INTRODUCTION
Rice is the most important cereal food crop in the world as rice remains the most necessary food to millions of people in Asia and among the poor, it is practically their only food. It has been stated by the F.A.O that rice is the traditional crop and traditional staple food in Asia.

Considering the world total area for under all cereals, rice occupied the second position, the highest being under wheat (210 million hectares) followed by rice (135.5 million hectares). In Asia rice occupied the highest area in 1970 viz., 90.6 million hectares followed by wheat 43.4 million hectares. Of its total area and production 90% centred in
South and South East Asia.

Its cultivation certainly dates to the earliest age of man and long before the era of which there is historical evidence. The ancient civilized nations in the near East did know rice is a cultivated plant, though the cultivation of cereals and the irrigation of fields were grown in vague several thousand years ago.

China is one of the countries which are stated to be associated with the origin of rice. Specimens of rice have been discovered in China dating from the Third millennium B.C. and the Chinese term for rice appears in inscriptions dating from the Second millennium B.C.

The oldest specimens of rice has been found in India at a site near Hastinapur in Uttar Pradesh dated between 1000 - 750 B.C. The Rigveda written prior to 1500 B.C. contains references of rice and rice cultivation. Rice became known in Europe only after the expedition of Alexander the Great.

The ancient Indian name for rice is "Dhanya" meaning
sustainer of the human race indicated its age old importance since it is regarded as an evidence of wealth, fortune and prosperity. The Sanskrit word "Vrihi" which most writers accept as the most direct name for the grain in that language finds mention in Atharvanaveda (1100 B.C.). The word rice is derived from the Greek word "Aruza".

The famous Ayurvedic doctor Susruta (1100 B.C.) mention in his "Materia medica" different groups of rice based on duration, water requirements and nutritional values, recommended for particular ailments.

Rice belong to the Genus Oryza in the family Graminaceae. The Genus Oryza includes 28 species, of which 26 are wild and only two races are cultivated viz., Oryza sativa and O. glaberrima. Varieties of O. sativa are commonly divided into 3 sub-specics; indica, japonica, and javanica (Matsuo, 1952; Sampath, 1962) based on mainly morphological differences and adaptation to different climatic regions of the world.

Rice is cultivated in almost all states in India and
about 85 million acres under this crop. Rice has a wide physiological adaptability and it is being grown from semi-arid zones of Rajasthan to very wet areas of Assam.

Different varieties of rice are grown in different altitudes and temperatures. The cultivation of this crop extends from sea level to high altitudes of 4000 feet to 5000 feet in Kashmir. It is grown in upland conditions moderately submerged conditions and in 150 to 500 cms of water.

There are nearly 3000 varieties and 9000 races in India which differ in morphological and agricultural characters. The varieties are selected in a particular region according to their suitability. The suitability depends upon the nature of soil, rainfall, temperature, and pH of the soil. The varieties differ in their season for growth, maturation and yield. The average rice yield ranges from less than one to more than 6 tonnes/hectare.

DESCRIPTION OF THE PLANT:

The rice plant can be described as an annual grass adopted to an aquatic habitat. The vegetative parts of
the plant consist of roots, the culms and leaves.

**Roots:**

The rice plant has two types of roots. The first root emerges through coleorhiza is known as the seminal root. Few more roots are then produced which in turn may form lateral roots, which are fibrous are produced in whorls from the underground nodes of rice plant. As the plant becomes old, adventitious roots develop from the lower nodes. The roots help the plant in buoyancy and in drawing nourishment from water.

**Culms:**

Culm consists of series of solid nodes alternating with hollow internodes. The internodes are short and thick at ground level and their length gradually increases from base upwards, the largest being the one bearing the earhead or panicle. Primary tillers are produced from the main culm in alternate fashion. Primary tillers produce secondary tillers which in turn develop into tertiary tillers.
Leaf:

The first leaf of the rice plant that persists for a short time enclosing the young plumule is known as "Sheath leaf" or "Coleoptile". The second leaf without a blade that emerges next to coleoptile is called "PropyII" or "Primary leaf". The leaves that develop subsequently are normal except the topmost leaf or flag leaf (boot leaf) subtending the earhead.

