mina) roots in 8 weeks. We stick 2 cuttings directly into a 4-inch pot.

We also root non-woody plants under the humidifiers. Joseph's coat (*Alternanthera bettzickiana*) roots in 3 weeks. After they grow large enough, we can sell these plants in the same cell packs they were rooted in. Dwarf scheffleras (*Schefflera arboricola*) are rooted in 3-inch pots and can be shifted into 6-inch pots within 12 weeks.

After the cuttings have rooted well enough, we shift them into another greenhouse. They are misted by hand 8 to 10 times a day for the first 3 days, 4 to 5 times a day for the next 3 days, then twice a day for a week. They are misted with a coarse spray Fogg-It nozzle. After that they are watered once a day by hand. The liners remain in the greenhouse during the winter. Starting in April the liners are shifted into 2-, 3-, and 5-gal containers. We may also have 1-, 2-, and 3-quart liners, which we plant in July and August. They are protected with plastic-covered greenhouses beginning in mid-November. Many of these will go into 5- and 7-gal containers in the spring. Some of the 1-gal liners of hardier species will be left outside and protected only with shade cloth during the winter. Our wholesale growing area is 10 acres in size; 2½ acres are taken up by our water reservoir; 5 acres are in the container area; and the rest is used for greenhouses, potting area, bark pile, and grinding and soil mixing facilities. We grind and screen the bark on site in order to get the fine grade needed for propagation and liner mixes. We use a Bouldin-Lawson Tumble Mixer with a 2 yd^3 mixing capacity for mixing all of our different types of rooting media.

ROOTING CUTTINGS UNDER A WET TENT[1]

CARL E. WHITCOMB

Department of Horticulture
Oklahoma State University
Stillwater, Oklahoma 74078

Abstract. A wet tent that maintains high humidity yet allows sufficient light penetration to support photosynthesis in leaves of cuttings has been devised. The system may be used alone or in conjunction with reduced conventional mist. With little or no mist, leaching of metabolites from leaves and overwatering of the media is reduced or eliminated. With less water in the mix, bottom heat is more effective and aeration is increased, thus stimulating more rapid root development and subsequent growth. Rooting of cuttings in the wet tent has been excellent in fall and winter. Summer softwood cuttings have required some mist since the fabrics tested have not allowed sufficient air exchange for cooling and humidification.

---

1 Journal Series #4258 of the Oklahoma Agricultural Experiment Station.

One of the major advances in plant propagation made in recent years was intermittent mist. However, excess water from misting cycles that are either too frequent or too long leaches an assortment of nutrients and metabolites from the leaves (2,4) and may overwater the rooting medium, reducing oxygen and suffocating new roots as they are being formed (5).

Prior to intermittent mist, many cuttings were rooted without mist or under polyethylene covered structures (3). Relatively few plants root well without mist due to desiccation of the foliage, thus the practice of cutting off part of the leaf. However, this causes more harm by reducing carbohydrates than it helps in reducing water loss. Rooting under polyethylene tents increases humidity part of the time. However, when exposed to direct sunlight, even for short periods, the temperature increases and humidity decreases very rapidly, frequently damaging the cuttings.

An ideal alternative would be a structure that provides very high humidity, even with fluctuating temperature, and then to limit misting of the cuttings. This would reduce or eliminate leaching and maintain a good moisture-air balance in the rooting medium. Disease problems could also be expected to be minimal. If such a system is incorporated into a propagation structure with constant bottom heat, further improved rooting of cuttings and/or plant growth may be achieved.

During September, 1980, while in Europe, I met Andre Franclet, an imaginative researcher with a private forestry research company in France. He was successfully rooting Scotch pine (*Pinus sylvestris*); Austrian pine (*Pinus nigra*), and Douglas fir (*Pseudotsuga menziesii*) under a wet fabric with bottom heat (1). The fabric was supported by a wire frame over the cuttings and wetted by troughs of water on each side of the bench. The primary problem with this system was getting sufficient light to the cuttings.

After returning to Oklahoma we tried several fabrics in a similar apparatus. We could not get the water to "wick" on the fabric more than 16-20 inches without using a fabric so heavy that very little light penetrated. After much trial and error, during September-October, 1980 a system was devised that works well in the fall and winter. This system is described here.

