DISCUSSION
The increase in spore population as the host matures or senescence as found in both the upland and lowland cultivation practices was earlier reported by Mason (1964), Mosse and Bowen (1968 b) and Hayman (1970). Saif (1977) and Smith (1980) had reported initial drop in spore number which had also been found in lowland cultivation in the present study (Fig.6). The reason may be the germination of spores for infection. The chances of availability of infected root debris in upland was much more than submerged lowland condition, which made possible of a very high infection in upland from beginning and eliminated the chance of drop in initial spore population. Menge (1984) was also of the view that infected root segments can quickly produce hyphae which can colonize roots and thus may have the ability to produce rapid infection.

The lowland paddy plants exhibited very low percent root infection in comparison to upland paddy. Gerdemann (1974) reported that roots of paddy are devoid of VA mycorrhizal infection in flooded soils, but become infected under drier conditions. We observed that lowland paddy was also VA mycorrhizal, though degree of infection was low even in the fields, continuously flooded during whole of the study period (Fig.3). Clayton and Bagyaraj (1984) also found VAM infection in 22 submerged water plant species but
with a very low infection level. Reduced soil aeration in lowland submerged condition could be one of the reasons for low infection (Saif, 1983).

In the present study the spores in lowland field might have come from upland field with rain water and in lowland on account of higher pH could not colonize roots as heavily as in acidic soils of upland. Inhibition in root colonization in the soil of higher pH by native VA mycorrhizal fungi of acidic soil was observed by Kucey and Biab (1984). In upland cultivation the lower moisture level may also be one of the reasons for higher percent root infection. Ponder (1983) got higher percent root infection in Walnut when he watered the crop at every 3rd or 4th day in comparison to plants watered every 1st or 2nd day. Due to transplanting practices in lowland cultivation, plants had more chances of possessing less surface roots than to direct sown upland paddy. St. John (1980 a) observed higher root infection in surface roots than to deeper roots. In both the cultivation practices, number of arbuscules was found to be the maximum at booting stage of the plant, a stage of active growth. The arbuscules are considered to be the preferential site for fungus/plant metabolite exchange (Cox et al., 1975).
The occurrence of high number of intra-radical vesicles in matured or senescent plants of both the cultivation practices (Fig. 5) may be for their survival, because presence of intra-radical vesicles in the infected roots increase the inoculum potential of the infected root (Biermann and Lindermann, 1983).

The optimum soil water potential and pH for spore germination and VA mycorrhiza formation differs from species to species (Danniels and Trappe, 1980; Green et al., 1976; Abbott and Robson, 1985 b). The preference of Glomus geosporum to high moisture level and pH may be the reason for presence of its spores in invariably larger numbers in lowland paddy rhizospheric soil.

The flooded conditions of the lowland field also made the nutrients availability to host more and that is why in spite of lower VA mycorrhizal infection, the phosphorus concentration in the roots and dry root weights of lowland paddy were higher than upland (Table 5). The easy availability of nutrient may make the lowland paddy less dependent on mycorrhiza. Sparling and Tinker (1978 b) were also of the view that plants become dependent on mycorrhizal uptake of nutrient only when nutrient become scarce to the plant.
The low root infection and less VAM spore population in lowland paddy crop might be due to submerged conditions which resulted in less soil aeration and very high soil moisture level. But submergence also made more nutrients available to the host resulting into more root dry weight and less dependance on mycorrhizal nutrient uptake.

The paddy varieties RCPL-101, tolerant to phosphorus deficiency and RCPL-104, susceptible to phosphorus deficiency differed to some extent in their reaction to VA mycorrhizal infection (Fig. 7 & 9). Manjunath et al., (1981 b) found variable susceptibility in paddy cultivars to VAM infection. Azcon and Ocampo (1981) reported different degrees of mycorrhizal infection and mycorrhizal dependancy by wheat cultivars. Guaye (1983) also found variation in response to different cowpea cultivars for Glomus mosseae in mycorrhiza formation. The phosphorus deficiency susceptible paddy variety produced more VAM spores but lagged behind in number of hyphal entry-points and intensity of infection compared to phosphorus deficiency tolerant paddy variety. From the beginning, the percent root infection was comparatively high in RCPL-101. About 100 percent root infection was achieved by RCPL-101 in just 75 days whereas RCPL-104 could attain the same in 120 days (Fig. 7 & 9).
The arbuscules, considered to be the preferential site for fungus/plant metabolite exchange (Cox et al., 1975), also appeared a little earlier in RCPL-101. The main factor which makes RCPL-101 tolerant to phosphorus deficiency seems to be greater root dry weight which enable the plants to extract phosphorus from larger soil volume. Since percent mycorrhizal infection in the roots of RCPL-101 was never less than RCPL-104, the total mycorrhizal roots in RCPL-101 becomes significantly higher than RCPL-104. The increased mycorrhizal roots of RCPL-101 enable the plants to extract available soil phosphorus from still larger soil volume and that was the reason for higher phosphorus concentration in the roots of RCPL-101 in the early stages of plant growth (Table 5).