The leaves are flat and sessile and are arranged in alternate fashion. The two main parts of leaf are the leaf sheath and leaf blade. The leaf blade is generally lanceolate. The surface is either pubescent (hairy) IET-4141 or glabrous (smooth) TN-1. The portion of the leaf where the sheath ends and blade starts is termed as the "Junctura" or "Collar". Two ciliate structures that develop on either side of the junctura are called "Auricle".

REPRODUCTIVE PARTS:

The rice flowers are borne on an inflorescence called the "Panicle". The panicle is branched and spikelets
are borne on secondary branches. Each spikelet may have only bisexual flowers or may have bisexual and male flowers or may have male and female flowers only. Each spikelet has a rachilla on which glumes or bracts present in two rows. The lowest glume may be larger than the upper one. The upper one is fertile, known as "lemma", it subtends a single flower in its axil. Flower is enclosed by the lemma from below and the palea from above. Perianth is reduced as 3 lodicules, but in many cases represent two lodicules only. Flower consists of stamens which are commonly 6, in whorls of 3 each and a pistil. The stamens have two celled anthers borne on long slender.

The grain (caryopsis) is tightly enclosed by the lemma and palea. According to Santos the aleurone layer is composed of a single layer. Cho (1942) states that the aleurone layer on the dorsal side of a rice grain of Japonica type is composed of five or six layers, while there are three layers without exception, in the Indica type (Matsuo, 1955).
RICE DISEASES:

Rice plants are affected by many diseases, i.e., fungal, bacterial, viral, insects and nematodes (Kannaiyan, 1987).

Bacterial diseases:

Bacterial leaf blight caused by Xanthomonas campestris pv. oryzae (Ishiyama, 1922) Dye, Leaf streak by Xanthomonas campestris pv. oryzae (Reinking, 1918), Bacterial stripe by Pseudomonas syringae pv. panici (Goto and Ohata, 1961), Bacterial sheath rot by Pseudomonas fuscovaginae (Klement, 1955), Black rot by Pseudomonas hoana (Iwadara, 1931), Bacterial foot rot by Erwinia chrysanthemi (Goto, 1979 b; Chaudhury and Ghifran, 1980) and other bacterial diseases of grain cinnamon speck of rice grain by Xanthomonas cinnamona (Miyake and Tsunoda), Black eyespot of rice grains by Xanthomonas atroviridi (Miyake and Tsunoda; Tagami and Mizukami), Bacterial grain rot by Pseudomonas glumae (Kurita and Tabei), Leaf brown blotch by Xanthomonas sps. (Veracruz et al., 1984), Bacterial wilt caused by Pseudomonas solanacearum, Bacterial halo blight of rice by Pseudomonas syringae pv. oryzae (Kuwata, 1985).
Fungal diseases:

off caused by *Dictyuchus* spp., *Pythium* spp., *Achlyas* spp., Rice wilt by *Pythium graminicola* (Kato et al., 1985), Seedling blight by *Corticium rolfsii*, Diseases in seed boxes by various fungi, False smut caused by *Ustilaginoidea virens*, Kernel smut by *Tilletia barclayana*, Udbetta disease by *Balansia oryzae sativae*, Black kernel by *Curvularia* spp., Minute leaf and grain spot by *Nigrospora* spp., Glume blight by *Phoma sorghina*, Scab by *Gibberella zeae* and Red blotch of strains by *Epicolcum purpurashens*, *Stemphylium* spp., *Tricoconiella padwickii*, *Phoma* spp., *Fusarium dimorom*, *F. semitectum*, *Aspergillus* spp., are also reported to be found in seeds of rice causing damage to grain.

**Virus and MLO diseases:**

Dwarf, Tungro, Yellow dwarf, Stripe, Black streaked dwarf, Hoja blanca, Transitory yellowing, Waika, Bunchy stunt, Grassy stunt, Wilted stunt, Ragged stunt, Orange leaf, Yellow mottle, Giallume, Chlorotic streak, Mosaic, Wrinkled stunt and Witches broom diseases are affecting the rice plants.
BACTERIAL LEAF BLIGHT OF RICE:

Bacterial leaf blight of rice caused by \(X._c._\text{pv. oryzae}\) (Ishiyama, 1922) Dye, (1978) is a major problem for the cultivation of rice in Asia (Ou, 1972). The disease has also been reported in Northern Australia (Aldrick et al., 1973), Latin America (Lozana, 1977), and Africa (Buddenhagen et al., 1979; Reckhaus, 1982).

