I. INTRODUCTION
INTRODUCTION

Soil is a basic substrate maintaining the microbial populations. It is a dynamic layer in which many complex-chemical, physical and biological activities are going on constantly. Soil is the habitat of a vast number of saprophytic and potentially pathogenic fungi. Their requirement of nutrition, interaction among themselves and various biochemical activities make the soil a dynamic system. The various biochemical processes initiated by microorganisms and their interplay with environment determine the status of soil. The importance of micro-biological aspects of soil was not felt before Winogradsky (1890) drew attention to the interesting aspect of biological transformation of nitrogen in the soil. After that extensive investigations were carried out on the ecological aspects of the soil microorganisms by various pioneer investigators (Beijerinck 1901, Waksman 1937, Warcup 1955).

The soil in which plants grow varies widely in its physical, chemical and biological properties. The soil with its various horizons form a complex micro-habitat. So it is difficult to determine the individual factors which govern the distribution of various microorganisms. It is known that in a soil having uniform texture and composition the number of microorganisms markedly fall off in the lower layer and continuously decrease with depth (Timonin 1935, Burges
1958, Mishra and Srivastava 1970). The availability of nutrient, oxygen and carbon dioxide concentration, pH, o.p. and oxidation reduction potentiality may vary at the microscopic dimension making different habitat at a slightest distance. Therefore, the size and type of the microbial population may vary at different micro habitats. Similarly, the pattern of microbial population may vary considerably at various places depending upon the moisture content of the soil, temperature, organic matters, manuring practices and types of cultivated crops.

Soils are composed of minerals, organic matter, water, air and a living population. The inanimate constituents, along with water, form a natural medium in which bacteria, actinomycetes, fungi, algae and protozoa thrive. The microbiological balance in soil is referred to as a "dynamic equilibrium" as such it is not static but subject to continuous fluctuation due to environmental factors. Such influences as season, temperature, moisture, cropping system, and fertilizer treatment may temporarily upset the equilibrium in soil, but it rapidly reestablishes itself in a modified form to cope with the changed conditions. In addition to physical and chemical factors, the microbiological balance in soil is dependent upon inter-relationships of the micro population itself. Soil inhabitants do not exist in an isolated state but as part of a complex community in which the individuals are subject to

Lochhead (1958), Starkey (1958) and Krasil'nikov (1958) reported that in addition to the associative and antagonistic effects within the micropopulation, it is becoming increasingly apparent that the growing plant exerts the most significant effect on the microbiological equilibrium in soils. In view of the increased density of the microbial flora in the rhizosphere, it is understandable that the interactions between micro-organisms are intensified at or near the plant roots. Quantitative and qualitative changes in the microbial balance in this root zone may be due to the direct or indirect effects of root excretions. The growing plant has been found to stimulate specific groups of microorganisms which, in turn have a beneficial effect on other microorganisms through the production of growth promoting substances.

The majority of associative and antagonistic phenomena taking place in soil are localized in the extent that only organisms lying in close proximity to one another are affected. Soil is not a uniform environment but rather an intricate, interwoven, biological system composed of a myriad of microenvironments. These microenvironments are created through the deposition of organic matter or the individual
interactions of microorganisms or they are induced through the proximity of plant roots. Each localized community harbours a rich microbial population where survival is the keynote and where the associative and antagonistic effects are intensified. According to Alexander (1961) the microbial equilibrium which becomes established in any soil is the result of the sum total of the innumerable individual reactions and interactions which are taking place.

Soil organic matter contributes substantially to the physical, chemical and biological processes in soils and is expressed in several distinctive soil characteristics. Mustafayer et al (1976) reported that by absorbing solar rays green plants and living organisms transform their energy into the energy of chemical bonds of organic compounds. The elemental composition of soil organic matter changes as it decomposes. Microorganisms use much of the carbon as a source of energy which is converted into carbon di-oxide. Most of the nitrogen however becomes part of the tissue of microorganisms. The relative accumulation of nitrogen in relation to carbon in decomposing soil organic matter evidently describes its degree of humification and indicates the availability of nitrogen. The C/N ratio is therefore a valuable index for describing soil organic matter.
Litter fall or leaf fall has a significant role in the formation of soil organic matter. According to Bray and Gorham (1964) measurements of litter production in African and American equatorial rainforests have given results ranging between 10.2 and 15.3 tonnes. The dry matter of roots and short stubble of grass and cereal crops adds about 2-4.5 tonnes/ha/yr. Shcherbakov (1970) observed that in sod-podzolic leam soils on the sloboda state farm near Moscow, ownless brome grass produced about 15 tonnes/ha of roots, Meadow fescue produced about 10 tonnes/ha and timothy produced about 8 tonnes/ha. Quality of the residues varies according to the crop. Apart from being a potential source of certain nutrients, organic matter influences soil physical properties, such as structure, waterholding capacity and resistance to erosion.

