LEN STOLTZ: Usually quick-dips give more uniform rooting than powders. I would urge that you not give up on quick-dips. With the soft cuttings you are using I would recommend that you start at 2,000 ppm.

CHARLIE PARKERSON: We think that the injury problem is related to the alcohol used to dissolve the IBA. We have changed to the potassium salt and cut with water.

RALPH SHUGERT: I would recommend lower rates of IBA/NAA because of the soft condition of your wood.

OUTDOOR ROOTING UNDER A WHITE POLYETHYLENE TENT[1]

NORMAN E. PELLETT, DAPHNE DIPPRE, and ANN HAZELRIGG

Department of Plant and Soil Science
University of Vermont
Burlington, Vermont 05405

Abstract. A white polyethylene tent was used for 3 years to successfully root softwood cuttings of 16 shrubs and ground cover plants. Three treatments, intermittent mist with and without bottom heat, and watering 3 times daily with spray stakes without bottom heat, were successful procedures for rooting most kinds of plants. A heated rooting medium was detrimental for rooting some kinds of plants. The heated medium reached a higher temperature on sunny days than unheated medium. When the outdoor temperature reached 26°C (82.4°F), air temperatures in the tent were not detrimental to the cuttings.

REVIEW OF LITERATURE

We have identified a variety of landscape shrubs adapted for northern landscapes (5). To encourage northern nurserymen to propagate these without major investment in equipment, we investigated several methods for summer outdoor rooting of cuttings under a white polyethylene tent.

Paul Joly, Windsor Road Nursery, Cornish, N.H., has used a white polyethylene tent for rooting cuttings during the summer. We adapted his structure for our studies because we felt that a white polyethylene tent would result in acceptable maximum temperatures and prevent rapid drying of cuttings which occurs if an intermittent mist system fails in an open frame. Nurserymen have successfully rooted cuttings under light transmitting covers during summer (1,4). Some light reduction by covers did not inhibit rooting of cuttings (3).

---

[1] Vermont Agr. Exp. Sta. Jour. Art. No. 532.

The effect of three systems on rooting of softwood cuttings were compared in 1980 and 1981: (1) intermittent mist, bottom heat, (2) intermittent mist, no bottom heat, and (3) watering 3 times daily with Twin Rod Spray Stakes (Chapin Watermatics, Inc., Watertown, N.Y. 13610). Systems 1 and 2 were compared again in 1982 for their effect on rooting cuttings and on medium and air temperatures in the tent.

MATERIALS AND METHODS

Propagation beds 0.9 x 4.5 m (3 x 15 ft) were prepared at the University of Vermont, Burlington, Vermont by covering thin-wall conduit arches with a white polyethylene sheet (Visqueen 1505 white greenhouse film) (Fig. 1). The beds were prepared by driving 40 cm (18 in) lengths of 1.9 cm (¾ in) diameter conduit at 76 cm (30 in) intervals and fastening them to a 3.5 x 13 cm (2 x 6 in) wooden frame 4.5 m (15 ft) in length and 0.9 m (3 ft) in width. Sections of 3 m (10 ft) long by 1.3 cm (½ in) diameter thin-walled conduit were arched over the bed and anchored in the larger diameter supports attached to the frame.

White polyethylene (4 mil) was stretched over the arches and fastened on one side. The opposite side was covered by gravel for easy access. The south end of the mist bed was enclosed by the polyethylene while the north end was left uncovered.

