Opportunities for the Application of Arbuscular Mycorrhizal Fungal Technology in Hawaii

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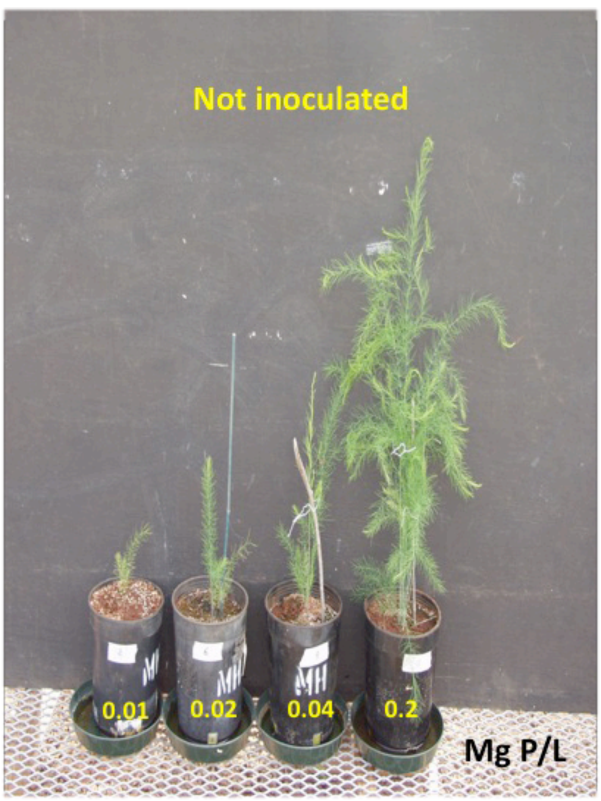
A vast majority of temperate and tropical plant species grow in the field under the influence of mutualistic soil fungi that inhabit their roots. Among these mutualistic associations, the most widespread, geographically as well as within the plant kingdom, are the arbuscular mycorrhizas. Mycorrhizas formed with over 90% of the plant species in the tropics are initiated by arbuscular mycorrhizal (AM) fungi. The most prominent and consistent function of the fungi is to enhance the uptake of diffusion-limited nutrients such as P, Cu, K, Zn, and Fe by associated plants. Other functions of the fungi include a) protection of associated plants against phytopathogenic fungi and phytoparasitic nematodes, b) enhancement host tolerance to environmental stresses such as soil acidity, heavy metal toxicity, and c) enhancement of soil aggregate development.

In most uncultivated lands and in former sugarcane lands in Hawaii, the concentration of P in the soil solution is not sufficient for mycorrhiza-free growth of plants. When we see plants growing normally under these conditions, we can be reasonably sure that AM fungi are making it possible. In the presence of a fully functional AM symbiosis, plants can grow at a small fraction of the P concentration required for maximal growth of mycorrhiza_free plants.

Response of asparagus to mycorrhizal colonization at four soil solution P concentrations.



Consequently, AM fungi can play crucial roles in a) native ecosystems such as forest ecosystems whereby fertilization of extensive land areas with large quantities of P is not done usually or is not practical, b) agricultural systems in which the high P fixing capacities of soils and the unavailability of P or its high cost limits crop production, c) situations whereby it is essential to reduce soil fertilizer application rates significantly because of environmental concerns, and d) situations in which phosphate rock is readily available and used instead of more soluble P sources.

If AM fungi occur at very low densities or are absent from a soil, the establishment and growth of forest and horticultural species on these lands will be very slow, erratic, and sometimes impossible. Examination of soil samples representing 5 soils orders obtained from Kauai, Big Island, and Oahu suggests that our soils generally contain inadequate numbers of AM fungi for rapid and effective mycorrhiza development. Under these kind of circumstances, AM fungi must be applied to the soils as inocula. There is a certain draw back to the obligate nature of the AM symbiosis, and that is the fact that the fungi cannot be multiplied apart from plants. This means that they cannot readily be multiplied in laboratory media. Because of this constraint the current state of AM fungal inoculum production technology makes direct application of inoculum of the fungi to extensive areas of land cumbersome and not cost-effective. At present, application of AM fungal inocula during nursery production of seedlings for subsequent outplanting to large areas of land is the most practical and cost-effective way of utilizing the AM fungal technology. Another area of application which is rapidly gaining recognition is the use of AM fungi in acclimatization and subsequent survival and growth of micropropagated species. The vegetative micropropagation of agronomic, horticultural and forest species is rapidly becoming the most widely accepted means of producing large numbers of genetically homogenous plants. Because many of the economically important species of plants in the above categories are mycorrhizal and because of the numerous benefits of AM fungi, there is a growing interest to integrate the AM fungal technology in protocols for production of micropropagated plants (Puthur, et al.1998; Yao, et al. 2004). A successful incorporation AM fungi in the micrpropagation process will lead to the production of robust plantlets, shorten the duration of acclimatization required, increase the survival of plants, protect plants against post-transplant stress, and possibly protect seedlings against diseases and nematodes, among other things.

Literature cited

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