The mycorrhizal infection was reduced by increasing soil phosphorus levels (Fig. 10). Mosse (1973) and Schubert and Haymann (1986) also reported inhibition in mycorrhizal infection by increasing soil phosphate levels. The inhibition in mycorrhizal infection may be due to increased root phosphorus concentration with enhanced soil phosphate level. Menge et al., (1978); Azcon et al., (1978) and Jasper et al., (1979) were also of the opinion that root phosphorus concentration and not the soil phosphorus concentration was responsible for mycorrhizal infection regulation. We found increased root phosphorus concentration by increasing soil phosphate
level and a concentration of 0.08 ppm seems to be the critical level for mycorrhizal infection by *Glomus etunicatum* in paddy under the experimental conditions (Figs. 10 & 15). The mycorrhizal infection decreased slowly up to this concentration, but beyond this level reduction in mycorrhizal infection was abrupt. The mechanism whereby the root phosphorus concentration regulates mycorrhizal infection is not clear. Cooper (1984) was of the view that mycorrhiza-specific phosphatases, which are associated with the most active phase of mycorrhizal infection, may be involved. We observed that the activity of acid phosphatase, though not mycorrhiza specific, was found to reduce with increased soil phosphate levels. The activity of alkaline phosphatase was also found to decrease with enhanced soil phosphate levels, but the drop was noted from 30 and 60 days onwards in RCPL-101 and RCPL-104 respectively (Table 11).

Though mycorrhizal infection was decreased with increase in soil phosphate levels, spore production increased. This increase was up to the soil phosphate level of 40 kg P ha\(^{-1}\) in RCPL-101 and 80 kg P ha\(^{-1}\) in RCPL-104 (Fig. 10). The plant dry weight of mycorrhizal plants also increased with increase in soil phosphate levels up to 40 kg P ha\(^{-1}\) in RCPL-101 and 80 kg P ha\(^{-1}\) in RCPL-104 (Fig. 12). Hetrick and Bloom (1986) also could not observe any correlation between degree of mycorrhizal infection
and spore production. Rather they found a positive correlation between spore production and plant dry weight. Here in this study also we found maximum spore production in plants having maximum plant dry weight.

In RCPL-101 the root phosphorus concentration was more than RCPL-104 at lower soil phosphate levels. The greater root biomass of RCPL-101 and higher total mycorrhizal roots may be responsible in extraction of more soil phosphate at lower soil phosphate levels and thus resulted in more root phosphorus concentration.