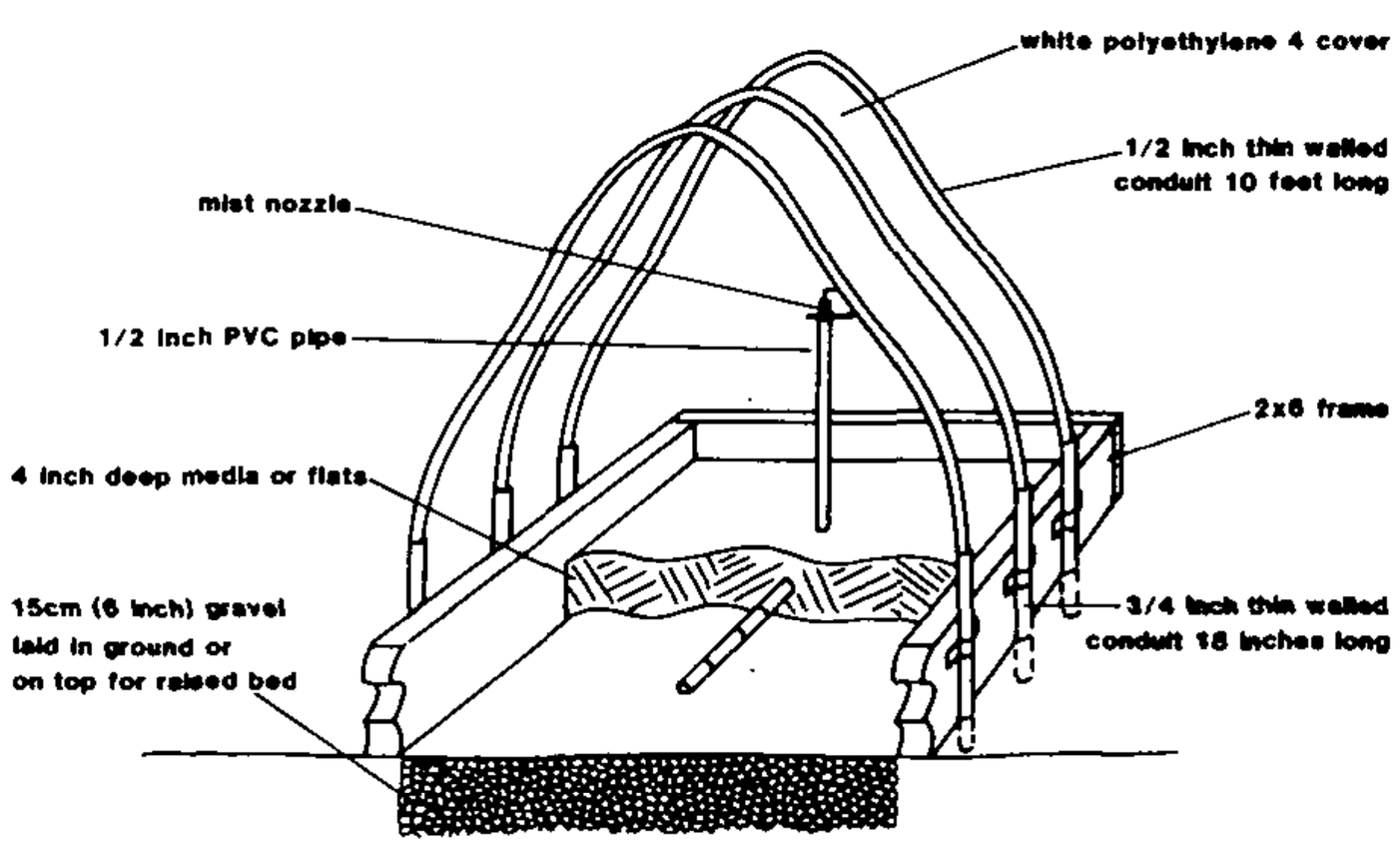

Figure 1. Components of white polyethylene propagating tent.

The frames were set on a 15 cm (6 in) deep base of gravel covered with wire mesh to prevent erosion of rooting medium. Lead heating cables for heating were placed on the mesh with not more than 10 cm (4 in.) between cables. Temperature controls for medium heating were set at 22°C (72°F) maximum. A 10 cm (4 in.) deep 1:1, v/v, mixture of perlite and vermiculite was used as the rooting medium.

An intermittent mist system consisted of Flora Mist nozzles (E. C. Geiger, Harleysville, PA 19438) on 1.3 cm (½ in) vertical PVC pipe 46 cm (18 in.) risers spread 16 cm (2 ft) apart. The mist was regulated by a Mist-A-Matic (E. C. Geiger) near the center of the structure. Water was applied at 40 to 60 psi.

Spray Stakes were attached to a 1.9 cm (¾ in) polyethylene pipe extending along one edge of the frame. Twin Rod Spray Stakes 61 cm (24 in) high were spaced every 76 cm (30 in) in the bed. This system was controlled by a timer which turned the water on for 10 min, 3 times daily at 0800, 1200, and 1700 hr. Heating cables were not used in this treatment.

Sixteen kinds (taxa) of ornamental plants were tested for rooting of cuttings. A group of 12 taxa each year was considered a block and was replicated 5 times in each treatment. Within a block there were 10 cuttings of each taxon, taxa being randomized within each block.

