Coverings for Overwintering Container Grown Plants in Northern Regions[1]

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Abstract

Several methods were compared for moderating temperatures and protecting container-grown nursery plants from winter injury. Three layers of microfoam covered by 1 layer of 4 mil white copolymer (poly) and 30 cm (12 in) straw between 2 layers of white poly greatly moderated minimum temperatures of growing medium. The straw-between-white poly treatment prevented rapid rise of air temperatures under the cover in early spring. All covers resulted in minimal winter injury to most plant species, but growing medium temperatures in containers under 1 layer of microfoam or 1 layer white poly dropped below -10°C (14°F), the temperature shown to be injurious to root systems of some plants.

Index words: winter protection, microfoam, winter hardiness, cold hardiness, root injury, winter injury, nursery plants

Introduction

Overwintering is the most limiting factor in container-growing of nursery plants in northern climates. Studies in Massachusetts and New York have shown that roots of container-grown plants are injured between -5 to -20°C (23 to -4°F) (4,7). Based on these studies we believe growers in the northern U.S. or Canada need to prevent container medium temperatures from falling below -10°C (14°F) so that many kinds of nursery plants will not be seriously injured. Unheated, poly-covered houses, useful in many regions for overwintering container-grown plants, seem impractical under heavy snow loads in northern areas where accumulation may exceed 1 m (3.3 ft) in depth. Also, poly houses provided insufficient protection from minimum temperatures to some plants in northern regions (2,5).

One layer of microfoam has proven useful in several northern areas for protecting container-grown plants during winter (1,2,5). Poly film, as either a cover on a poly house or over a supporting frame, has provided protection in areas with milder winters than ours (3,5). When only 1 layer of microfoam or poly was used as a cover, minimum air temperatures dropped below -10°C (14°F) (5). Havis (4) and Steponkus *et al.* (7) observed injury to roots at these temperatures.

We compared blanket covering of container-grown plants to determine which gave the most protection from mid-winter minimum and early spring maximum temperatures. Our research plan recognized several factors: roots in the container medium may be injured by winter minimum temperatures, shoot-growth may occur when temperatures get too high in the spring under covers, and subsequent freezing may injure the forced plants when the covers are removed.

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Materials and Methods

Fourteen or more species were used under covering treatments each year, but the same species were not available every year. The species shown in Tables 1 and 2 are representative of the species compared when winter injury occurred.

During each of 4 years, rooted cuttings of woody nursery crops and herbaceous perennials were rooted in summer and potted in August in 11.3 cm (4.5 in) diameter green plastic containers. The growing medium was 1:1:1 (by vol) of topsoil, peat moss and perlite amended with 5.95 kg (13.1 lb) dolomitic lime and 2.5 kg P (5.5 lb) as superphosphate 0.0N-8.6P-0.0K (0-20-20) per cubic meter of media. Plants were fertilized at every watering with 150 ppm N as 20N-8.6P-16.6K (20-20-20)

In late November, plants in containers were placed tightly together in 1.2 by 1.8 m (4x6 ft) beds and treated as follows:

1. No winter protection.
2. Containers placed upright or tipped on side under a 38 cm (15 in) high supported snowfence frame and covered by 1 or 3 layers of microfoam 0.63 cm (1/4 in) thick, covered with 4 mil white poly.
3. Containers tipped on side and covered with 1 or 3 layers or microfoam and white poly.
4. Containers tipped on side over 1 layer of 4 mil black poly and covered by 1 layer of microfoam and white poly.
5. Containers tipped on side covered with 2 layers of white poly with 30 cm (12 in) fluffed oat straw between layers.
6. Containers tipped on side and covered by 1 layer of 4 mil white poly.
7. Containers tipped on side covered with 1 layer of polyfoam 0.63 cm (1/4 in) thick.

Treatments were replicated in 2 or 3 blocks. Microfoam has a thermal conductivity of 0.27 Btu/hr. sq.ft./°F/in. Microfoam is made by Ametek, Inc., 410 Park Ave., New York, NY 10022. The polyfoam we used had a thermal conductivity of 0.44 Btu/hr.sq.ft./°F/in. Polyfoam is now manufactured by Guilford Packaging and Fiber Inc., P.O. Box 2643, High Point, NC 27261 and sold as Guilbond® insulating blanket. The thermal conductivity of this product is 0.3125 Btu/hr.sq.ft./°F/in.

A white poly cover was used over microform to reflect light and to protect microfoam from wind damage. Polyfoam was not covered because it seemed strong enough to avoid wind damage.