The delayed formation of vesicles and arbuscules at high fertility level is in conformity with the findings of Bhattarai (1983). Reduction in mycorrhizal infection and the number of arbuscules and vesicles by increasing fertility levels, as observed in the present study was also reported by Bhattarai (1983). According to Abbott and Robson (1979), addition of phosphate above that which is required for maximum plant yield eliminated the vesicle formation. We found reduced number of vesicles and arbuscules with increasing root phosphorus concentration. Menge et al. (1978) were also of the view that root phosphorus concentration is inversely correlated with number of arbuscules and vesicles. VA mycorrhizal inoculation increased plant dry weight.
and shoot length at soil phosphate levels of 20 to 80 kg P ha\(^{-1}\) in both the varieties (Table 6 & 8). Mycorrhizal response in increasing plant growth had been reported by many workers like Ross and Harper (1970), Hayman and Mosse (1971), Mosse and Hayman (1971), but these mycorrhizal induced increase in growth was mainly reported in phosphorus deficient soil, though Buwalda et al. (1985) found increased yields of wheat and barley by VA mycorrhizal inoculation even up to the soil phosphate level of 60 kg P ha\(^{-1}\). Better growth of mycorrhizal paddy was also reported by Sahni (1976) and Iqbal (1978 a). Mycorrhizal response in increasing plant growth was found to be more at lower soil phosphate levels (20 to 40 kg P ha\(^{-1}\)) in RCPL-101, but in RCPL-104 the response was maximum at the soil phosphate level of 80 kg P ha\(^{-1}\) (Fig. 12). The dry root weight of RCPL-101 was significantly more than RCPL-104, the phosphorus in the soil remains a limiting factor for RCPL-101 only at lower soil phosphate levels, but for RCPL-104, the phosphorus remains a limiting factor even up to 80 kg P ha\(^{-1}\). Daft and Nicolson (1966) and Paulman et al. (1980) also reported a reduction in the mycorrhizal induced growth when phosphorus in the soil was no longer a limiting factor. The root : shoot ratio was less in mycorrhizal plants which was also reported by Mosse and Hayman (1971); Crush (1974) and Hunt et al. (1975). The root :
shoot ratio was found to decrease with enhanced soil phosphate levels. This suggests that the lower root : shoot ratio in mycorrhizal plants may be due to improved nutrition. Sanders (1975) also suggested that the reduction in root : shoot ratio in mycorrhizal plants may be due to improved nutrition.

Mycorrhiza also helped the plants in enhanced phosphorus uptake (Powell, 1975 a; Abbott and Robson, 1982; Rhodes and Gerdemann, 1980). The RCPL-101 responded to VA mycorrhiza in enhancing the phosphorus uptake maximum at 20 kg P ha\(^{-1}\) whereas in RCPL-104, it was at 80 kg P ha\(^{-1}\) (Fig. 14). The difference in these two varieties in mycorrhizal response may be because of the fact that phosphorus remains a limiting factor only at the lower level of soil phosphate for RCPL-101 whereas it is upto 80 kg P ha\(^{-1}\) for RCPL-104. Difference in mycorrhizal response by cultivars are earlier reported by Hall et al., (1977) and Azcon and Ocampo (1981).

The acid and alkaline phosphatase activity was higher in mycorrhizal roots (Table 10 & 11). Gianinazzi-Pearson and Gianinazzi (1976,73) and Dodd et al., (1987) also found higher acid phosphatase activity in mycorrhizal roots. Acid phosphatase activity was found to increase with age upto 60 days and later it decreased. The alkaline phosphatase
activity decreased with advancement of age. An increase in acid phosphatase activity upto 51 days in wheat was observed by Dodd et al., (1987). In confirmation to our findings, Gianinazzi-Pearson and Gianinazzi (1978) had also reported a reduction in both acid and alkaline phosphatase activity with increase in the age of the plants and addition of soil phosphorus.

The paddy variety RCPL-101, being capable of producing better root system than RCPL-104 responded mycorrhizal infection well at lower soil phosphate level. At higher soil phosphate level, phosphorus in soil was no more a limiting factor for RCPL-101, and thus do not depend on mycorrhizal nutrient uptake, while RCPL-104, with poor root system depends on mycorrhizal nutrient uptake even upto 80 kg soil P ha⁻¹.

The difference in VA mycorrhizal infection due to soil phosphate level gradually decreased with advancement of host age. The root phosphorus concentration, considered to be responsible for VA mycorrhizal infection (Meneg et al., 1978), was also found to reduce in added phosphorus treatments with advancement of host age and thus enabled the roots of phosphorus added plants for higher VA mycorrhizal infection and thus reduction in difference of infection percentage. The increasing nitrogen levels was found to reduce the mycorrhizal infection in both the soil phosphate
treatments. Such reduction in mycorrhizal infection was observed earlier also (Hayman, 1970; Jensen and Jeckobsen, 1980; Chambers et al., 1980; Bhattacharai, 1983). An increase in phosphorus concentration in root by increasing nitrogen levels at no phosphorus level may be responsible for the reduction in mycorrhizal infection, however, at added phosphorus level, the increasing nitrogen levels reduced both the root phosphorus concentration and mycorrhizal infection. It indicated that root phosphorus concentration hypothesis of Menge et al., (1978) may not be the only explanation. Reduction in soluble carbohydrates in root extracts and exudates were observed by Thomson et al., (1986) to reduce the mycorrhizal infection. At higher phosphorus level, the role of increasing nitrogen levels on soluble carbohydrates concentration in root extracts and exudates needs further studies.