METHODS AND MATERIALS

The system consists of 2-inch PVC pipe (schedule 40) cut on one side the entire length using a jig saw with a thin, fine-toothed blade. The center fold of a fabric of desired size and density is inserted into the slit along with 6- to 8-inch wide filler or wick fabric (Figure 1). The first fabric tested was 100%

polyester, which provided about 40% shade. The filler or wick fabric used to fill the slit in the pipe was a heavy wool fabric. The ends of the pipe were fitted with a bell reducer and standard waterhose fitting and cap. The PVC pipe and fabric tent, with the slit down, was then suspended over the desired area. Triangular end frames covered with clear polyethylene were put in place. The hose was adjusted to allow a small but continuous quantity of water to the pipe and tent, using a flow-control valve. Only enough water is used to keep the fabric wet.

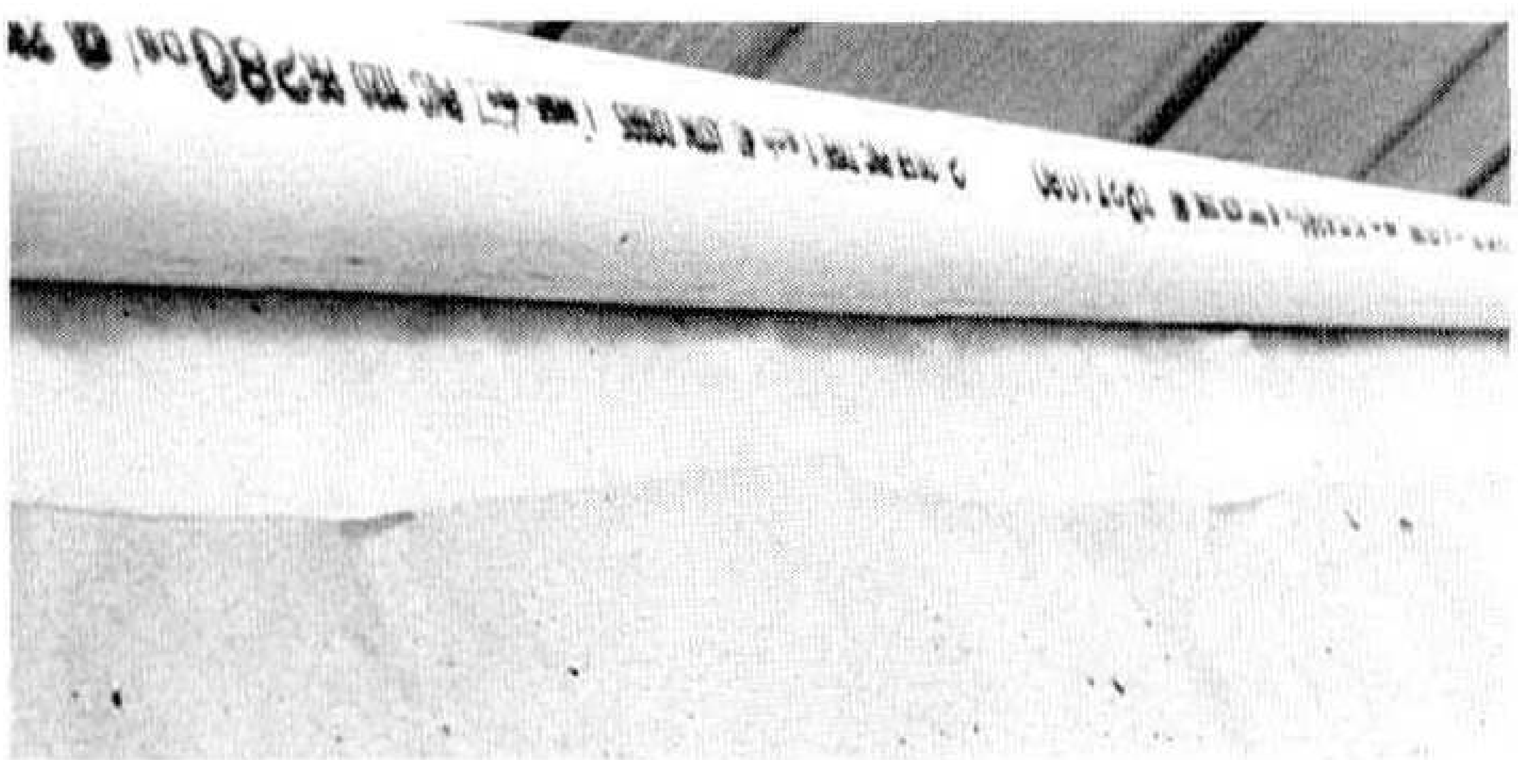

Figure 1. Wick fabric and filler fabric are inserted into the slit, cut the length of the pipe.