Organic matter influences the capacity of soils to retain available water. Hollis et al (1977) noted that within the soil profile the organic content may correlate with hydrophysical properties either due to its direct influence or to its indirect influence on soil structure and porosity. In cultivated soils, moisture characteristics of manured and unmanured soils are often significantly different. More water is released at low tensions and increases in available water capacity compared with unmanured soils of the same series of up to 75% were observed.
Temperature plays an important element of soil climate. It has been reported that soil temperature at 20 cm depth is an average index of the thermal state of the root inhabited layer. Soil temperature are always higher than the corresponding air temperature due to the full glare of the sun. Soil temperature may be the critical factor determining germination and growth of seeds.

Soil is regarded as a reservoir of saprophytic and potentially pathogenic fungi. Burges (1939) dealing with the substrate relationships of soil fungi proposed an ecological classification of root-infecting fungi including mycorrhisal fungi and obligate saprophytes. He divided the latter which he termed 'true soil fungi' into 'sugar fungi' and 'humus fungi'; he further pointed out that the sugar fungi which are capable of utilizing the easily available sugars and simpler carbon compounds but not cellulose or lignin are fast growing species and the first to colonise dead plant tissues buried in the soil. Hepple and Burges (1956) studying directly the soil by means of soil sections found that different soil fungi exploit the soil in different ways that can be recognised by such growth patterns as (i) Penicillium type (ii) Sugar type (iii) Basidiomycetes type (iv) Bygorrhynchus type (v) Fairy ring type. Garrett (1956) classified the soil fungi as soil inhabitants or soil-invaders or root inhabiting fungi. Al Doory, Tolba and Al Ami (1959) studying the fungal
flora of Iraqi soils observed that the order of dominance of the fungi shows great variation as amongst various soil samples. Gaumann (1950) in discussing the soil organisms suggests that three types of relations may be defined; competitors, satellites and antagonists. In terms of functions of satellites Mucor aremnianus and Rhodoterula rubra as such synthesise only one molecule of the vitamin thiamine, although they each need both moieties for growth. Together they can produce both parts of the molecule. Parkinson and Waid (1960) emphasised particularly many of the important aspects of the soil fungi indicating their nature of growth in different soil types, their antagonisms and dynamic equilibria, their physiology and decomposing power of organic substrates.

Living plants excret certain chemical substances through their root system into the surrounding soil (Sachs 1860, Knops 1864). Considering the importance of these factors Hiltner (1904) used the term 'Rhizosphere' to designate the zone of enhanced microbiological activity influenced by root excretion immediately around the living roots. Since then various other investigators have confirmed that soil is the vicinity of roots contain higher number of microorganisms than soil away from the plants. In the majority of plants the rhizosphere effect may extend several mm beyond the roots (Starkey 1958). The association of microorganisms with plant roots is highly beneficial for both plants and microbes.
Greatest 'rhizosphere effect' is observed on the root surface and in the soil adhering to the roots. The microbial population of this region is subjected to certain variations due to the influence of some factors such as the kind of crops, age of the plants, soil types, soil treatment, seasons, temperature and moisture conditions (Starkey 1929 I, II & III; Graf 1930; Clark 1939; Timonin 1940; Das 1963; Kagti 1964).

The influence of living plant is manifest, not only in a marked increase in total number of microorganisms in soil-adjacent to the root system but also it shows selective stimulatory action on different microorganisms. It is interesting to know whether the whole mass of the soil microflora is simply encouraged by the presence of plant roots or whether certain types are selectively favoured. Gottheil (1901) and Lehnis (1910) believed that the general soil flora constituted the bulk of the root population. Later various workers have however, proved that plant roots harbour specialised microbial population and that roots show selective stimulatory action on different microorganisms. Bacteria are stimulated to a greater extent than fungi and actinomycetes, algae and protozoa are least affected (Starkey 1931 I & II; Thom & Humfeld 1932; Adati 1939). West and Lochhead (1940) reported that bacteria in the rhizosphere of flax and tobacco possessed more complex nutritive requirements than did those of the corresponding control soils. Vosniakovskaia (1948)
found much larger numbers of microorganisms in the rhizosphere of living wheat roots than in that of dead roots. Katznelson and Richardson (1948) observed qualitative differences between the fungal flora of the soil and that of the rhizosphere.

