7. Mosse, B. and J.M. Phillips. 1971. The influence of phosphate and other nutrients on the development of vesicular-arbuscular mycorrhizae in culture. *J. Gen. Microbiol.* 69: 156.
8. Phillips, J.M. and D.S. Hayman. 1970. Improved procedure for clearing roots and staining parasitic vesicular-arbuscular mycorrhizae fungi for rapid assessment of infection. *Trans. British Mycol. Soc.* 66: 158-161.
9. Strain, J.R. 1980. Business analysis of container nurseries in Florida, 1980. *Econ. Information.* Report 165, Univ. Florida, Gainesville.

IMPROVED PRODUCTION OF NURSERY CROPS WITH MYCORRHIZAL FUNGI

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Mycorrhizae are the symbiotic (beneficial) association of helpful fungi with the fine roots of plants. All horticultural crops form associations with mycorrhizal fungi. What we need to do is learn how to manipulate mycorrhizal associations to reduce nursery production costs and increase profits (2).

Some of the problems confronting the nursery industry are increased production costs and greater governmental regulations, which may curtail water usage of water runoff containing undesirable levels of salt fertilizers, fungicides, pesticides, etc. We also need to produce and market more stress-efficient native ornamental plants that utilize lower levels of water and fertilization. The California industry is currently facing strict water runoff regulations and water salinity problems. The Texas nursery industry stands to benefit from more efficient production systems utilizing mycorrhizal fungi that enable production of nursery crops under reduced watering and fertility regimes. Nurseries throughout the Southeast can benefit from knowledge of mycorrhizal associations for the same and other reasons.

The association with mycorrhizal fungi makes plants more efficient in absorbing nutrients and water from the soil. Other benefits are increased pathogen resistance, adventitious root formation, enhanced seedling growth and plant establishment in the landscape. It has been documented that mycorrhizal nursery crops, which are more efficient and stress resistant, may consequently command a premium price on the market place.

Clearly there is a need for more research to be done with nursery crops looking at mycorrhizal benefits and potential ways for incorporation of mycorrhizal fungi into production schemes. Likewise, there is a need for industry to support general research towards developing more efficient production systems.

An important point to remember is that by researching with mycorrhizae we are learning to manipulate *natural systems* to produce better nursery crops. Some California citrus nurseries are currently using mycorrhizae. Likewise, the forestry industry has been using commercial batches of mycorrhizae to increase tree seedling growth and production.

There are two basic types of mycorrhizae: the ectomycorrhizae and endomycorrhizae. A third lesser-known type is called endo-ectomycorrhizae, but it is not well understood. The ectomycorrhizae from associations with 5% of all higher plants such as pines, oaks, and other hardwoods. Ectomycorrhizae form fruiting bodies like puffballs and mushroom. Their mycelium strands colonize the fine roots of plants and form fungal mantles and hartig nets. An advantage of ectomycorrhizae is they can artificially be synthesized (grown) on a modified Melin-Norkrans medium and then be transferred to a canning medium and incorporated with the nursery crop (1).

Endomycorrhizae form associations with 90% of all higher plants and also colonize the fine roots of plants. They form vesicles and arbuscules inside the root, which are used for food storage and the transfer of nutrients and water from the fungi to the nursery plant and carbohydrates (sugars) from the nursery plant to the fungi. Inoculum of endomycorrhizae are increased by growing spores and mycelium on live roots of sudan grass, sorghum, or strawberries. Later a mixture of roots and soil containing the endomycorrhizae can be incorporated into the canning mix of a nursery crop (1).

We have been testing Texas native ornamental plants such as *Sophora secundiflora* (Mountain laurel or muscal bean), which has potential in the nursery trade. Sophora is an attractive evergreen shrub and is very stress resistent. Our research has shown that under natural conditions sophora forms both endo- and ectomycorrhizal associations and develops root nodules. The mycorrhizae enable this plant to pick up water and nutrients more efficiently. The development of nodules means sophora can capture and convert nitrogen into a utilizable form; i.e., the plant makes its own nitrogen fertilizer. We have obtained increased seedling growth and phosphorus uptake by incorporating endomycorrhizae into the potting mix.

Research recently completed by Michael Sweatt, an M.S. graduate student, showed that geraniums could be successfully grown under lower water regimes when mycorrhizal fungi were incorporated. In comparison with control plants, mycorrhizal geraniums had greater plant growth, flower development, and increased internal nitrogen levels. Mycorrhizal geraniums also recovered from water stress more rapidly, which is an important factor in the diverse and often stressful climates of Texas.

Current research is designed to investigate the potential of utilizing mycorrhizae in the production systems of field roses, oaks, pines, and other Texas nursery crops.

LITERATURE CITED

1. Maronek, D.M., J.W. Hendrix and J. Kiernan. 1981. Mycorrhizal fungi and their importance in horticultural crop production. In: Janick, J. ed., *Horticultural Reviews III*, pp. 172-213.
2. Schenk, N.C., Ed 1982. Methods and Principles of Mycorrhizal Research. St. Paul, Minn.: *Amer. Phytopath Soc.*

RHODODENDRON PROPAGATION — NO MIST WITH BOTTOM HEAT

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Since 1975, when Roadview Farm Nursery was established, rhododendron propagation has normally started in September. At this time the summer growth on the container-grown plants has matured sufficiently so that cuttings may be taken. The cuttings are stripped of the lower leaves, trimmed to a uniform length and double wounded. Leaf surface area is not reduced. Cuttings are then soaked in a Captan-Benlate solution. They are stuck in trays to give 1½-in. spacing. In the early years of the nursery the cuttings were stuck in 6-in. deep peat and perlite beds raised 3 ft. off the ground. The beds were in double poly propagation houses. Warm air from counter-flow oil-fired furnaces was blown under the benches, which were enclosed with plastic to contain the heat. Mist regulated by time clocks was applied to the cuttings until rooting was well developed. We found that the hot air furnaces were running constantly on cold nights and, with rising fuel oil costs, a more efficient system had to be installed.

In 1979, in an attempt to reduce heating costs, we switched from hot air furnances to hot water boilers to heat two of our three propagation houses. After considerable discussion it was decided to run 1-in. plastic pipe in loops in the ground to heat the cuttings. To increase the efficiency of the