As the temperature in the greenhouse increases, additional water evaporates from the fabric, increasing the humidity inside the wet tent and moderating the temperature increase. As the temperature inside the tent decreases in the evening, some moisture condenses on the foliage of the cuttings and/or the surface of the rooting medium. This action stabilizes the moisture level of the rooting medium while avoiding the common waterlogged condition. The wet tent was first set up in a double-layer poly greenhouse with a solar-heated floor maintained at approximately 75°F.

During the late October and early November, 1980, cuttings of several species were stuck in 2×2×3 in deep containers in a rooting medium of 1:1 peat and perlite. Identical blocks of cuttings were handled similarly and placed under conventional intermittent mist.

RESULTS AND DISCUSSION

Cuttings of most species rooted similarly under intermittent mist and the wet tent. Three exceptions were noted, however;

(1) *Ilex vomitoria* 'Nana', dwarf yaupon holly, rooted 100% under both conditions, but cuttings dropped 94% of the original leaves under mist, whereas no leaves were lost under the tent. As a result the dwarf yaupon liners from the tent were much larger with more roots at transplant time.

(2) *Rhododendron* 'Fashion', rooted 42% under mist and 96% under the tent.

(3) *Cedrus atlantica* 'Glauca' did not root under mist but rooted 66% under the tent.

During the fall, winter and spring of 1981-82 the tent continued to work reasonably well. However, as with any new technique, some complications remained. With the original 100% polyester fabric over a conventional mist system, and the mist cycle reduced to 4 seconds every 30 minutes, the system worked well (Figure 2). However, if we did not use the mist, on some bright sunny days, even during fall and winter, the humidity in the tent would drop below the desired 98-100% level as a result of heat build-up in the tent.