All cuttings taken during the first 2 weeks in June were dipped in a commercial rooting hormone (IBA, 0.1, 0.3 or 0.8% in talc) suited to the species before placing in the bed. Cuttings were considered rooted when at least 1 root, 1 cm long was observed at weekly evaluations.

Temperatures were recorded at 3 hr intervals during August, 1982 at 6 locations throughout the propagating beds. At each position 2 temperatures were recorded, one 7.5 cm (3 in) above the medium and the other embedded in the medium 2.5 cm (1 in) above the heating cable. Temperatures in the tent for typical days were compared with Vermont outdoor temperatures (Fig. 2).

RESULTS

All treatments resulted in 50% or better rooting of most taxa for most years, a percentage we find acceptable for economic nursery production with the systems used. No one treatment consistently promoted better rooting of all taxa over several years. For most species, bottom heat did not consistently increase rooting (Table 1). Bottom heat resulted in a lower rooting percentage for *Viburnum sargentii* 'Onondaga' in 1982 and *Spiraea* × *arguta* 'Compacta' in 1981.

Watering 3 times daily with Spray Stakes gave acceptable rooting of most kinds of cuttings. The surface of cuttings dried between waterings and they became more mature (stems more rigid) under this regime. The more mature cuttings rooted better under Spray Stakes than less mature cuttings. *Juniperus sabina* 'Blue Danube' and *Lonicera* × *bella* cuttings rooted best with Spray Stakes in 1981 when cuttings were more mature

(Table 1). *Berberis, Hydrangea, Cornus,* and *Viburnum* cuttings under Spray Stakes rooted as well as, or better than those under intermittent mist.