It is occasionally causes severe damage to rice yields and it is now becoming one of the most serious diseases, especially prevalent in irrigated and rainfed lowland areas. It is said to have been first seen by farmers in Fukuoka areas of Japan in 1884. Several references (Padwick, 1950; Dickson, 1956; Pordesimo, 1958; Tagami and Mizukami, 1962) have been made to the report of Reinking (1918) that the disease occurred in Philippines.

The disease was reported from India (Srinivasan et al., 1959; Bhapkar et al., 1960). Latter studies showed that the disease was present in most of the rice growing states of India (Mizukami, 1964; Srivastava and Rao, 1964 a; Srivastava, 1967).
Bacterial blight has three types of symptoms - Leaf blight, Kresek or Seedling blight or Wilt phase of syndrome and Pale yellow leaves. The disease has been referred to as 'BLB' indicating that the leaf blight, phase syndrome is distinct.

The Kresek symptoms signify severe infection, those isolates causing Kresek plants were assumed to be more aggressive than those causing leaf blight (Devadath, 1970). The name kresek was introduced by Schure (1953). The final stage of kresek complete death of the entire plant is known as 'hamalodoh'. Severe kresek was observed and total crop failure was reported in Punjab, Haryana and Western U.P. states of India in 1979 and 1980 (Durgapal, 1985). The disease is associated with the age of the plant. This disease has now been shown to be a severe form of 'BLB' which is found in various parts of the tropics (Goto, 1964). Pale yellow symptoms found on mature plants and these symptoms are very similar to those of iron deficiency.

Ou (1985) believed that it could be due to gradual build up of the bacterial population in the lower portion
of the stem reaching a point at which little nutrient is available for the young leaves which therefore become pale yellow.

Bacterial blight is a vascular disease. A lesion develops when the bacteria multiply in the vascular tissue. The bacterium enters the leaf blade through hydathodes (Mizukami, 1960; Tabei and Mukoo, 1960, 1977) growth cracks caused by the emergence of new roots at the base of leaf sheath and wounds are the points where the pathogen invades. Tabei (1977) observed the colonization of the bacterium in stomata, but the bacterium did not reach the vascular system to cause disease.

A hydathode of rice is composed of series of water pores. Mew et al., (1984), showed that water pores are not only portals of entry for X.c. pv. oryzae but also involved in the specificity of the rice X.c. pv. oryzae interaction.

Causal organism - X.c. pv. oryzae:

X.c. pv. oryzae is infected with bacteriophage. It was first isolated by Yoshii et al., (1953). Wakimoto's
(1954 a) classified bacteriophages into four strains and it has variable phage groups. Pathologically a filamentous phage infected bacteria appeared to be more aggressive than infected bacteria.

Sucrose is the most favourable carbon source but other carbon sources, except fructose are also utilized to some extent (Fang et al., 1957; Watanabe, 1963, 1966). The essential aminoacids for good growth of X.c. pv. oryzae was found to be glutamic acid and methionine (Watanabe, 1963; Noda and Ohuchi, 1984). Krishna Rao and Nayudu (1978) reported that X.c. pv. oryzae exhibited better growth in the presence of glutamic acid, methionine, cysteine and serine. Tanaka (1963, 1964 a) found glucose and sucrose to be best carbon sources and glutamic acid, aspartic acid, methionine, cysteine and asparagine to be a good N₂ sources. Mannose and maltose also supported good growth in a synthetic medium, but no growth was observed with fructose, dextrin and citric acid (Hsu, 1966).

The pH range for the growth of the organism is 4 - 8.8. The optimum pH values are reported as 6.0 - 6.5 by Fang
et al., (1957) and 6.2 – 6.4, 6.8 – 7.0 in Japan. The bacterium does not require vitamins as indispensable growth factors but small amounts of riboflavin, thiamine, calcium, pantothenate, nicotine or pyrodoxin give some stimulating effect (Watanabe, 1966).

The best method of maintaining the organism is in a clay suspension. A high percentage of viable bacteria may be recovered even after 400 days (Goto, 1969).