Temperatures in each plot were monitored with a copper constantan thermocouple placed in the center of the container medium, near the center of the bed. At the same location in the bed, air temperatures under the covers were measured among stems approximately 13 cm (5 in) above medium. Outside ambient temperatures were monitored at 38 cm (15 in) height at the site. Temperatures were recorded with a multipoint Honeywell recorder at 6:30 a.m., 1:30 p.m., 5:30 p.m. and 12:00 a.m. daily.

Plants were uncovered in late March or early April when we observed that some treatments caused flower or shoot buds to start growth. Plants were rated for root injury and new growth in May. Ratings are described in footnote, Table 2.

Results and Discussion

The outdoor ambient temperature dropped from -1 to -32 °C (30 to -25 °F) over a 36 hr period in December 1980 (Fig. 1). The air temperature under 1 layer of microfoam covered with white poly was -12 °C (10 °F) and container medium temperature was -9 °C (16 °F) when the outside ambient temperature reached -32 °C (-25 °F). The medium in the pots was frozen at the beginning of this period. Three layers of microfoam covered with white poly moderated air and growing medium temperatures under covers approximately 5 °C (9 °F) more than 1 layer. The growing medium temperature under 3 layers of microfoam was -4 °C (25 °F) when temperature under layer was -9 °C (16 °F).

Many roots of container-grown plants grow on the surface of the growing medium at the interface between the medium and the container. Gouin (3) observed that minimum medium temperature on the outside of the medium was approximately equal to the outside air temperature in midwinter. Accepting this, the roots on the surface of the medium in our study were probably exposed to temperatures nearer the air temperature under covers than the growing medium temperature in the center of the medium.

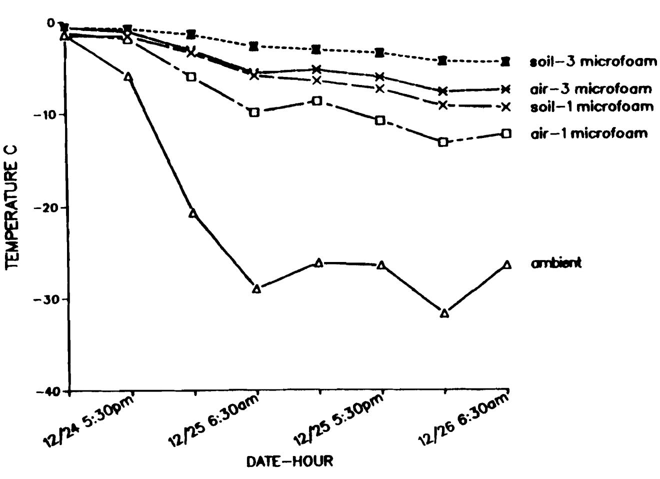

Fig. 1. Air and container media temperatures under 1 or 3 layers of microfoam covered by white poly compared to ambient temperatures, December 1980.

One layer of microfoam occasionally resulted in air temperatures below -10 °C (14 °F) under the cover during the 4 winters. However, one layer of microfoam gave adequate protection to *Thuja, Juniperus* and *Taxus* in containers in Ottawa Ontario (USDA hardiness zone 4b) and to 4 taxa in Truro N.S. (zone 5a) in Canada (2,5).

Havis (4) observed that 20 of the 35 species of container-grown plants he tested had more than 50 percent of their root system killed at medium temperatures higher than -10 °C (14 °F). We don't consider most of these 20 species cold hardy in Burlington, VT (USDA hardiness zone 5a). We have observed that most of the 18 species that Havis reported were root hardy at temperatures below -10 °C (14 °F) grow in nurseries in zone 5a. During the 1980-81 winter, growing medium temperatures were the lowest for any winter in the study. Container medium temperatures under 1 layer of microfoam reached -10 °C (14 °F) on January 15 when minimum outdoor ambient temperatures were -13 to -21 °C (9 to -6 °F) for 5 days. Some plants had severe root injury (Table 1). Unprotected *Phlox subulata* 'White Delight' and *Syringa patula* 'Miss Kim' had vigorous regrowth in the spring with little apparent root injury. Unprotected *Iberis, Ligustrum* and *Viburnum* had severe injury with little regrowth.

In general, the amount of root injury among covering treatments did not differ consistently. There were considerable differences in injury among replicates possibly due to variations in snow cover caused by variable drifting. All covers gave acceptable winter protection for most, but not all, species. *Daphne* exhibited more than 40 percent loss under all covers (Table 1).

