reasonable estimate of relative response of plants to the same when they are mature.

Abiotic stress such as salinity, water stress and extreme temperature adversely affect the growth of rice in different parts of the world. The present work is an attempt to know the details of root, shoot and other biochemical characteristics of certain MO varieties of rice and their response towards different salinity conditions in the early stages of growth. In the field, crops experience a multitude of stress conditions, it is important to understand the way plants react to different such conditions. The ability of root systems to adapt itself to varied local stress conditions and to periodic or accidental changes determines to a great extent the success of plants in nature (Ray, 1994). Therefore, it is important to do a comparative investigation on root and shoot and their biochemical characteristics towards salinity tolerance in high yielding varieties of rice. Experimental studies in laboratory conditions would enable successful field trials later.
1.3 Novelty in Present Theme

Kuttanadu is one of the most famous and unique wetlands (a *Ramzar site*) situated in the south west coast of India, in the State of Kerala. A greater part of its land is lying below mean sea level (MSL) and includes about 50 thousand hectares of paddy fields. This region is known as the *Rice Bowl* of Kerala. Green revolution efforts in the last 30 to 40 years have caused tremendous ecological changes in this region. The Moncombu Rice Research Institute (RRI at Moncombu, Alappuzha district) is one of the research stations of the Kerala Agricultural University dedicated to release high yielding cultivars suitable for this region. However, their selection methods are based mostly on high yield and disease resistance. Morphological and physiological tendencies of the high yielding cultivars released (MO varieties of rice), are not analyzed in detail. This is the first attempt to reveal the details of root, shoot as well as some biochemical characteristics of some of them in normal and stressed environmental conditions. Among the MO varieties, MO18 and MO19 are found to be the most adapted and widely cultivated high yielding cultivars in the region.

One of the major environmental problems of Kuttanadu region is the incursion of salinity in the paddy fields during the non-monsoon seasons. The Thannirmukkam barrage across the Vembanadu Lake has controlled the problems of salinity to a great extent. Hence investigations on the response of high yielding varieties in this region towards salinity conditions are yet very significant. The present work is the first and unique attempt to develop a holistic idea of the root, shoot and some important biochemical characteristics of MO18 and MO19 rice in different laboratory conditions of salinity.

1.4 Objectives

The main objectives of the present study are

- To study the fundamental principles operating in the mechanism of salt tolerance in MO 18 and MO 19 varieties of *Oryza sativa* L.

- To study the changes in the root characteristics of MO-varieties of rice such as seminal root length, total number of nodal roots, total length of nodal roots, number of root hairs per unit length of nodal roots, distribution of root hairs, average length of root hairs and morphology of the root tip in response to salt stress.
➢ To investigate the variations in the morphological characteristics such as shoot length, leaf area and biomass under stress

➢ To study the importance of biochemical factors like starch, protein, amino acid, proline, enzymes (peroxidase and superoxide dismutase), electrophoretic separation of proteins and isoenzyme study that determine the tolerance to NaCl.

➢ To study the importance of physiological factors like ions, such as Na\(^+\), K\(^+\), Cl\(^-\) and P and Na/K under NaCl stress

➢ To study the anatomical changes in the root and shoot under stress

➢ To identify the morphological and biochemical characteristics of the salt tolerant MO-varieties of rice