X.c. pv. oryzae produced bacteriocin like substances on solid media. Aerobic bacteria does not liquefy gelatin, does not use nitrates, does not produce NH₃, produces H₂S slightly. It produces no indol, it ferments but does not coagulate milk, litmus milk is turned red; it does not produce gas or acid from sugar. Muko and Isaka (1964) using Japanese isolates and Goto (1964) using tropical strains both reported gelatin liquefaction, production of NH₃ and H₂S, alkaline reaction of litmus milk and acid production from some sugars.

Hifni et al. (1975) studied 30 isolates from Indonesia and Japan or less confirmed with the results of Goto
(1964), Muko and Isaka (1964), Reddy and Ou (1976 a) studied 40 isolated from nine countries of Asia and tried to establish a norm for the physiological characters of bacterium.

In incompatible interactions, the fibrillar material, a polysaccharide of host origin, appeared to the inside of the vessel walls of leaves within 3 days after inoculation with X.c. pv. oryzae. The fibrillar material depressed bacterial multiplication and finally enveloped bacteria thus involving in the protective reaction of host. No antibacterial substance was detected. But in compatible the fibrillar material appeared at a later stages (20 days after inoculation) and it has little ability to enclose bacteria (Horino, 1973).

Shekhawat and Srivastava (1968) reported that X.c. pv. oryzae produced proteolytic enzymes in culture of certain strains of Indian isolates. Fujii and Uematsu (1975) found correlation of virulence of the pathogen with protease activity from the Japanese isolates of X.c. pv. oryzae. However, no definite correlation was found by Reddy and Ou (1976) from isolates collected from various countries.
This was based on the ability of organism in hydrolysing the gelatin. An avirulent *X.c. pv. oryzae* (BU-26) to TN-1 was found to be a very good gelatin liquefier (Sreeramulu, 1984) whereas the virulent bacterium (APX₂) was not under the conditions and methods tested by him. Reddy and Ou (1974) found that the organism produced catalase and lipase but not phenylalanine deaminase, tyrosinase or β-glucosidase which were produced by *X.c. pv. oryzicola* this can be used for differentiating the two organisms. *X.c. pv. oryzae* produces neither phenylalanine ammonialyase nor hydrosinase culture (Reddy and Ou, 1974). It has a role in the conversion of phenylalanine and tyrosine into phenols.

**Serology:**

Lin *et al.*, (1969) reported that virulent and weak strains are serologically different and can be easily distinguished by the gel diffusion test. Addy and Dhal (1977) found that only one sero type among 45 isolates based upon agglutination and gel diffusion tests. Mahanta and Addy (1971) reported heat stable species specific antigen in *X.c. pv. oryzae*. *X.c. pv. oryzae* produced phenylacetic acid, 4 different polysaccharides and an unidentified
phenol. Kuo et al. (1970) showed that culture of 
produced X.c. pv. oryzae polysaccharides with estimated M.wt. 
of 200,000; 150,000; 147,000 and 29,000. The first 
three compounds are antigenic and phytotoxic. The largest 
weight compound was reported to be a polymer of 
mannose and glucose.

Several authors have tried to classify X.c. pv. oryzae 
strains on the phase sensitivity (Wakimoto's, 1960), 
serological properties (Choi et al., 1980), phenotypic 
features (Shekhawat and Srivastava, 1968; Hifni et al., 
1975; Reddy and Ou, 1976; Tsuchiya et al., 1982) and 
pathogenic variability (Ezuka and Sakaguchi, 1978; Mew 
and Veracurz, 1979).

No phenotypic features were found allowing a sub-
division of X.c. pv. oryzae. This taxon is also fairly 
homogenous on the basis of protein electrophoregrams.

Classification of X.c. pv. oryzae:

In the phenotypic analysis two strains (PXO61 NCPPB 1152) 
clustered at a lower level in phenon 1 and strain IRN 235
grouped at the border of phenon 2. The latter strain occupied a separate position according to its protein electrophoretic pattern. However this strain causes bacterial blight symptoms, typical of \textit{X.c. pv. oryzae}. Hifni \textit{et al.} (1975), Reddy and Ou (1976) and Tsuchiya \textit{et al.} (1983 a) were likewise notable to define biochemical groups with \textit{X.c. pv. oryzae}. The protein electrophoregram of the highly virulent strain IRN 325 (isolated in Indonesia) was almost indistinguishable from the pattern of the less virulent strain NCPPB 1153 (isolate) in Japan.