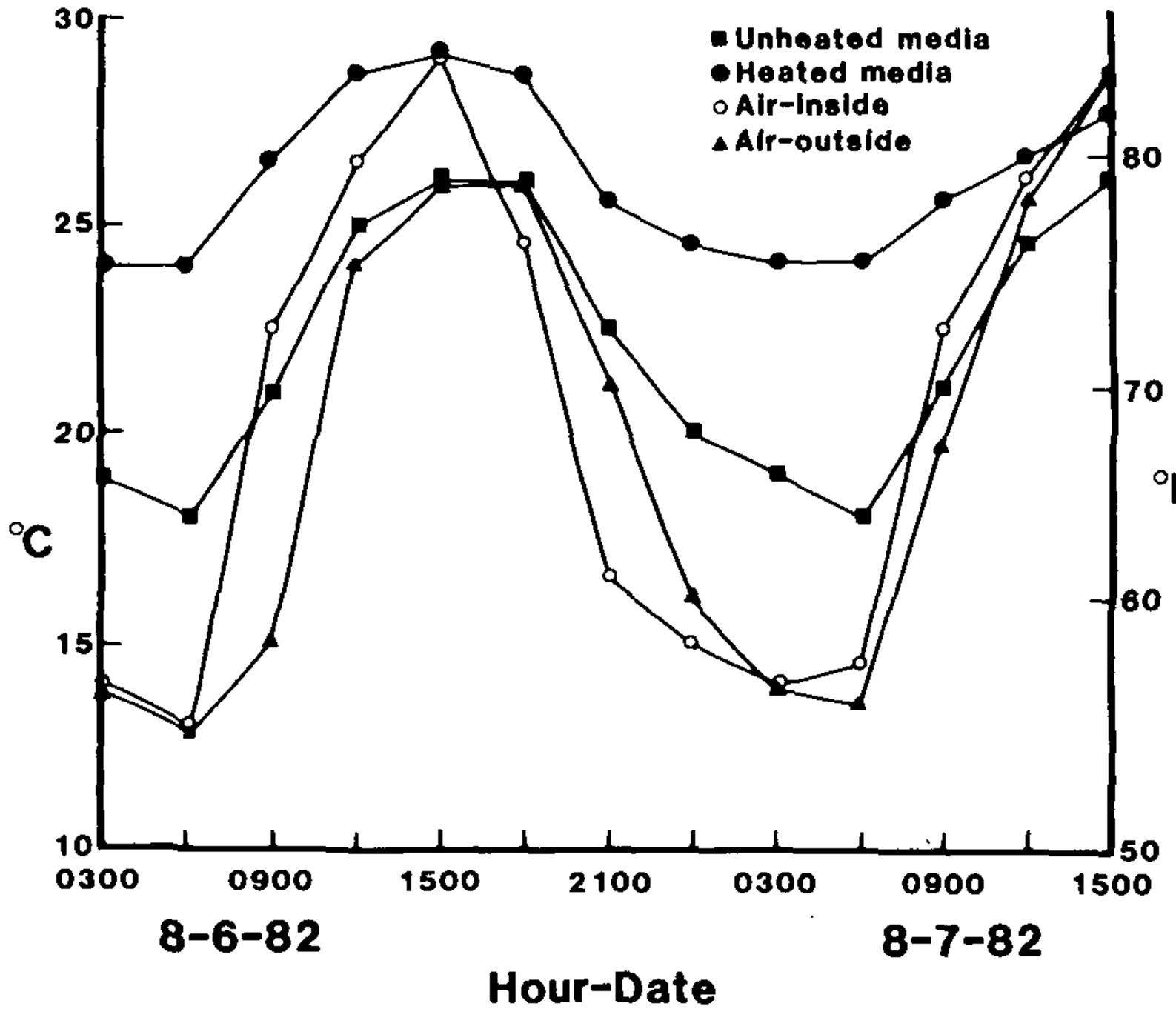

Figure 2. Comparison of rooting media and air temperatures.

Table 1. Effect of mist, with and without bottom heat, and Spray Stakes watering on percent of cuttings rooted under a white polyethylene tent.

Taxon (weeks for rooting)	Mist (no bottom heat)	Mist, (bottom heat)	Spray Stakes
Berberis thunbergii (7)			
1980	100a[1]	94a	100a
1981	62a	64a	96a
1982	96a	86a	—[2]
Cornus sericea 'Isanti' (3)			
1981	92a	60a	75a
1982	94a	63a	—
Euonymus europaea 'Burtonii' (9)			
1982	84a	87a	—
Forsythia mandschurica 'Vermont Sun' (8)			
1982	78a	82a	—
Hydrangea paniculata 'Grandiflora Compacta' (2)			
1980	100a	98a	100a
1981	100a	100a	92a
Iberis 'Alexander's White' (3)			
1980	36a	56a	62a

Table 1. Effect of mist, with and without bottom heat, and Spray Stakes watering on percent of cuttings rooted under a white polyethylene tent (continued).

Taxon (weeks for rooting)	Mist (no bottom heat)	Mist, (bottom heat)	Spray Stakes
Juniperus chinensis 'Hetzii' (9)			
1981	38b	18b	94a
1982	71a	67a	—
Juniperus sabina 'Blue Danube' (8)			
1980	56a	74a	46a
1981	22b	10b	64a
1982	82a	74a	—
Ligustrum vulgare 'Cheyenne' (6)			
1980	38a	66a	13a
1981	86a	72a	92a
1982	90a	66a	—
Lonicera × *bella* (6)			
1980	64a	56a	60a
1981	40b	18b	86a
Pachysandra terminalis (8)			
1982	96a	94a	—
Phlox subulata 'White Delight' (5)			
1981	92a	82a	90a
Prunus × *cistena* (6)			
1980	20a	46a	14a
1981			15
1982	77a	81a	—
Spiraea × *arguta* 'Compacta' (3)			
1980	88a	90a	84a
1981	86a	54b	44b
1982	90a	90a	-
Viburnum lantana 'Mohican' (7)			
1982	90a	78a	—
Viburnum sargentii 'Onondaga' (6)			
1980	100a	100a	75a
1981	80a	77a	90a
1982	98a	59b	—

[1] Means in a row followed by the same letter are not significantly different at the .05 level, Duncan's Multiple Range Test.
[2] A dash indicates no cuttings in that treatment or no date collected.

Variable results from year-to-year appeared to have been affected by vigor of cuttings. Shorter shoot growth of stock plants due to low rainfall prior to cutting appeared to affect rooting response. For example, *Prunus* × *cistena* cuttings gave poorer rooting in 1980 and 1981 than in 1982 when cuttings were more vigorous.

Air temperatures in the tent were comparable to outdoor air temperatures during the night, but during typical sunny

days rose 3° to 5°C higher (Fig. 2) When the outdoor temperature reached 26°C (70°F) on a typical sunny day, the air temperature at foliage level in the tent was 29°C (82°F). Temperatures were warmest at the closed south end of the tunnel and coolest near the open end.

