Increasing the concentration of IBA was found to stimulate the frequency of rooting, increased the number of roots formed, and reduced the time taken for the emergence of roots (10 days). These observations are consistent with previous attempts to root oak microshoots (Perez and Postigo, 1989; Chever et al., 1983; Veitez and Veitez, 1983; Manzanera and Por dos, 1990).

*Philodendron 'ceylon gold'*

The maximum intensity of growth and the percentage of explants established (72%) was observed with IBA + BAP (0.5+2.0 mg/L). Further increase or decrease in IBA concentration reduced the establishment of plantlets (Table 4). Similar findings were also reported by Cai et al., (1984) and Dunston and Sutter (1984).

BAP at 10 mg/L gave maximum number of shoots (8) at 20 days (Table 5). These findings are in conformity with those of Prakash and Tiwari (1993) and Singh and Tiwari (1996). Medium containing ½ strength IBA (1.0 mg/L) was the best rooting treatment than full strength. IBA and other treatments (Table 6b) similar findings have also been reported by Samarti, R. et al. (1986).
**Caladium hortulanum**

*In vitro* shoot formation in Caladium varied with the type of auxin used. The largest number of shoots being obtained with NAA and BAP at (0.5+2.0 mg/L⁻¹) (Table 7). In Caladium shoot formation is decreased with increase in NAA and BAP concentration (1.0-2.0 mg/L⁻¹) comparable results have been found for *Begonia* (Fonnesbech, 1974) and *Lythrum* (Heuser, 1983).

The percentage of explants established was (80%) (Table 10) BAP was the most effective cytokinin for promoting shoot production the number of shoots significantly increased at 0.5 and 10 NAA and BAP combinations (Table 8). The same was found for apple by Lindergan and Janick (1980).

IBA was more effective for root induction and the intensity of root initiation was very high at 1.0 mg/l⁻¹. IBA in ½ strength basal medium than full strength (Table 9b).

Increasing the concentration of IBA was found to stimulate rooting within 10 days as compared to control (25 days).

The observations are consistent with previous attempts of Gaspar and Gouman (1987) reported that low concentration of IBA may be necessary for root formation.
Hartmann was very successful in culturing Caladium and was able to clonally propagate *Philodendron oxycardium*, *Philodendron lacerum*, *Alocasia* and *Spathiphyllum* through nodal explants.

*Musa urenoscopus*

MS medium supplemented with growth regulators IBA and BAP increased the intensity of growth. The explants were established within 30 days (80%) thus, indicating the synergistic effect of hormones. The best response was obtained in the hormonal combination of IBA 1.0 and 3.0 mg/L BAP. Hence, IBA and BAP was found to be very potent for axillary shoot establishment is in agreement with Van Nievvkesk J.P., Zummerman, R.H. and Fordham, J. 1986.

In Castor (Das et al., 1996) reported four axillary shoots in leaf axils and two in shoot tips when seedling explants were grown on MS medium containing 1 mg/L BAP, 0.5 mg/L kinetin.

Ma and Shi (1972) have demonstrated the morphogenetic potentialities of terminal and axillary meristem of banana the terminal buds produce only one plantlet, whereas a larger explant with axillary buds can produce multiple plants. The results of this study clearly indicated that the initial explants of *Musa urenoscopus*. 2-3 leaf primordia with apical meristem (Plate 11) turned green and induction of shoot buds was noticed within 18 days of inoculation.
The explant surface turned blackish, a possible consequence of oxidation of polyphenols (Summonds, 1966) regardless of their genotypic status (Banerjee and Sharma, 1988). Shoot tip multiplication from meristem cell line obviously has great potential for obtaining pathogen free, true to type plants.

Among the commercial cultivars of banana – Musa urensinopus has serious limitations because low rate of multiplication. This is in agreement with those published for Cavandish (Baker, 1959; Hamilton 1965; Asenso 1967) multiple plantlets have also been produced from isolated axillary buds in pineapple Ananas comosus (Mathews and Rangan, 1979) similar responses obtained with Musa urensinopus suggest that this technique could be used for rapid multiplication of clones and hybrids with desirable qualities.