Classification system for \textit{X.c. pv. oryzae} strains based on their virulence on rice varieties bearing different major genes for resistance towards bacterial blight, have been developed in Japan (Ezuka and Sakaguchi, 1978) and in the Philippines (Mew and Vera curz, 1979) and five and four pathogenic groups. The Philippine groups I, II, III and IV were represented respectively by strains, PX061, PX086, PX079 and PX071 whereas strains T7174, T7147, T7133 and H75304 were chosen from Japanese pathogenic groups I, II, III and V respectively presentative of group IV was available. It can be concluded that there is no correlation between clustering obtained from phenotypic
analysed with \( S_{sm} \) or SJ coefficients that differentiated the pathogenic groups or correlated with the virulence of the strains.

This confirms the conclusion of Reddy and Ou (1976) and Tsuchiya et al. (1982 a). Also the protein electrophoregrams of strain PX061, PX086, PX079 and PX071 were very similar, suggesting a high degree of relatedness between the Philippine groups I, II, III and IV. Bacteria displaying a strong similarity in the electrophoretic protein patterns are known to share a high degree of DNA relatedness (Kersters and Deley, 1980; Izard et al., 1981; Owen and Jackman, 1982). Vera cruz et al. (1984) concluded that the sub-division in pathogenic races determined only a minute fraction of the genetic material of the bacterial cell.

**Metabolic changes:**

By the invasion of the pathogen into the host tissue, metabolic alterations take place.

Rajuphilip and Devadath (1981) found loss of chlorophyll in the rice leaves infected with \( X.c. \) pv. oryzae. Changes in the amount of carbohydrates and
nitrogenous compounds in the rice leaves incited by *X. c. pv. oryzae* (Uyeda and Ishiyama) Dowson, the incitant of bacterial leaf blight of rice. Misawa and Miyazaki (1972) also reported that alterations in the content of carbohydrates, nitrogenous and phosphorus compound in diseased leaves.

Fang et al. (1963) reported the susceptible cultivars tended to have higher contents of some free aminoacids and lower contents of polyphenol and reducing sugars. Higher concentrations of sugars and polyphenols have been reported as less favourable to the pathogen. Krishna Rao and Nayudu (1979) observed decreased level of total and non-reducing sugars and increased levels of reducing sugars and starch in susceptible infected rice plants. Starch content increased in the infected tissue particularly towards the last phases of disease progress when tissue desiccation was also high. Similar results were reported by Misawa and Miyazaki (1972, 1973); Moses et al. (1975) reported both reducing and non-reducing sugars were decreased in rice leaves developed after bacterial leaf blight infected rice leaves.
In bacterial leaf blight, accumulation of amino acids like leucine, valine, methionine, alanine, glutamic acid and an unidentified amino acid 'b' was reported in the infected susceptible rice plants (Mizukami and Murayama, 1960). Purushothaman (1974) recorded a marked reduction of phenylalanine and tyrosine in the resistant rice plants, while high accumulation of phenylalanine and tyrosine was reported in inoculated rice leaves of susceptible plants by Krishna Rao and Nayudu (1979). Besides the above reported amino acids glutamine, histidine, asparagine and serine were also found to be accumulating in the susceptible leaves of rice plants (Krishna Rao and Nayudu, 1979).

Watanabe and Asaumi (1975) found an increased respiratory rate in infected leaves to be due to host response than to the respiration of an increased bacterial population.