Each soil type appears to be sufficiently specific for its microflora due to various ecological and climatic factors. Moskovets & Shdanova (1960) observed that in maize rhizosphere the predominance of *Penicillium* was followed by *Fusarium* and *Paele hypomycetes*. Lugawks (1961) reported that the rhizosphere microflora of fodder plant is associated with genera like *Penicillium*, *Fusarium*, *Trichoderma*, *Macor*, *Gliocladium* and *Alternaria*. Tyner (1961) showed that sterilised soil is invaded primarily by fungi like *Rhizopus*, *Penicillium*, *Aspergillus*.

Agnihothrud (1959, 1961) observed the greater diversity of species of fungi in tea rhizosphere soil. He also found that amino acid requiring fungi tended to be higher in the rhizosphere soil than in the non-rhizosphere soil. Baruah and Bordoloi (1967-1968) reported that rhizosphere soils of tea is predominant by bacteria followed by *Aspergillus*, *Penicillium*, *Trichoderma*, *Alternaria*, *Curvularia*, *Fusarium* and less number species of *Macor*, *Pythium*, *Rhizopus* and *Cladosporium* were found.
The qualitative and quantitative variations of microorganisms in different soil types have been observed by several workers (Starkey 1929 I & II, 1938; Stoklasa 1926; Truffaut and Vladykov 1930; Thom 1935; Timin and Thexton 1950; Lochhead 1959; Katsnelson 1965; Revira 1965; Baruah and Baruah 1972). It has also been reported by various workers (Taylor and Lochhead 1938; Rao and Reddy 1965; Stevenson and Chase 1957; Venkatesan and Rangaswami 1965) that interactions between plant roots and soil microorganisms may be influenced by various soil factors, cultural practices and irrigation. In such a way it may also effect in the composition of the rhizosphere population (Timin 1940; Lochhead 1940; Starkey 1958; Bagyaraj and Rangaswami 1966, 1967).

Soil amendments with fertilizer is known to directly influence the microbial population (Waksman 1922; Turk 1939; Louw and Webley 1959; Sundar Rao and Chayanulu 1961; Venkatesan 1962; Bagyaraj and Rangaswami 1967). Bue et al. (1955) observed that numbers of fungi generally increased with increasing the rates of fertilisation and the total number of microorganisms could be correlated with concentrations of nitrate nitrogen and potash. Voroshileva (1956) reported that complete mineral fertilisers had little effect on the number of organisms in the rhizosphere. Louw and Webley (1959) reported a favourable bacterial response in oat rhizosphere
in addition of superphosphate and concluded that this was due to increased plant growth, but no such effect occurred in the uncropped control soil. Devey and Papavizas (1960) obtained a positive effect when the beans were planted 25 days after the amendment was added; the R:S ratio increased from 6.6, in the untreated soil to 9.3 in the amended soil, but the degree of variation was such that this change may not be particularly significant. The addition of nitrogen source increased the fungus R:S ratio from 8 to 20. Reddy (1960) studied the influence of nitrogen on sclerotia production of *Curvularia* isolated from rice field soil and the rhizosphere of rice seedlings. Samtsevich and Borisova (1961) reported that in pot experiments mineral and organic fertilizers had little effect on the microbial counts in the uncropped soil or in wheat rhizosphere, but in field experiment the effect depended on the time of the year. The effect of mineral fertilizers (NPK) and soil reaction has been studied by several workers (Melquori and Florence 1961; Venkatesan 1962; Absalyamova 1963; Kaufman and Williams 1964; Raghu and Macrae 1966; Ershov 1966; Bagyaraj and Rangaswami 1968; Rangaswami 1968; Ray and Mandal 1968). Shankar Bhat (1969) studied the effects of foliar spray of Kitazin (0,0-Diethyl-S-Benzyl thiosulphate) on rhizosphere microflora.