Addition of phosphorus increased spore production and dry shoot weight but reduced the mycorrhizal infection. At added phosphorus treatments, 200 kg N ha\(^{-1}\) produced highest number of spores and maximum dry shoot weight and minimum mycorrhizal infection. At no phosphorus treatments, the highest mycorrhizal infection was found at 0 kg N ha\(^{-1}\), but the highest spore production and dry shoot weight was at 200 kg N ha\(^{-1}\) at 30 days and 100 kg N ha\(^{-1}\) at 90 days (Table 16 & 18). These findings closely supported the
hypothesis of Hetrick and Bloom (1986) that the spore production is correlated with plant growth and not the degree of mycorrhizal infection.

Khruscheva (1977) found a decrease in the occurrence of vesicles by addition of either phosphorus or nitrogen in the soil. With addition of phosphate in the soil a definite reduction in vesicle formation was observed. The increasing nitrogen levels also reduced the vesicle formation at no added phosphorus level, but at added phosphorus level, decrease in vesicle numbers was not observed (Fig. 17).

The reduction in the number of fungal entry-points due to addition of soil phosphate was reported earlier (Thomson et al., 1986). The arbuscules, considered to be the preferential site for fungus/plant metabolite exchange (Cox et al., 1975), was maximum at 100 kg N ha\(^{-1}\) under no phosphorus level and at 200 kg N ha\(^{-1}\) under added phosphorus level. These were the levels where maximum mycorrhizal response in increasing plant growth was observed.

At no phosphorus condition addition of upto 200 kg N ha\(^{-1}\) increased dry shoot weight at 30 days, but at 60 days increase was only upto 100 kg N ha\(^{-1}\) and at 90 days the increase even upto 100 kg N ha\(^{-1}\) was not significant (P = 0.05),
whereas at added phosphorus level the significant ($P = 0.01$) increase was observed up to 200 kg N ha$^{-1}$ even at 90 days (Table 12). This shows that at no phosphorus level absence of response of mycorrhizal plants to nitrogen at 90 days may be due to the limited supply of phosphorus. But non-mycorrhizal plants, where phosphorus uptake was less, responded to nitrogen under both the phosphorus levels even up to 90 days. This was because in non-mycorrhizal plants phosphorus does not seem to be a limiting factor even at no phosphorus level. Ames et al., (1983) found higher nitrogen recovery from soil by mycorrhizal plants than non-mycorrhizal plants through hyphal uptake and translocation. The growth response to mycorrhizal infection is more in the presence of ammonium nitrogen (Chambers et al., 1980; Brown et al., 1981). Ammonium nitrogen was used in the present study. The possibility is that under no phosphorus level, due to greater uptake of phosphorus and nitrogen the growth of mycorrhizal plants at higher nitrogen levels was more. This resulted in greater demand of phosphorus which became a limiting factor at 200 kg N ha$^{-1}$ at 60 days. Similarly after 60 days, due to still more growth of mycorrhizal plants at 100 kg N ha$^{-1}$ the phosphate in soil was not able to fulfil the still increased demand of phosphorus and thus at 90 days even at 100 kg N ha$^{-1}$, increase in the dry shoot weight was not significant and at 200 kg N ha$^{-1}$ due to more depletion of soil phosphate the dry shoot weight was
even less than the non-mycorrhizal plants. At added phosphorus level, the increased demand of phosphorus by mycorrhizal plants was fulfilled and thus a significant ($P = 0.01$) increase in dry shoot weight was observed even at 200 kg N ha$^{-1}$ at 90 days. At no phosphorus level the nitrogen concentrations of mycorrhizal shoots were significantly ($P = 0.01$) reduced by increasing nitrogen levels due to better growth of mycorrhizal plants (Smith, 1980) at 30 days. At 60 days, due to limited supply of phosphorus and checked plant growth the nitrogen concentration was not significantly low and at 90 days the nitrogen concentration at 200 kg N ha$^{-1}$ was significantly higher than 100 kg N ha$^{-1}$, though nitrogen uptake was at par. Because of the poor growth of mycorrhizal plants at 0 kg N ha$^{-1}$ due to limited supply of nitrogen, the nitrogen uptake of 90 days old plants, placed under both the phosphorus treatments, was similar. At higher nitrogen levels, due to sufficient supply of nitrogen the growth of mycorrhizal plants placed under added phosphorus level was comparatively better and thus the nitrogen uptake was also 2 and 3 fold at 100 and 200 kg N ha$^{-1}$, respectively more than the mycorrhizal plants placed under no phosphorus level. Due to depletion of soil phosphate at no phosphorus level, the phosphorus uptake was also found to reduce with increasing nitrogen levels at 90 days. For non-mycorrhizal plants even at no phosphorus level, due to low nitrogen uptake the plant growth was less
and thus the demand of phosphorus never became so high that the phosphate present in soil becomes a limiting factor and thus non-mycorrhizal plants responded to nitrogen application even at 90 days.