Purushothaman (1974) noticed that resistant cultivars synthesized more phenols than susceptible ones and were associated with high phenylalanine ammonia-lyase activities. Phenols accumulate in the fungal and bacterial infected rice leaves (Sridhar, 1972 a, b; Sridhar and Ou, 1974 a; Purushothaman, 1975; Reddy and Sridhar, 1975 a, b) and these
arise, as a result of the shift in carbohydrate metabolism. Krishna Rao and Nayudu (1979) reported total phenols in the susceptible inoculated leaves was less than that of healthy leaves, cis-ferulic, trans-ferulic, cis-p-coumaric, trans-p-coumaric, cis-cafeic, trans-cafeic, salicylic, chlorogenic, p-hydroxy benzoic and vanillic acid and UK₁ to UK₅ were identified in both healthy and inoculated rice leaves. In the inoculated rice leaves cis-ferulic, cis-p-coumaric and chlorogenic acids were less than in the healthy leaves. Contrarily Mohanty et al. (1982) reported that susceptible rice cultivars possessed higher amounts of phenols than the less susceptible and resistant cultivars. Higher phenols (278.26 mg/100 g leaf) and reducing sugars in IR-20, resistant variety the lesion size smaller and lowest phenols (100 mg/100 g leaf) in Anand, susceptible variety had lower sugars where lesion size was greater (Mahto et al., 1987).

Alteration in auxin level of the diseased plant is an important phenomenon (Sequeira, 1973). Infection results in an increase in the concentration of indole acetic acid. Microorganisms synthesize IAA from tryptophan either by decarboxylating it to tryptamine which is deaminated to indole-3-acetaldehyde. Alternatively tryptophan is deaminated to indole-3-pyruvic acid followed by decarboxylation to indole-3-acetaldehyde which is oxidized to IAA. X.c.pv.
*oryzae* (Reddy and Ou, 1976) is poor producer of IAA from tryptophan.

Phenols inhibit IAA oxidase, which may minimise IAA oxidation leading to auxin accumulation (Sondhemier, 1964). Furthermore Gordon and Paleg (1961) showed that phenol oxidase in the presence of phenols catalyzes the conversion of tryptophan to IAA. Excess auxin might stimulate the production of phenols in diseased tissue (Kosuge, 1969). The interaction of auxin and phenol in the infected plants might play a vital role in determining the resistance of rice plants.

Miyazaki et al., (1976) compared the activities of hydrolytic enzymes in diseased and healthy leaves. Low activity of enzyme aspartate aminotransferase was reported by Sreeramulu (1984) in this host pathogen system and he concluded that their low activity may lead to aspartic acid and \( \alpha \)-ketoglutarate accumulation.

Low ascorbic acid content in rice leaves inoculated with *X.c. pv. oryzae* was correlated with resistance (Mohan, 1971; Prasad et al., 1972). This would reflect resistance since only change in ascorbic acid would
necessarily change the oxidation reduction potentials of the cells which is in turn would influence the rapidity of the oxidation of phenols.

Despite numerous reports on the formation of phytoalexins and their biosynthesis in many host parasite combinations (Ingham, 1972; Purkayastha, 1973; Mahadevan, 1978). Little attention has been paid to this aspect in rice. The phytoalexins are non-specific and it was decreased by ether treatment. It was distinguishable in resistant cultivars but not in susceptible ones (Uenara, 1962). Akutsu and Watanabe (1978) reported that peroxidase activity increased markedly as lesions enlarged and it was higher in susceptible leaves when compared to resistant leaves.

Nakaniishi and Watanabe (1977) reported that antibacterial substances which were active at 250 ppm concentrations were produced in bacterial leaf blight infected rice leaves and not in healthy leaves. They were extracted by ethylacetate fractions. Acidic antibacterial components, which were present in the residue of ethylacetate extract, seemed to be different from chlorogenic
acid, caffeic acid, ferulic acid, vanillic acid, salicylic acid, p-coumaric acid or umbelliferone which were known to be present in rice leaves.

**Disease physiology:**

Physiological changes in the infected host could be due to pathogen induction by the production of toxic metabolites continues within the plant in the case of bacterial and fungal diseases. These toxins were named as host specific and host non-specific toxins (Patil, 1974; Rudolph, 1976; Yoder, 1980; Durbin, 1981). There are several reports of different kinds of toxins produced by the incitant namely *X.c. pv. oryzae* the incitant of the bacterial leaf blight of rice (Noda et al., 1980; Sreeramulu et al., 1983).