Fertilizer application during rice cultivation also bring about changes in microflora of the rice field both
quantitatively and qualitatively. Guillenat and Montegut (1960) reported that the effect of mineral fertilizers (NPK) on the soil microflora of cultivated soil and found that soil fungi were affected by mineral fertilizers. They reported that Moniliaceae and Penicillium are the most sensitive to mineral fertilizer. Emmimath and Rangaswami (1971) studied the qualitative and quantitative changes in the microflora of soil and rhizosphere of Taichung-65 variety of rice grown under water logged condition with heavy doses of fertilizers (N, as ammonium sulphate, P as superphosphate and K, as muriate of potash). They observed the significant changes in the number and quality of bacteria, actinomycetes and fungi under the influence of heavy doses of fertilizer application. There was selective stimulation of bacteria and fungi in the rice rhizosphere during the early stages of plant growth whereas such an effect was more on actinomycetes at crop maturity. Veroshilova (1956) and Papavisas and Davey (1961) observed that fertilizer application to the soil has little effect on the number of organisms in the rhizosphere. Venkataram (1960) reported that urea sprays decreased both fungal and bacterial populations in the rhizosphere of tea.

Various workers (Agnihotri 1964; Dwivedi and Singh 1971; Gupta 1971; Ranga Rao et al 1972; Sullia 1968; Vangura and Hovadik 1965) studied the rhizosphere mycoflora population by foliar application of antibiotics, growth regulators,
and urea and reported profound changes in the rhizosphere microflora.

Venkatesan and Rangaswami (1965) reported that a marked decrease in the microbial population in rice field soils, subjected to prolonged water logging. Rangswami and Narayanswami (1965) found that rainfall, ploughing and puddling, application of fertilizers, Farm yard manure and green leaf manure altered the microbial population in the rice field soil. Williams and David (1976) reported that beneath sub-tropical clover pastures in South Australia the residual fertilizer phosphorus and organic matter accumulate which usually increases the amounts of available P, S, N and trace elements and augments the soil’s nutrient holding capacity.

Turner and Newman (1984) in their pots experiments on Lolium perenne roots observed the influence of nitrogen and phosphorus on fungal abundance. They have also reported that fungal abundance on the root surface, expressed as length of mycelium per unit root surface area, was increased several fold when either nitrogen or phosphorus was omitted from the nutrient supply and observed a close negative relation to plant weight but when expressed as mycelium weights/plant weight the increase was tenfold or more.
Euninath and Rangaswami (1971) and Mishra (1971) reported that (NH₄)₂SO₄ or NH₄NO₃ may increase the fungal population in the rhizosphere of rice plant. Papavizas and Davey (1961) using lupin reported that NH₄NO₃ has no effect on rhizosphere fungi. Vuurde (1976) observed no effect of NPK fertilizer on wheat rhizosphere fungi. Newman, Heap and Lawley (1981) measured rhizoplane fungal density on plantago lanceolata from 40 sites by direct observation and they have noted that there was a negative relationship to leaf P concentration but none to N or K. Bedi and Dhiman (1983) observed the influence of nitrogen, phosphorus and potassium on the development of early blight of tomato (using different doses of NPK) and reported that the application of N, P and K to the plants singly and in various combinations had a predisposing effect on them.

Chattopadhyay and Paul (1980) worked on three crops of rice, namely, aus (autumn rice) variety tall indica Dular, aman (winter rice) and boro (summer rice) - variety dwarf indica IR₆ with NPK treatment in four different doses 1/3 optimum NPK, 1/3 optimum NP, 1/2 optimum NPK, optimum NPK and they have reported by estimating quantitatively the population of fungi and bacteria that microbial populations are fluctuated at different fertility levels of continuously cropped soils. According to them the practice of intensive cultivation of rice at high fertility level is likely to
cause a change on edaphic conditions of rice plant. Altered physico-chemical conditions in rice continuously cropped soil may bring about changes in microflora both quantitatively and qualitatively. Chattopadhyay and Mukhopadhyay (1967) observed change in microflora under such conditions in rice field soil. Similar effect was also observed in rice field soil by Chattopadhyay and Mukherjee (1967).