We observed reduction in root : shoot ratio by increasing phosphorus and nitrogen (Table 14). Increasing levels of soil phosphate (Bowen and Cartwright, 1977) and nitrogen (Jenkinson et al., 1972; Hunt, 1975) have earlier been shown to reduce root : shoot ratio of mycorrhizal plants. Increasing levels of phosphorus and nitrogen also reduced root : shoot ratio of non-mycorrhizal plants. This demonstrates that reduction in root : shoot ratio is due to improved nutrition of the plant (Sanders, 1975) and that is why mycorrhizal plants possess lower root : shoot ratio.

Powell (1975 b) was of the view that potassium uptake is less likely to be enhanced by mycorrhizae, since soluble K is usually maintained at a reasonably high concentration in the soil solution by a diffusion rate 10 to 20 times faster than that of P (Newman and Andrews, 1973). The increased K uptake by mycorrhizal plants than non-mycorrhizal ones even in fertile soils, receiving sufficient K fertilizer, may be because of increased absorptive surfaces due to increased root growth and presence of mycorrhizal hyphae and thus are able to explore more soil volume (Mosse, 1973).
The acid and alkaline phosphatase activity seems to be related with the phosphorus requirement of the plant. The mycorrhizal plants due to better growth than non-mycorrhizal plants required more phosphorus and thus higher enzyme activity was observed. The increasing nitrogen levels in the soil also increased the phosphorus demand which resulted in higher phosphatase activity in plants receiving higher nitrogen (Table 24 & 25). Addition of soluble phosphate reduced the scarcity of phosphorus and thus the enzyme activity was reduced. Higher acid and alkaline phosphatase activity in mycorrhizal roots and reduction in enzymes activity by increasing levels of soil phosphate was reported earlier too (Gianinazzi-Pearson and Gianinazzi, 1976, 78; Dodd et al., 1987).

*Glomus mosseae* was more efficient in the ability to form extensive infection in the host root system, compared to *G. caledonium*, but was less efficient in improving host growth (Table 26 & 28). *G. caledonium* produced more extraradical hyphae in the soil than *G. mosseae* (Table 35). Graham et al. (1982b) proposed a hypothesis that vesicular arbuscular mycorrhizal fungi may differ in their capacity to develop an external hyphal system independent of their capacity to colonize root cortex. Abbott and Robson (1984) were also of the same view. Bethlenfalvay et al. (1982) proposed that ratio of extra to intra-radical mycelium may
be taken as an index for the endophyte's usefulness to the host. Sanders et al., (1977) found a linear correlation between weight of external mycelium and root length infected for different endophytes, in contrast to our study, in which colonization of the root cortex was independent of the ability of forming extra-radical mycelium by different endophytes. The increase in intensity of infection and number of fungal entry-points with increase in drought stress was earlier reported by Nelson and Safir (1982). They explained that low moisture levels reduce the diffusion rate of nutrient such as phosphorus and decrease the availability of these nutrients to the plants. The increase in drought stress also increased the spore production. Daniels and Trappe (1980) found declined spore germination, when soil water potential was reduced below field capacity. This decrease in spore germination under more drought stress conditions resulted in increase in spore population and reduction in fungal entry-points. Increased spore production by soil water stress was also observed by Bildusas et al., (1986).