**Toxins:**

High molecular weight polysaccharide were reported to be toxins (Misaki et al., 1962; Kuo et al., 1970; Angadi, 1978). Watanabe (1966) isolated polysaccharides composed of mannose, galactose and maltose from eight strains of *X.c. pv. oryzae* which were toxic, non-specific
and not correlated with virulence. Rai (1978) reported that the non-specific toxin of virulent and weakly virulent isolates of *X.c. pv. oryzae* was a glycopeptide and its toxicity (at 0.2%) to rice cut shoots were due to plugging vessels. According to him, the toxin of weakly virulent strain lacked maltose, raffinose, two Unknown sugars and glutamic acid unlike that of the toxin of the virulent strain. Krishna Rao and Nayudu (1978) also reported that the culture filtrate and precipitate obtained after acetone treatment of the 44 hr culture fluid of *X.c. pv. oryzae* induced reversible wilting due to blocking of vessels in rice cut shoots. Sreeramulu (1984) also found that the dialysed acetone precipitate of cell free culture filtrate of the bacterium induced reversible flaccidity followed by wilting of rice cut shoots at 20 ppm in 20 hr.

Egawa *et al.*, (1968) reported that *X.c. pv. oryzae* produced phenylacetic acid in the culture filtrate that depressed the growth of roots of seedlings. Purushothaman and Prasad (1972) reported that it is a phenolic and not phenylacetic acid that is responsible for depressive growth of roots of rice seedlings. Miyazaki *et al.*, 
(1975) found phenylacetic acid in diseased leaves. Angadi (1978) reported that the presence of extracellular polysaccharides in infected rice leaves and found it to be identical to the toxin produce in culture, using immunoserological cross absorption tests, disc electrophoresis and infrared spectral analysis. Lin and Tseng (1979) showed exopolysaccharide synthesis was affected by nutritional condition of the medium. Phenylacetic acid, succinic acid, methylthiopropionic acid, trans-3-thioacrylic acid, fumaric, tiglic acid and isovaleric acids, were reported, to be secreted into the culture medium by *X.c. pv. oryzae* which were all phytotoxic to rice seedlings (Noda *et al.*, 1980). This report does not refer to the levels of virulence of the isolate used.

Sreeramulu (1984) reported that these toxic substances were produced by the virulent, non-virulent and less virulent isolates of *X.c. pv. oryzae*. However, only phenylacetic acid and succinic acids were detected in vivo in virulent susceptible host system (Sreeramulu, 1984). In addition, two new toxic compounds which were produced by the virulent isolate of *X.c. pv. oryzae* both in vitro and in vivo (Sreeramulu, 1983). One of these compounds
namely toxin 'c' induced desiccation of the rice leaf which is the initial symptom of the bacterial blight disease. Toxin 'e' induced water-soaking at 5th hour of incubation in rice cut shoots followed by unrecoverable desiccation of leaves which might be due to membrane disruption of the host cells.

**SCOPE OF THE PRESENT INVESTIGATION:**

In the present study, physiological studies during bacterial leaf blight disease development in rice leaves were carried out in two different rice cultivars, TN-1 (Susceptible) and IET-4141 (Tolerant) using a 'virulent isolate (Biotype-I) of *Xanthomonas campestris* pv. oryzae (Ishiyama) Dye.

Various physiological and biochemical studies were carried out during bacterial leaf blight disease development: changes in chlorophyll, carotenoid contents, changes in total lipids, glycolipids and phospholipids composition in affected leaves, healthy leaves and in culture were studied. Changes in nucleic acids: RNA and DNA during
disease development in healthy and infected leaves were studied. To find out whether RNase has any significant role in the levels of nucleic acids RNase activity was estimated in healthy and in infected leaves of the rice cultivars and in bacterial culture.

As no information is available on the aminoacid composition of IET-4141 cultivar and their significance with BLB disease, analysis of aminoacids in IET-4141 (Tolerant) and TN-1 (Susceptible) cultivar of both healthy and infected leaves was carried out. To find out whether protease enzyme has any role in the amounts of aminoacids found in infected leaves protease enzyme was estimated in culture of the pathogen and in infected leaves.

Whether the enzymes namely peroxidase, catalase and polyphenol oxidase enzymes have any relation to disease resistance in these rice cultivars, they were estimated in healthy and infected leaves of both the rice cultivars.

Induction of resistance is a well known phenomenon. In the present study a few chemicals were pretreated and inoculated the rice leaves followed by disease intensity
determination. Estimation of total sugars, total phenols, starch, total reducing and non-reducing sugars were carried out.