The problem whether the application of fertilizers to soil affects the rhizosphere population in soils has been studied by different workers (Peteseva & Rogaseva 1958; Louw and Webley 1959; Bagyaraj and Rangaswami 1967, 1968). Shetty and Rangaswami (1968) reported that 80 lbs of P$_2$O$_5$ per acre when applied to soil enhanced the growth of microbial population in soil and rhizosphere of sun hemp. Shivappa et al (1969) reported that superphosphate along with usual dose of ammonium sulphate and potash in the ratio of 60:40:180 and 60:40:360 caused a significant increase in the microbial population of soil and rhizosphere. The application of higher doses of phosphatic fertilizer had an inhibitory effect on phospho-bacteria in the rhizosphere of Ragi. Singh et al (1983) observed the effect of sawdust with different nitrogenous sources (urea, cowdung, oilcakes of castor, mustard) on rhizosphere fungi of tomato and noted the increase in frequency of saprophytic fungi and a decrease in the frequency of parasitic fungi. Ramarao and UshaRaja (1983)
studied the effect of organic amendments in soil on foot and root rot of wheat caused by *Sclerotium rolfsii* and reported that organic amendments in soil alter the bacterial and fungal populations in the rhizosphere of wheat. The alteration in the rhizoplane mycoflora due to soil amendments, foliar application, soil sterilisation, etc., have been reported by several workers (Gangawane and Deshpande 1976, 1978; Subha Rao 1977).

Assam has an area of 78,523 sq.kms. which account for 2.4 per cent of the total land masses of India. Assam is basically agrarian since a vast majority of the state's population depends directly or indirectly on agriculture. As per the latest available 1971 census report nearly 77 p.c. of the state's working force are engaged in agriculture and allied activities. The percentage of area placed under different crops constitute 42 p.c. of the total geographical area of the state compared to all India coverage of about 50 p.c.\(^1\) It is to be noted that large chunks of the geographical area in the state is covered by hills, rivers, beels and other low lying areas etc. thereby making the extension of area under agriculture extremely difficult.

\(^{1}\text{Source - Economic Survey, Assam 1983-84, Directorate of Eco. \\ & Sts., Govt. of Assam, pp. 3, 7, 9.}\)
The area under rice which was 22.75 lakh hectares in 1980-81 increased to 23.22 lakh hectares in 1983-84 displaying a rise of about 2 p.c. over the period. Variety-wise it was 625.9 thousand hectares for Autumn Rice, 1642.0 thousand hectares for Winter Rice and 33.9 thousand hectares for Summer Rice in 1982-83 increased to 1662.8 thousand hectares for Winter Rice, 43.4 thousand hectares for Summer Rice and decreased to 616.0 for Autumn Rice in 1983-84.  

The yield rate of rice which was 1038 kg. per hectare in 1975-76 stood at 1145 kg. per hectare in 1983-84. Variety-wise in 1983-84 it was 1230 kg/hectare for Winter Rice and 1231 kg/hectare for Summer Rice. But total production of rice came down marginally to 25.32 lakh tonnes in 1983-84 as against the record production of 25.83 lakh tonnes in 1982-83.  

Since the past few years the use of High Yielding varieties (HYV) is increasing in the state. It has been that up to 1983-84, more than 40 p.c. of the total area under paddy in the state has been brought under the coverage of HYV cultivation. The coverage of area under HYV paddy in the state is reported to have gone up from only 3.5 lakh hectares

2. Source : Statistical Hand Book Assam 1984, Directorate of Eco. & Sts., Govt. of Assam, p. 67
in 1979-80 to 9.2 lakh hectares in 1982-83 and then to 10.5 lakh hectares in 1983-84.

The modern farming requires intensive cultivation of the land. As a consequence a high number of Agro-Chemicals are incorporated into the soil to obtain high yields of crops. Recently some evidences have become available to show that fertilizers both organic and inorganic applied to the soil markedly influence the efficacy of seed treating fungicides used for the control of pathogens causing root disease.

Kataria et al (1981) reported that amendments of nutrient deficient sandy soil with different N, P, K fertilizers and micronutrients modified the disease control potentials of methoxyethyl mercury chloride (M.E.M.C) the controlling Rhizoctonia solani seedling rot of cowpea. Bandyopadhyaya et al (1982) reported that the magnitude of reduction in fungicidal activity varied with the type and quantity of organic manure amendments on soils. It has been reported by various workers (Toussoun et al 1960; Wolts and Jones 1968; Weinhold et al 1972; Tripathi and Grover 1975) that depending upon the nutrient status of the soil, several soil inhabiting species of Fusarium, Rhizoctonia, Pythium etc. also develop differential pathogenic abilities. In another study conducted by Hooda and Grover (1984), a pathogenic isolate of