The root : shoot ratio of mycorrhizal plants was less than non-mycorrhizal plants. The mycorrhizal plants, inoculated by G. caledonium which prompted higher plant growth were having lower root : shoot ratio than the plants inoculated by G. mossaeae (Table 30). The findings of Sanders
(1975) also indicate that reduction in root:shoot ratio is due to improved host growth.

Leaf water content and transpiration rate was higher in mycorrhizal plants than to non-mycorrhizal ones. Among mycorrhizal plants, plants inoculated by G. caledonium were found to have higher leaf water content and transpiration rate (Table 33 & 34). This may be either due to decrease in resistance to water transport in mycorrhizal plants (Levy and Knikun 1980; Allen, et al., 1981; Hardie and Leyton, 1981; Allen, 1982; Bildusas et al., 1986) or because of vesicular-arbuscular mycorrhizal hyphal spread in the soil which enabled the mycorrhizal roots to have increased absorptive surface area for water uptake. Increased root length and substantially greater water flow rates per unit root length with mycorrhizal infection was reported by Hardie and Leyton (1981). They supported that the external fungal hyphae were required to account for the increased water-throughflow. Mycorrhizal infection increased water uptake rates even with similarly sized root systems and the estimated difference was within the range of evapotranspiration in other fungal species (Allen, 1982). The extra-radical mycelium and its spread per fungal entry-point were more in G. caledonium. The plants inoculated with G. caledonium also showed higher transpiration rate. This supported a predominantly direct flow mechanism (Hardie and Leyton, 1981) as the greater flow rates is due to
increased absorptive surface area (Fiscus, 1977). Vesicular-arbuscular mycorrhiza improved drought tolerance of plants (Nelson and Safir, 1982) and mycorrhizal plants frequently appeared to be less susceptible to wilting (Sieverding, 1979, Levy and Krikun, 1980; Hardie and Leyton, 1981). Allen et al., (1981) had reported 90% decrease in resistance to water transport under conditions of water stress as a result of mycorrhizal infection. Allen and Boosalis (1983) reported that mycorrhizal plants can transpire at soil water potential where non-mycorrhizal plants stopped transpiring. Though increased water stress reduced the transpiration rate and leaf water content of both mycorrhizal and non-mycorrhizal plants, this reduction however, was more in non-mycorrhizal plants showing wilting symptoms at severe drought stress. This may be possible only when even under drought stress condition, the mycorrhizal plants were able to extract more soil moisture.

The better plant growth improvement by *G. caledonium* than *G. mosseae* under both wet and drought stressed conditions supported the view of Hetrick et al., (1987) that the ability of VA endophyte to benefit plant growth under drought stress was apparently plant mediated.

Daniels and Trappe (1980) reported best spore germination of *Glomus epigaeum* between field capacity and saturation.
Below field capacity they found a gradual decrease in spore germination with decrease in soil moisture. Enhanced spore germination may be an important factor in higher number of fungal entry-points and root colonization and lower spore number in rhizosphere of plants placed under higher soil moisture. However, Reid and Bowen (1979) observed maximum VAM colonization at -0.2 bar water potential which dropped with further decrease in water potential and this reduction was 50% or above when the soil was saturated. Drastic reduction in vesicular arbuscular mycorrhizal colonization and spore production in waterlogged conditions may be the result of reduced oxygen concentration. Mosse et al. (1981) and Saif (1981) found inhibition in spore germination and root colonization by reduced oxygen concentration. Under waterlogged conditions, anaerobiosis develop, which can result in the release of toxic compounds such as Mn\(_2\)H\(_2\)S and various organic acids (Menge, 1984).

The greatest mycorrhizal response in improving plant growth was at moisture level of 75% of the soil water holding capacity and under this soil moisture the non-mycorrhizal plants also produced the best plant growth (Table 39). At this moisture level the transpiration rate and leaf water content were also highest. This again confirms the view of
Hetrick et al., (1987) that the mycorrhizal response in improving plant growth at water stress conditions are plant mediated and not due to any improvement in hosts water relations.