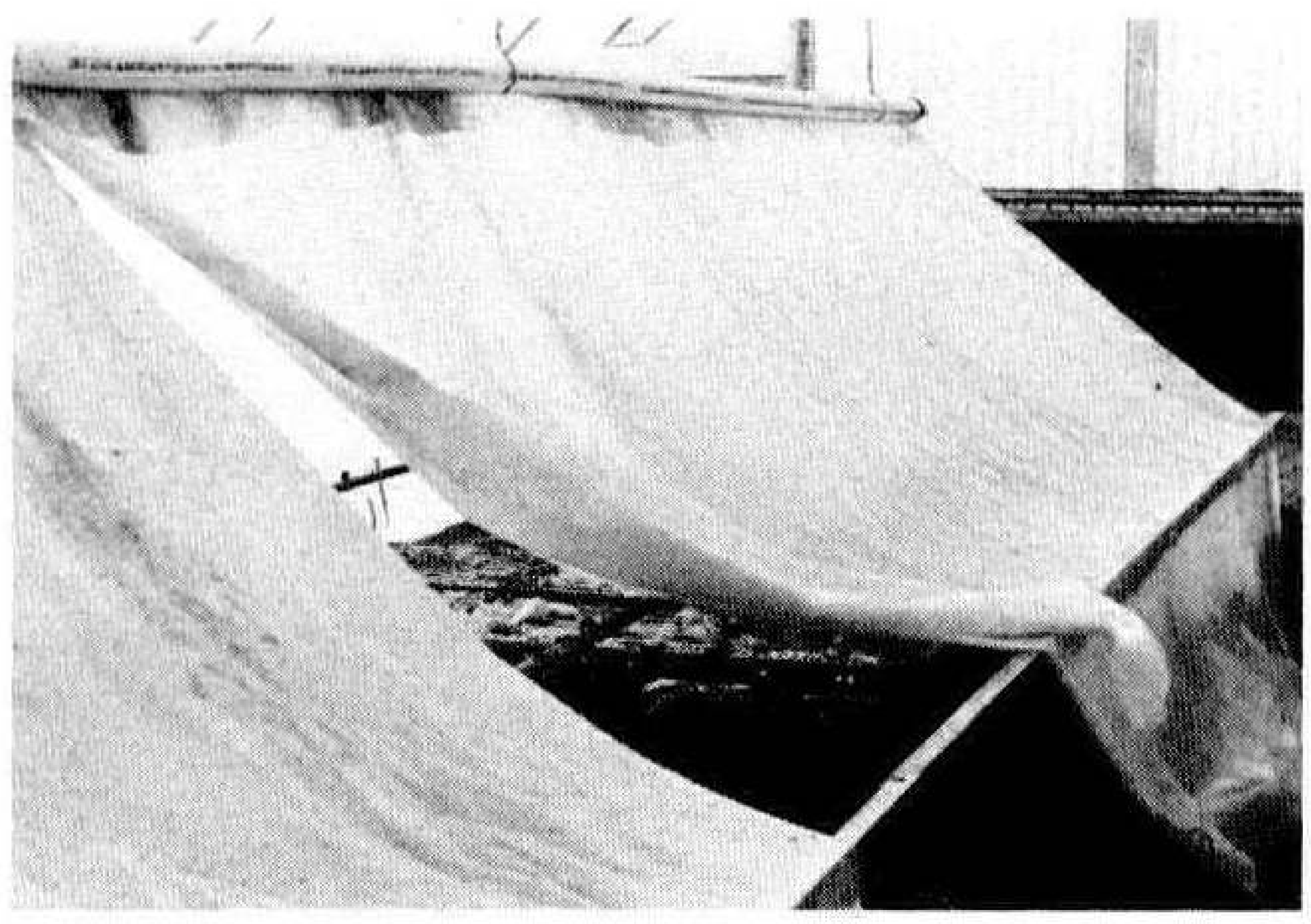

Figure 2. A wet tent over a conventional mist propagation system. The tent allows the mist cycle to be reduced substantially without creating moisture stress on the cuttings.

Even though the fabric was porous when dry, it functioned as a solid sheet when wet and prevented any air movement into or out of the tent. The next approach was to try a more porous fabric, and during the summer of 1982, a small thermostatically controlled exhaust fan was added (Figure 3).

Figure 3. Location of a small "squirrel cage" fan inside the tent increased air flow into the tent and provided substantial moisture coating during warm, sunny days. The thermostat, with sensor inside the tent, was set at 70°F.

A knit polyester fabric was found (Figure 4) that allowed air movement through the tent even when wet. Some natural convection air currents could be observed as the warm air rose in the tent, exited the top, and cooler air moved in. The exhaust fan drew more air through the fabric and created an evaporative cooling effect. The fabric in Figure 4 has rows of large and small holes. The small holes are approaching the ideal size. The large holes allow some air into the tent without ample humidification. On the other hand, if the openings in the fabric are too small, the holes will be sealed off as a film of water forms around each thread. We have not yet found the "ideal" fabric. However, we feel it should have the following characteristics: (1) have holes or pores large enough to remain open when wet, yet small enough to provide a large combined surface area around each hole for evaporation and humidification of the air; (2) be of polyester or other non-organic material that does not support algae growth readily; (3) have sufficient strength and flexibility to allow for easy movement and handling; (4) be sufficiently thin to provide no more than 30 to 40% shade. White fabric appears to be most effective in transmitting light as opposed to other light colors.