Root formation can be readily induced on MS medium supplemented with IBA at 2.0 mg/L\(^{-1}\) (Plate 11, Table 12a & 12b). Other investigators have employed a number of auxins (Berg and Bustamante 1974). Root formation was slow process and NAA was effective in inducing rooting. Rooting in Musa culture was easily induced when individual shootlets were transferred to basal medium (Sandoval, 1985). Addition of auxin to half strength basal medium stimulated further root growth. The same was found by Banerjee and Delanghe, 1985, that addition of IBA was very effective in inducing rooting at 1.0 mg/L\(^{-1}\).
Musa root inducing effects in the presence of activated charcoal at 2 mg/L \(^1\) and MS basal medium supplemented with 2.0 mg/L \(^1\) IBA was found suitable for rapid root initiation (Table 12 a & 12b).

Thus the study shows that in vitro propagation of Syngonium infrared Philodendron ceylon gold Caladium hortulanum and Musa urenoscopus is much faster than conventional means. Thus culturing new accession of these anods in vitro and screening plantlets before releasing them would greatly minimise the possibility of accidental introduction of potentially dangerous pathogens into new areas.

Hardening of plantlets to make them adapt to the outside environment is a critical process due to the anatomical and physiological peculiarities of the plantlets. Water loss from the plants had been recorded which is attributed to the improper development of the cuticle and slowness of stomatal response to water stress (Fabbri et al. 1984).

The problem may be aggravated if the vascular connection between the root and shoot is improper. A period of humidity acclimatization is considered necessary for the newly transferred plantlets to adapt to the outside environment, during which the plantlets undergo morphological and physiological adaptation enabling them to develop typical terrestrial plant-water control mechanisms (Grant and Aston 1977).
The commercial success of any micropropagation technique depends upon the ease and efficiency with which the plantlets can be established in soil. The transfer of plantlets from the culture to soil requires meticulous and careful step-wise procedure.

**Syngonium ‘infra red’**

The extent of root colonization was very high in mycorrhizal inoculated plants. The maximum growth benefits are realised by micropropagated plantlets when inoculated with AM fungus *Glomus mosseae* in *Syngonium infra red*.

This suggests that there is a possibility of reduction in the application of phosphatic fertilizer when *Glomus mosseae* was inoculated to the soils in which micropropagated *Syngonium infra red* plantlets are raised.

Regarding plant biomass (Table 13) *Syngonium infra red* plantlets inoculated with *Glomus mosseae* had more total plant dry biomass compared to uninoculated plants. The results uphold the observations made by Wang et al. (1993) in micropropagated *Gerbera Nephrolepis*, also in *Cactus* by Rincon et al. (1993). The results clearly indicated that micropropagated *Syngonium infra red* plantlets are beneficial when they are raised in the presence of AM fungus *Glomus mosseae*. Further maximum benefits of this fungus host can be harnessed when the soils are amended with half the recommended...
phosphatic fertilizer, thus, resulting a saving in P application and subsequently reduction in cost of cultivation (Bagyaraj and Verma, 1996)

*Philodendron 'ceylon gold'*

Arbuscular Mycorrhizal Fungi are well known to enhance the nutritional status of several micropropagated plants and thereby aid in the increased growth and better establishment.

Results of these investigations clearly indicate a profound positive influence of *Glomus mosseae* on growth of micropropagated *Philodendron ceylon gold* plantlets with *Glomus mosseae* colonized plantlets showing an enhanced growth compared to those grown in the absence of *Glomus mosseae* inoculation (Table 14) such improvement in growth and nutritional status of micropropagated plantlets in the presence of AM fungi are well documented in the case of apple (Granger et al., 1993) and grapevine (Schubert et al., 1990).

The beneficial effects of this fungi on the growth of *Philodendron 'ceylon gold'* is so marked, that plantlets growing in *Glomus mosseae* exhibited significantly higher plant height, shoot length and total biomass compared to those grown in the absence of *Glomus mosseae* inoculation (control). Such increased growth is primarily contributed to enhanced nutrient uptake, particularly P apart from increased uptake of other
micronutrients (Jeffries, P 1987) The plantlets colonized by *Glomus mosseae* have harnessed significant increase in growth compared to all other treatments.