Long periods of snow cover and mild winter temperatures protected the plants during the winters of 1981-82 and 1982-83 resulting in no differences in winter injury among covering treatments. Some unprotected plants showed injury after the 1982-83 winter when the minimum container medium temperature reached -15.5 °C (4 °F) on January 4 (Table 2). All treatments were snow covered when colder temperatures occurred after this date.

The 38 cm high (15 in) microfoam covered frames over containers moderated minimum air and container medium temperatures among upright containers better than when containers were tipped over and microfoam laid directly on them (Fig. 2). With frames, 3 layers of microfoam gave about 5 °C (9 °F) more protection (not shown) than 1 layer of microfoam as it did when the covers were laid on tipped over containers. The frame-covered plants, with their higher elevation, were less often covered with snow, which frequently insulates plants in northern regions.

Some growers use black poly under containers for weed control. The growing medium and air tempera-

Table 1. **Percentage of plants with normal spring shoot growth (no winter injury) under several winter covering treatments 1980-81.**

Species	Plants per treatment	1 microfoam, frame, pots upright	1 microfoam, no frame, pots down	3 microfoam frame, pots upright
Berberis thunbergii	32	94a[z]	89a	84a
Daphne x burkwoodii 'Somerset'	40	50a	39a	56a
Hydrangea arborescens 'Grandiflora Compacta'	36	87a	95a	97a
Juniperus sabina 'Blue Danube'	50	91a	95b	82b
Lonicera x bella	35	86a	82a	86a
		No cover, pots upright	**1 microfoam, no frame, pots down**	**3 microfoam, no frame, pots down**
Abies koreana 'Prostrata'	10	0	50	60
Ligustrum vulgare 'Cheyenne'	30	14b	76a	85a
Spiraea arguta 'Compacta'	23	61b	100a	96a
Syringa patula 'Miss Kim'	12	92	86	83
Phlox subulata 'White Delight'	5	100	100	100
Iberis spp. 'Alexander's White'	16	6	100	88
Viburnum rhytidiphyllum 'Allegheny'	8	0	100	—

[z]Means in a row followed by the same letter are not significantly different at the 5% level using Kruskal-Wallis test for non-parametic comparisons (6). Means followed by letters are of 3 blocks. No statistical comparisons were made where less than 20 plants were used per treatment.

Table 2. **Visual ratings[z,y] of overwintering injury to first year container-grown plants from summer rooted cuttings.**

Species	no cover	1 layer microfoam
Abies koreana 'Prostrata'	2.4	3.0
Berberis thunbergii	2.3	2.9
Cornus sericea	2.2	3.0
Daphne x burkwoodii 'Somerset'	1.0	2.8
Euonymus europaeus 'Burtonii'	1.0	2.2
Forsythia mandschurica 'Vermont Sun'	2.7	2.9
Juniperus chinensis 'Hetzi'	1.6	2.6
Juniperus sabina 'Blue Danube'	2.0	2.9
Ligustrum vulgare 'Cheyenne'	2.5	2.8
Pachysandra terminalis	1.3	3.0
Prunus cistena	1.9	2.2
Spiraea arguta 'Compacta'	2.0	2.0
Viburnum lantana 'Mohican'	1.3	2.5
Viburnum sargentii 'Onondaga'	1.8	2.8
Weigela florida 'Pink Princess'	2.5	2.8

[z]Ratings made 5-21-83 where 1 = severe root damage or death, little or no top growth; 2 = restricted regrowth of tops, damage to some but not all surface roots; and 3 = vigorous regrowth of tops, no surface roots injured.

[y]Means of 2 blocks (replicates).

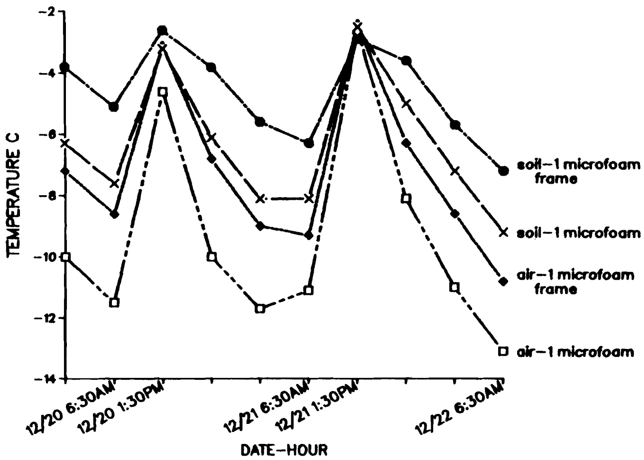

Fig. 2. **Comparison of air and container medium temperatures under 1 layer of microfoam covered by 4 mil white poly when containers were upright under a 38 cm (15 in) high frame supporting covering (1 microfoam frame) or when containers were tipped over the directly covered (1 microfoam). December 1981.**

tures for containers on black poly dropped more quickly in response to falling air temperatures than containers on the bare soil when both were covered with 1 layer microfoam and white poly (Fig. 3). The black poly probably prevented the warming effect of radiation from the soil under the containers.

