Initial studies in this program have involved introducing bacteria into the vascular system of elms that are antagonistic to the DED fungus. We hope that we can find bacteria that will become permanent residents in elm tree vessels and prevent the DED fungus from becoming established.

Integrated Control. It is popular in complicated disease situations like DED to indicate that an integrated control program is needed. With integrated control a variety of control procedures are used together. It must be remembered that the integration of control procedures that do not initially work will not enhance their inherent effectiveness. Adequate control of Dutch elm disease will not come about integrating present procedures, but rather through research to improve these procedures and to find new ones.

PHYSICAL PROPERTIES OF CONTAINER MEDIA

by J.R. Havis and W.W. Hamilton

Most container nurserymen use soil-less media in the containers. Elimination of soil reduces the weed problem. Until recently, the most common medium was a mixture of sphagnum peat from Europe or Canada with either fine sand, as suggested in the "U.C. System", or coarse sand (builder's concrete grade) as is more commonly used in the East. More recently container nurserymen have been interested in finding less expensive substitutes for at least part of the sphagnum peat in the mix. Shredded bark is a popular material for this use. Hardwood bark, mostly oak, is available in the Midwest; softwood is available on the West Coast and in the Southeast. The bark in the Northeast may be largely softwood, but usually contains some hardwood species other than oak. Sawdust is used commonly by container growers in Western Canada.

This study was undertaken to compare water retention and aeration properties of mixes prepared from some of the above materials. Mixes studied were 1) peat and coarse sand 1:1, 2) bark (screened to maximum ½ inch) and coarse sand 1:1, 3) bark-peat-coarse sand 2:1:1, 4) bark-peat-fine sand 2:1:1, 5) sawdust-peat-coarse sand 2:1:1, and 6) sawdust-peat-fine sand 2:1:1. The mixes were studied in 1-gallon containers, which held 2.1 liters of mix, and in specially constructed tension funnels in the laboratory.

A container mix is made up of two parts: the "dry" material and pores, the latter being filled with either air or water. It is desirable that the pore phase constitute more than 50% by volume. All of the mixes studied met this qualification.

When the mix is saturated, all of the pores are filled with water. *Large* pores empty of water and fill with air when the containers drain by gravity (container capacity). Since air is essential for plant roots, a container mix should contain 20 to 25% air by volume after drainage. All of the mixes contained more than 20% air-filled pores one hour after overhead irrigation.

After drainage, water continues to be removed from the container mix by evaporation and the process of absorption by plant roots and transpiration from leaves. Water in *medium* size pores is easily removed by the plant, and can be called "readily available" water. After this readily available water is removed, the remaining water is held in *small* pores with sufficient tension that the plant has difficulty in extracting it. This condition results in slight wilting, closure of stomata and some reduction in growth. Further drying of the mix removes all water except that held with high tension in *very small* pores, and this condition results in severe wilting.

For best growth of plants, the objective is to keep the water in the container mix at the readily available stage. This is more easily done if the mix has relatively large proportion of its pores in the medium size range.

It was found that the peat-sand mix and the bark-sand mix had about the same volume of total pores, equal to ⅔ their total volume. However, the size distribution of the pores was quite different between the two mixes. In the peat-sand mix 38% of the pores were large (empty at container capacity), compared with 55% in bark-sand mix. Also, in the peat-sand mix 31% of the pores were medium (held readily available water), compared with only 13% in the bark-sand mix.

As a result of these pore-sizes, a 1-gallon container of the peat-sand mix held 430 ml of water readily available to plants, whereas a container of the bark-sand mix held 187 ml readily available water, less than one-half that of the peat-sand mix. In addition, the peat-sand mix held twice as much water as the bark-sand mix in the next range which acts as a "buffer" before the plants become severely stressed.

This information has very practical meaning. If a nurseryman should change his container media from peat-sand to bark-sand, he would need to apply irrigation more frequently to the bark-sand mix than may have been his custom with peat-sand mix to avoid wilting and obtain best growth.

The addition of peat to bark and coarse sand (bark-peat-sand 2:1:1) changed the pore-size distribution so that the amount of readily available water was intermediate between peat-sand and bark-sand mixes. Apparently, the value of adding peat to the mix is to increase the medium size pores and thus the quantity of readily available water.

The substitution of sawdust for bark in the three-part mix did not significantly change the total pore space or the pore-size distribution. Apparently, sawdust and bark are equally useful as ingredients in container mixes and irrigation management for the two kinds of mixes would be similar.

The substitution of fine sand for coarse sand in the three-part mixes reduced the proportion of large pores and increased the proportion of medium and very small pores. However, the mixes with fine sand had certain disadvantages such as swelling and shrinking and surface growth of mold, which interfered with water penetration.

Ilex crenata and *Magnolia stellata* plants were grown successfully in these mixes, indicating that physical properties were favorable for good plant growth provided proper management is given. Extra nitrogen is required for mixes with bark and sawdust to compensate for that used by decomposing bacteria. Frequency of irrigation and fertilization must be adjusted based on the pore-size distribution of the mix.

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ABSTRACT

Schuder, D.L. 1976. **Galls on Shade Trees and Shrubs.** Purdue University Coop. Ext. Service Publ. E-56. 4 p.

Galls are abnormal growth on plants. They are caused by certain feeding organisms, including bacteria, fungi, nematodes, mites, and insects. These organisms stimulate plant cells in such a way that the cells grow into galls, which serve as protection for the pests. There are hundreds of kinds of galls, each characteristic of the organism producing it. This publication deals only with galls caused by mites and insects. In general, mite and insect-produced growths do not seriously affect the health or vigor of the host plant. They may disfigure twigs and foliage, but if the plant is unhealthy or dying, something else is usually causing the trouble. Included are some of the common galls found on trees and shrubs in Indiana, and suggestions on how to prevent or control them.