Macrophomina phaseolina was altered in its pathogenicity by growing it in different substrate nutrients. Bassus (1967) noted the reduction of semiparasitic nematodes feeding on fungi by the application of fertilizers. Gupta (1986) reported the suppression of the population of nematodes when the soil was treated with urea. Gupta (1986) further studied the effect of certain carbonaceous and nitrogenous amendments on Mononchus and Dorylaimus in soil and reported that amongst the inorganic amendments urea was most toxic to Mononchus species and calcium nitrate to Dorylaimus species. Devadath, Premalatha and Jain (1987) studied the effect of NPK fertilizer on the incidence of bacterial blight of rice. Tripathi, Singh and Chaube (1987) observed the effect of NPK fertilizers on the severity of Ascochyta blight of chickpea.

Rice field is generally subjected to alternate water logging and drying during the year. It may bring about considerable variation of the microbial population in the rice field soil. Chetia (1965) observed the seasonal fluctuation of microfungi of paddy fields. He noted that during the months of September (2.2%), March (3.8%) and October (5.1%) the fungal population was lowest of the total occurrence of the year. The predominant genera of this period were Aspergillus, Penicillium, Trichoderma, Rhizopus, Curvularia and Periconia.
De and Bose (1938) observed that the microbial population of the rice field soil was greatly reduced in water-logged soil, which again increased on gradual drying of the soil. Takijima & Sukuma (1961) reported that due to water logging the quantitative nature of fungal population decreases while the bacterial population does not show any sharp decline. It has been reported that soil under water logged conditions reveals larger number of microorganisms (Egorova & Issatchenko 1944; Putulina 1940; Thaysen 1936).

The insoluble phosphates present in the soil generally remain unavailable to higher plants unless they are converted into soluble form. Soil microorganisms are known to play an important role in the solubilisation of water insoluble phosphate compounds by the process 'phosphate fixation' (Sperber 1957; Sen and Paul 1957; Myskov 1960; Ramos et al 1968). It has been reported that microorganisms actively solubilising rock phosphate are Bacillus, Pseudomonas, Flavobacterium, Streptomyces, Aspergillus and Penicillium. Moreover it is also reported that some species of bacteria of the Bacillus group such as B. mycoides, B. megatherium and B. cereus having more ability to mineralize the organic phosphate which constitute a major part of fixed phosphate present in soil and thereby make them available to plants.

Rao and Sinha (1963) observed that fungi were more efficient in solubilising phosphates than bacteria because
of their ability to produce organic acids. Goswami and Sen (1962) noted that the maximum solubilization of phosphate occurred in the case of inoculated medium within two weeks and decreased thereafter. They also observed that the addition of peptones as the source of nitrogen enhanced the solubilization of phosphates. Talukdar and Barthakur (1978) recorded the highest rock phosphate solubilization in the liquid media inoculated with the root suspension of rice variety Prasadbhog and Manohar Sali was recorded next.

According to Johnston (1952, 1956, 1959), Sperber (1957), Louw and Webley (1959), Duff et al (1963), Paul (1966), Taha et al (1969) the dissolution of mineral phosphate by the microorganisms takes place due to production of organic acids especially hydroxy and keto acids of di-carboxylic or tri-carboxylic group. These acids have got the chelating properties and form the stable metallo organic complexes with Al$^{+++}$, Fe$^{+++}$, Cr$^{+++}$, Mg$^{+++}$, thus liberating the orthophosphate from rock phosphate. Sperber (1958c) reported that lactic, glycolic, citric and succinic acids were the products by soil microorganisms and the first three acids were effective in solubilizing the synthetic apatite. Johnston (1959) further noted the effectiveness of citric, gluconic and galacturonic acids in solubilizing calcium phosphate and other insoluble inorganic phosphates. Neuberg et al (1961) suggested the suitability of 3-phospho-glyceric
acid as an agent for solubilization of phosphate in nature.

Casida (1959) observed that soil fungi such as *Aspergillus* contain phosphatase enzymes which dephosphorylase inorganic and organic phosphorus when added to the soil as fertilizers and in crop residues. He also suggested that in most cases the greatest phosphatase activity occurred at low pH value. Sperber (1958), Louw & Webley (1959), Rao and Sinha (1963) noted that the solubilization of insoluble phosphate was higher in lower pH and the decrease in pH was due to the formation of organic acids by the action of microorganisms and it also supported the view that the acid products of microbial activity affect the solution of phosphate.