The fungal population in the rhizosphere of paddy plants inoculated with Glomus caledonium was more than the un-inoculated ones (Table 46). An increase in the population of bacteria and actinomycetes in the rhizosphere of tomato plants inoculated with Glomus fasciculatum was earlier observed by Bagyaraj and Menge (1978). Ames et al., (1984), however, reported a reduction in bacterial population in the rhizosphere of blue gram plants, inoculated with Glomus mosseae. It is now well established that mycorrhizal plants usually contain higher phosphorus concentrations than non-mycorrhizal plants (Bagyaraj, 1984). Ratnayake et al., (1978) demonstrated that high phosphorus status in the host plant increased the phospholipid content, which in turn reduced the root membrane permeability and led to less root-exudation. A decrease in root-exudation in mycorrhizal wheat plants due to high phosphate status was also reported by Graham and Menge (1982). Dixon et al., (1988) reported lower reducing sugar and amino acid in the root exudates of mycorrhizal citrus seedlings. Snellgrove et al., (1982) found that about 7% more of the total fixed C was translocated from shoot to
root in mycorrhizal plants compared to non-mycorrhizal ones and this extra translocate could be accounted for by increased root respiration plus increased loss of fixed C to the soil. This changed mycorrhizal plants physiology altered the microclimate of the rhizosphere and in turn the changed rhizospheric soil environment influenced fungal species in different ways. *Absidia cylindrosporale, Penicillium* spp. and *Macor* spp. preferred this changed environment and thus their population increased, though the environment did not influence *Trichoderma* spp. The population of *Fusarium oxysporum, Geotrichum* sp. and *Verticillium* spp. decreased in the rhizosphere of mycorrhizal plants (Table 48). This may be due to the direct effect of changed rhizospheric soil environment or the indirect effect of VA mycorrhiza, by enhancing growth and population of some of the fungal species which may in turn acted antagonistically or a combination of both. A decrease in the population of *Fusarium oxysporum* by VA mycorrhiza has been reported by many workers (Chakraborty and Mishra, 1986 a, 1986 b; Caron et al., 1986; Melo et al., (1985) reported a decrease in the population of *Verticillium alboatrum* by *Gigaspora heterogena* and *G. margarita*, but *Glomus leptotichum* and *G. macrocarpum* on the other hand increased its population.
The addition of some rhizospheric fungi in the rhizosphere of mycorrhizal plants did not significantly influence the mycorrhizal infection level (Table 47). Paget (1975) observed either very little or almost no change in mycorrhizal infection in Fragaria seedlings in the presence of Cylindrocarpon destructans. He, however, found that Fraxinus seedlings, when grown in unsterile soil, had higher mycorrhizal infection, than seedlings grown in irradiated soil.

The sclerotial population of Sclerotium oryzae was reduced in the rhizosphere of mycorrhizal plants (Table 49). A reduction in sclerotial population of Sclerotium rolfsii in the rhizosphere of mycorrhizal pea-nut plants was observed by Krishna and Baggaraj (1983). They found a high concentration of OD phenols in mycorrhizal plants. An equivalent concentration of OD phenols in vitro was found by them inhibitory to the growth of Sclerotium rolfsii. The inhibitory factors of mycorrhizal roots may interfere the establishment of S. oryzae in the rhizosphere and thus more percent reduction in sclerotial population was observed by VA endophytes when S. oryzae was inoculated 30 days after VA endophyte inoculation. Difference in efficiency of G. mossea and G. etunicatum in reducing sclerotial population supported
the view of Davis and Menge (1981) that different vesicular arbuscular mycorrhizal fungi might confer variable tolerance or resistance to the host against their pathogen.

Bagyaraj (1984) was of the view that resistance in mycorrhizal plants could be due to the morphological, physiological and biochemical changes in the host induced by the mycorrhizal fungi. The presence of *G. oryzae* in the rhizosphere of mycorrhizal paddy plants influenced the VA endophytes to produce more spores, vesicles and mycorrhizal infection. Their longer association resulted in still higher numbers of these structures. *G. etunicatum*, being more efficient than *G. mossaeae* in reducing sclerotial population of *G. oryzae*, responded more in increasing the production of spores, vesicles and mycorrhizal infection (Table 50). These results indicated a probable existence of a direct interaction of VA endophyte with its host's pathogen, *G. oryzae*. 