Media temperatures changed rapidly in response to air temperatures (Fig. 2). A typical daily event is shown for August 6, 1982 when between 0600 and 1500 hr, the unheated media temperatures rose from 14°C (57°F) to 29°C (84°F). A minimum temperature between 22° and 24°C (72 to 76°F) was maintained in the heated medium but rose rapidly during sunny periods to temperatures 5 to 6°C above the unheated media. The temperatures of the heated medium were often above 30°C which may be detrimental to rooting of cuttings.

The temperature of the unheated media generally was 1.5° to 3°C warmer at the closed end of the tent than at the open end (Fig. 3). This did not result in detectable differences between rooting of cuttings at either end.

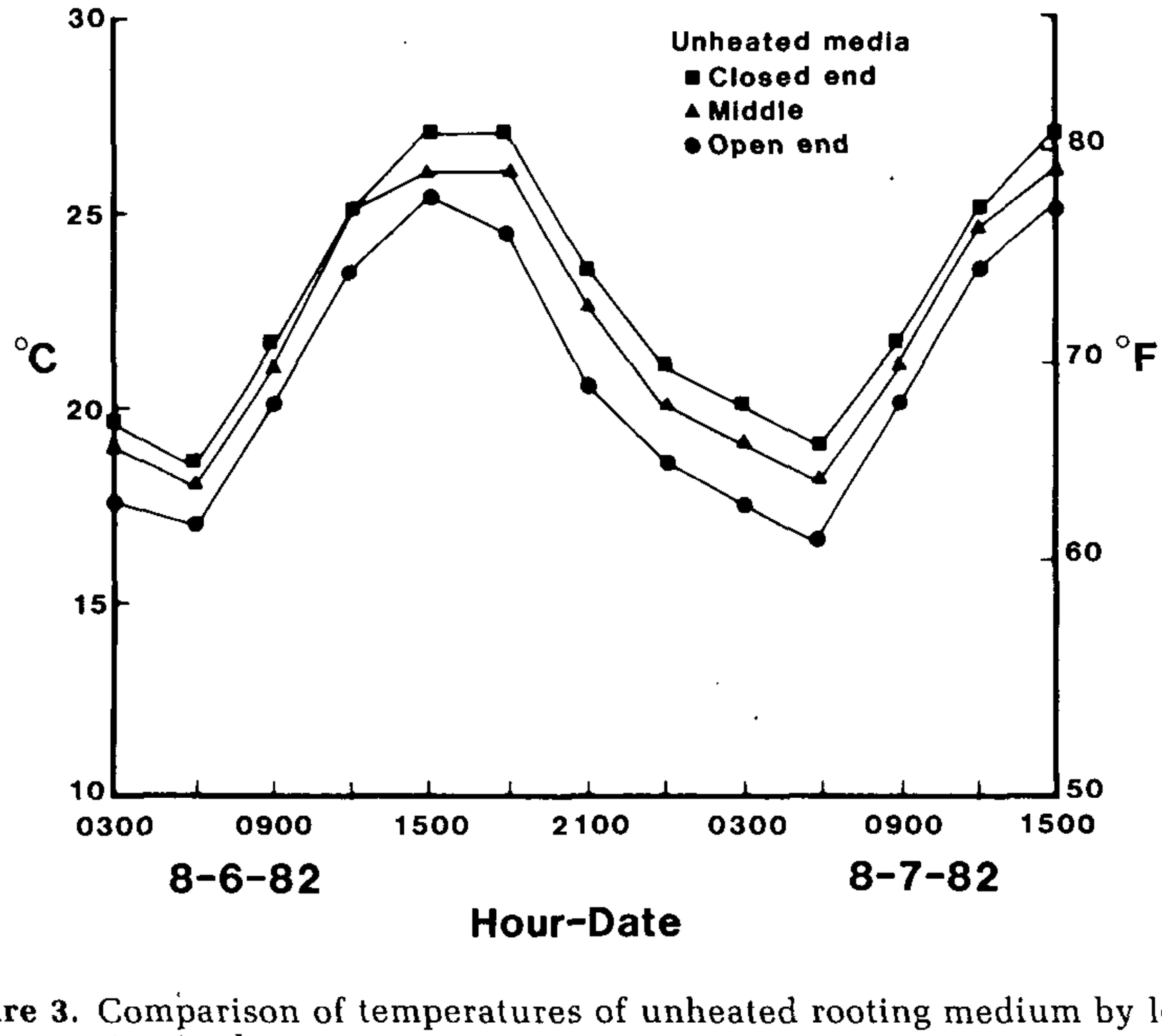

Figure 3. Comparison of temperatures of unheated rooting medium by location in the tent.