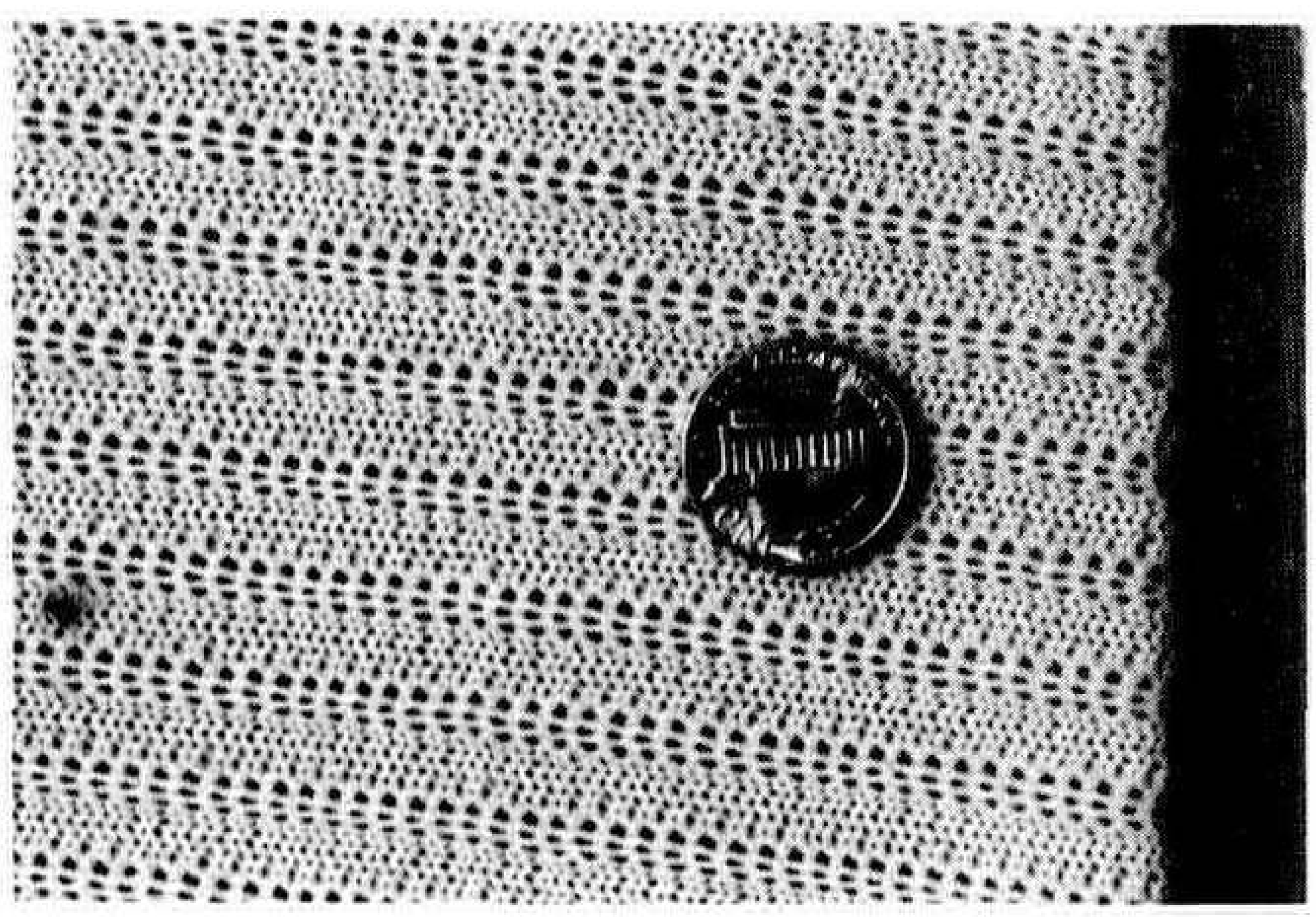

Figure 4. This polyester knit was one of the most promising fabrics tested. However, the large holes were probably too large, thus allowing some air to enter without sufficient humidification. The strips with the smaller holes appear near ideal, and holes are not filled when water is moving down the side of the tent.

The wet tent system should not be viewed as a cure-all for propagating difficult-to-root plants. However, it does provide an inexpensive method for reducing moisture stress of cuttings and improving control of water and air in the rooting medium with little or no mist required. With this amount of light transmission through the tent, supplemental light would not be needed.

LITERATURE CITED

1. Franclet, A. 1977. Conditions de milieu favorables a'l'enracinement des boutures de Douglas In: FOCEL Annals 1977:69-97.

2. Good, G.L. and H.B. Tukey, Jr. 1966. Leaching of metabolites from cuttings under intermittent mist. *J. Amer. Soc. Hort. Sci.* 89:727-733.
3. Snyder, W. 1965. A history of mist propagation. *Proc. Inter. Plant Prop. Soc.* 15:63-67.
4. Tukey, H.B., Jr., H.B. Tukey, and S.H. Wittwer. 1958. Loss of nutrients by foliar leaching as determined by radioisotopes. *Proc. Amer. Soc. Hort. Sci.* 71:496-505.
5. Whitcomb, Carl E. 1981. Propagating woody plants from cuttings. Okla. Ag. Exp. Sta. Bulletin #755. 18 pages.

Nursery Organization Panel

MODERATOR BYERS: Nurseries are a complicated, complex, and difficult form of agricultural production. Our efforts are greatly affected by factors outside our control — the weather, the economy, and the labor supply. In Huntsville Alabama, we have an average of 151 winter days between first and last frost. Of these 45 are weekends and holidays and about 40 are bad weather. Thus, we have 66 working days. Divide this figure into sales volume, and it's obvious that efficient management is critical for survival and success. That we are almost a cottage industry means we have no price or production controls. Also many nurseries are undercapitalized. We have on our panel three nurserymen to discuss the systems they use for efficient management.

GENERAL ORGANIZATION OF GREENLEAF NURSERY

AUSTIN F. KENYON

Greenleaf Nursery Company, Inc.
Route 1, Box 98
Park Hill, Oklahoma 74451

Greenleaf Nursery Co., Inc. is a wholesale nursery specializing in production of container-grown ornamental plant material. Our offices are located in northeastern Oklahoma on the banks of beautiful Tenkiller Lake, which also is our source of irrigation water. In addition, we have a branch operation located 4 miles south of El Campo, Texas, which is 31 miles from the Gulf of Mexico.

The Oklahoma operation, which receives low temperatures each year of at least 0°F., primarily grows junipers, deciduous trees, and deciduous shrubs. The Texas operation, with the more gentle Gulf Coast climate, specializes in broadleaved evergreen plant material, such as, azaleas, hollies, euonymus, pyracantha, pittosporum, etc.