Garretson (1948) reported that plant supplied with insoluble phosphorus had improved growth and increased phosphorus uptake when inoculated with soil organisms. Hannapel *et al* (1964) observed that phosphorus movement was closely related to the soil microbial population and consequently to those factors which govern microbial metabolic activities. He showed that soil treated with formaldehyde suppressed the activity of the microbial population and reduced phosphorus movement. Gilliam and Sample (1968) reported that the change in phosphate availability at different pH level may cause a change in microbial population. Sperber (1958b) studied the interrelationship of plant and
microorganisms in respect of phosphorus supply for crop nutrition and reported that rhizosphere provides nutrition to the phosphorus solubilizing organisms and these organisms in turn provides phosphorus nutrition to the crop.

Increased agricultural production in different parts of Assam has led to an increase in agricultural wastes. Such wastes if recycled through bio-degradation by efficient degraders can cause significant improvement in soil fertility (Chatterjee and Nandi 1981b).

Efficiency of rice stubble degradation was observed by various workers. Chatterjee and Nandi (1981a) from their work on rice fields of Burdwan in W.B. reported that highest efficiency of rice stubble degradation was shown by Oospora lactis followed by Geotrichum candidum, Penicillium wakamani, Aspergillus niger, Aspergillus wentii, Thielavia terricola and Penicillium cyanum in descending order. Venkatesan and Rangaswami (1965) reported that the presence of rice crop in the field did not alter much the actinomycetes population, but when the crop was harvested and the basal portions left over in the field, the population increased significantly. They further reported that when rice stubbles were pulled out after harvest the actinomycetes population decreased markedly.

Ghosh and Nandi (1982) from their work on rice stubble of Jaya variety reported that Verticillium albostrum
(32.32%) and *Penicillium* sp. (17.74%) were most efficient degraders of holocellulose and lignin respectively after 60 days of incubation. Bhargava (1972) observed that the efficient cellulose decomposers were efficient also in decomposing wheat straw. Alexander (1977) found that *Penicillium* sp. of *Aspergillus*, *Penicillium* and *Fusarium* were efficient lignin degraders. Gulyas (1967) noted that 20% loss of lignin in wheat straw by *Fusarium* sp. Weni and Shinde (1977) reported *Aspergillus* sp. as the most efficient straw degraders. Chatterjee and Nandi (1981b) noted that a loss of 11%-19% of wheat straw lignin by *Penicillium*, *Aspergillus*, *Verticillium* and *Fusarium*.

Agricultural rice fields of Assam may be deficient in certain vital micro-nutrients due to the non-application of fertilizer in traditional rice cultivation and natural deficiency in some types of soil. However this deficiency can be corrected artificially by applying certain fertilizers. Fertilizers can also be used in the build up of soil fertility in general. Lack of fertility in soils reduce the production of crops. It is now well known that production of rice can be increased many times by using fertilizers and HYV. Therefore now a days, much emphasis has been given on fertilizers application during the rice cultivation to enhance the net production. To meet the nitrogen deficiency in rice fields UREA \([\text{CO (NH}_2\text{)}_2]\) has been commonly used by the farmers.
To make up the P and K deficiency in rice fields superphosphate (P\textsubscript{2}O\textsubscript{5}) and Muriate of potash (K\textsubscript{2}O\textsubscript{5}) is generally used. Urea is a synthetic semigranular organic nitrogenous fertilizer containing 46% N\textsubscript{2}. Urea is converted into ammonium carbonate in the soil within a period of 2 to 5 days of its application and then to nitrates for being utilised by plants. Agarwal (1965) reported that urea can also be used for top-dressing standing crops although it is best used at sowing. Urea is a good source of nitrogenous fertilizer to the cultivated crops specially to the rice cultivation of Assam as the acidity of the soil is not increased due to its application (Dey 1984, Choudhury and Choudhury 1988).

The composition and activities of the microfungi in the soil of rice fields and the effect of nitrogenous fertilizer application on the quality and quantity of the microfungi has not so far been studied in the rice fields soil of this area. Therefore the aim of the present investigation was to make a detail qualitative and quantitative analysis of the microfungi of rice field soils at different seasons of the year and to study the influence of the application of a certain nitrogenous fertilizer (urea) on the quality and quantity of the microfungi in the rice field soils and also to study certain activities as well as physiological aspects of the growth of some predominating microfungi which were abundantly recorded in the rice field soils of this area.