DISCUSSION

Summer maximum temperatures in our climate under the white polyethylene apparently were not detrimental to rooting. Burlington, Vermont, temperatures average 26.4°C (79.5°F)

maximum and 16.6°C (59.8°F) minimum during July, the warmest month, with a daily average of 20.9°C (69.7°F) (2).

The white polyethylene tent provided a suitable environment for summer rooting of cuttings using either frequent misting or watering 3 times daily. The polyethylene tent system is useful for small nurseries where supervising personnel often are not present to guard against failure of an intermittent mist system. The polyethylene cover may reduce the loss of cuttings from system failure. The success of 3 daily waterings from Spray Stakes may result in less leaching of minerals from cuttings than frequent misting, although we did not measure mineral content of cuttings.

LITERATURE CITED

1. Haines, S. J., 1980. Sunframes and low polyethylene tunnel propagation. *Proc. Inter. Plant Prop. Soc.* 30: 237-238.
2. Ingram, R. S. and S. C. Wiggans, 1968. Climate of Burlington, Vermont. *Vt. Ag. Exp. Sta. Res.* MP 53.
3. Loach K. and A. P. Gay, 1979. The light requirement for propagating hardy ornamental species from leafy cuttings. *Scienta Hortic.* 10:217-230.
4. Orum, P. and J. Wilde. 1969. A practical system of cold frame propagation. *The Plant Propagator* 15(2): 15-20
5. Pellett, N. E. 1981. Uncommon landscape trees and shrubs; winter survival and performance in Vermont. *Vt. Ag. Exp. Sta. Res. Rep.* 4.

CARMINE RAGONESE: It's hard to believe that you can get good rooting under the white plastic.

NORMAN PELLETT: We have no problem.

HARRISON FLINT: Just a comment on the Mist-A-Matic system. It does not work well in calcareous soils.

CHARLIE PARKERSON: Did you see any differences because of the drying.

NORMAN PELLETT: The spray stake bed got a little warmer, maybe 2°C.

CLAYTON FULLER: Why did you not use clear poly with a little shading to increase the air temperature, which we have found to increase rooting.

NORMAN PELLETT: We just essentially used the same system as Paul Joly, who had good rooting.

GERALD VERKADE: Why was the medium temperature so difficult to control?

NORMAN PELLETT: I am not sure what your experience with thermostats has been, but they appear to be very difficult to control.

HARRISON FLINT: Just a comment on controlling medium temperature with a thermostat. For relatively good control the trick is to keep the sensing unit close to the cable. If you keep the sensing unit too far from the cable, the medium will overheat close to the cable.

DAVE BAKKER: I think we nursery people are often cheap when we buy thermostats. You can buy thermostats with a 1 to 2 degree differential, if you order special.

A COMPARISON OF DIFFERENT HEAT SOURCES IN OUTDOOR MIST BEDS[1]

JOHN J. MCGUIRE, CHARLES G. MCKIEL AND STEPHEN MACDONALD

Department of Plant Science
College of Resource Development
University of Rhode Island
Kingston, Rhode Island 02881

Abstract. A comparison was made of five different unheated or heated insulated outdoor mist systems and a heated greenhouse mist system. Systems were evaluated for seasonal operating and construction costs as well as rooting efficiency of broadleaved and narrowleaved evergreens and deciduous plants. Spring propagation is practical in southern New England and three successive crops could be obtained in a heated outdoor system.

REVIEW OF LITERATURE

Increased cost of fossil fuels has placed plant producers in the U.S. northeast at an economic disadvantage. It has also stimulated research in designing both energy efficient plant production procedures and structures (1,2,3,4,5,6,7,8,10).

Recent studies have shown that it is not practical to attempt to provide all of the heat necessary for propagation from solar energy on an annual basis because of the limited efficiency of present solar energy systems in the north (11). However, it has been shown that such systems can be used to supplement conventional fossil fuel systems with fuel cost

[1] Approved by the Director of the Rhode Island Agricultural Experiment Station, Contribution No. 2170. Research was supported in part by funds from the Hatch Act.