*Caladium hortulanum*

Inoculation by *Glomus fasciculatum* was effective in promoting plant growth and development of micropropagated caladium although the leaf area and number of leaves were more pronounced in *Glomus fasciculatum* treated than uninoculated probably indicating a change in normal balance induced by mycorrhizal symbiosis (Allen et al. 1980, 1985).

The development variation found in inoculated and uninoculated plants in both VAM treated resulted from differences in plant biomass. The total plant fresh weight was significantly increased by mycorrhizal treatment.

The data support the earlier morphological observations of Heslin and Douglas (1986) which showed the formation of highly developed mycorrhiza with the combination of fungus and host under sterile conditions.
Godbout and Forten (1985) reported that mycorrhizal formation with *T. terrestris* in combination with seedlings of *Populus tremuloides* under semi-sterile condition. Plants colonized by *Glomus fasciculatum* (Table 16) increased significantly the root shoot length and plant biomass while those colonized by *Glomus mosseae* produced lesser spores.

The response of *Caladium hortulanum* to colonization by diverse VAM fungal species varied and depended on the host endophyte combinations such responses, including both growth enhancement and depression were noted by others (Daft and El-giahmi, 1975).

The behaviour of each species may suggest an inoculation strategy for foliage plants in pots during propagation which however cannot be extrapolated easily to the foliage nursery, where plant roots and VAM mycelium are exposed to different environmental condition.

Root length, shoot length and plant biomass was appreciably increased in *Glomus fasciculatum* treated than *Glomus mosseae* and control (Plate 24, 25, 26 & 27). In *Poplar* an increase in the number and dry weight of roots have been reported for mycorrhizal plants (Navratil and Rochan, 1981).

The increase in dry matter accumulation in plants depends on the photosynthetic capacity of plants, in turn the photosynthetic capacity depends on the dry matter accumulation in leaves, leaf area and leaf area index.
In *Caladium hortulanum*, which is a leafy ornamental plant showed an increase in leaf area to the extent of 80 percent (Table 15 and Fig. 10,11 & 12), compared to uninoculated plants. This supports the earlier observation made by Blermann and Lindermann (1983) in Chinaster and Brend *et al.* (1983) in Geranium showed greatest leaf area in plants inoculated with VAM fungus.

It is interesting to observe that *Caladium hortulanum* responded best to *Glomus fasciculatum* at different duration. Though VAM fungi are not host specific, recent studies have brought out the phenomenon of host preference in VAM fungi (Mosse, 1973; Bagyaraj and Varma,1996). Thus, there is always a compatible host endophyte combination that result in maximum symbiotic response, perhaps *Glomus mosseae* is not the best symbiotic partner for *Caladium hortulanum*.

The results suggest that some VAM endophytes are more effective than other in enhancing the foliage plant growth and fungal species not naturally present in the soil can be efficient in increasing plant growth in pots. The behaviour of each species may suggest an inoculation strategy for foliage ornamental in pots, e.g. during propagation which however, cannot be extrapolated easily to the horticultural nursery where the plant roots and VAM mycelium are exposed to different environmental condition.
Musa urenoscopus

Banana plantlets growing in the presence of Glomus mosseae exhibited the highest per cent root colonization and the rhizosphere containing the highest number of spores per 50 ml of soil compared to other treatments (Table 13). Micropropagated Musa urenoscopus showed a positive correlation between per cent mycorrhizal colonization and plant growth. This findings support an earlier observation made by Hayman and Schubert (1986) working with onion.

The colonization and spore numbers perhaps enable more fungal host contact and more exchange of nutrients and hence better plant growth supports the earlier findings of Daft and Nicolson (1972)

In conclusion, the results show that it is possible to successfully produce mycorrhizal plants of foliage ornamental plants by inoculation with VAM fungi while plants are undergoing the transition from heterotrophic condition in vitro to autotrophic condition in green house. In addition, it is desirable to screen several VAM species to determine those combination which result in good root infection and enhanced growth formation of effective mycorrhizas at an earlier stage resulted in stimulation of growth for all the foliage plants used in the present study.

This may have altered application for other species which are micropropagated and a specific application for foliage plants.