Straw between 2 layers of white poly kept temperatures of the growing medium at -1.5 °C (29 °F) when the outside air reached -24 °C (-11 °F) (Fig. 3). In general, the straw between 2 layers of poly gave approximately the same minimum temperature moderation as 3 layers of microfoam. One layer of polyfoam cover resulted in approximately the same minimum growing medium temperatures as 1 layer of microfoam.

The white poly cover gave less growing medium and air temperature moderation than other covers. When container medium temperatures under white poly fell below -12 °C (10 °F), the container medium temperature under 1 layer microfoam covered with white poly was approximately -5 °C (23 °F) (Fig. 3).

High temperatures under transparent or translucent covers caused by the greenhouse effect may stimulate plants to lose cold hardiness and begin growth. One of the difficulties with thermoblankets is determining when

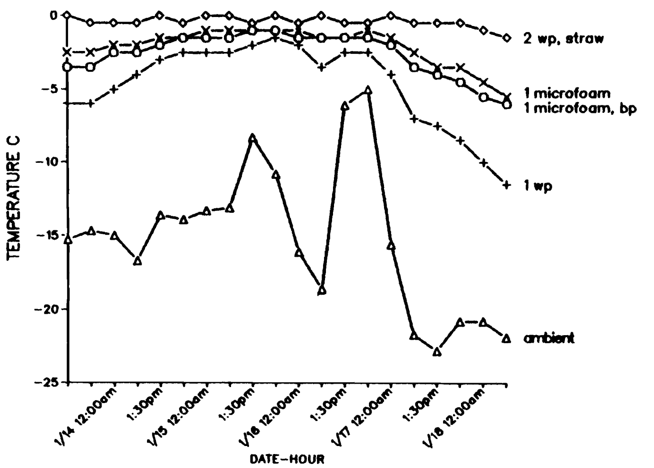

Fig. 3. Ambient temperatures and container medium temperatures under 1 layer of white poly (1 wp), 30 cm (12 in) deep straw between 2 layers of white poly (2 wp, straw), 1 layer of microfoam with (1 microfoam, bp) and without black poly (1 microfoam) under containers, January 1982. Containers were tipped on side and covered.

to remove them in the spring. Air temperatures under 1 and 3 layers of microfoam covered with white poly were 5 °C (9 °F) higher than the ambient temperatures while air temperatures under straw between 2 layers of white poly were lower than ambient air temperatures on a sunny day, April 2, 1983 (Fig. 4A). Air temperatures under 1 layer of microfoam covered by white poly, and 1 layer of white poly alone, were 18 °C (64 °F) and 21 °C (70 °F), respectively, when the ambient temperature was 9 °C (48 °F) (Fig. 4B). Air temperatures under polyfoam were 40 °C (104 °F) at the same time.

When the covers were removed on April 9, 1983, two early spring flowering species, *Spiraea arguta* 'Compacta' and *Forsythia mandschurica* 'Vermont Sun,' were observed for flowering. *Forsythia* under plant foam were in full flower, while florets of *Spiraea* were visible. Plants under 3 layers of microfoam covered by white poly and under straw between 2 layers of white poly were the least advanced with only slight evidence of bud swell.

Significance to the Nursery Industry

Although plants growing in containers may grow twice as fast as similar plants under field production, overwintering of container-grown plants in northern areas can be a severe limitation. Our observations coupled with those in other northern areas (1,2,3,5) demonstrate that 1 or more layers or microfoam are useful for winter protection of container-grown nursery crops. One layer of white poly alone is insufficient protection for prevention of winter temperatures injurious to roots of many species. Straw or hay between layers of poly may be useful in northern areas where grain and dairy farms are a source of fibrous material that provides dead air space between poly sheets.

Polyfoam provided moderation of minimum temperatures equal to microfoam. When used without white poly covering, early spring temperatures under the

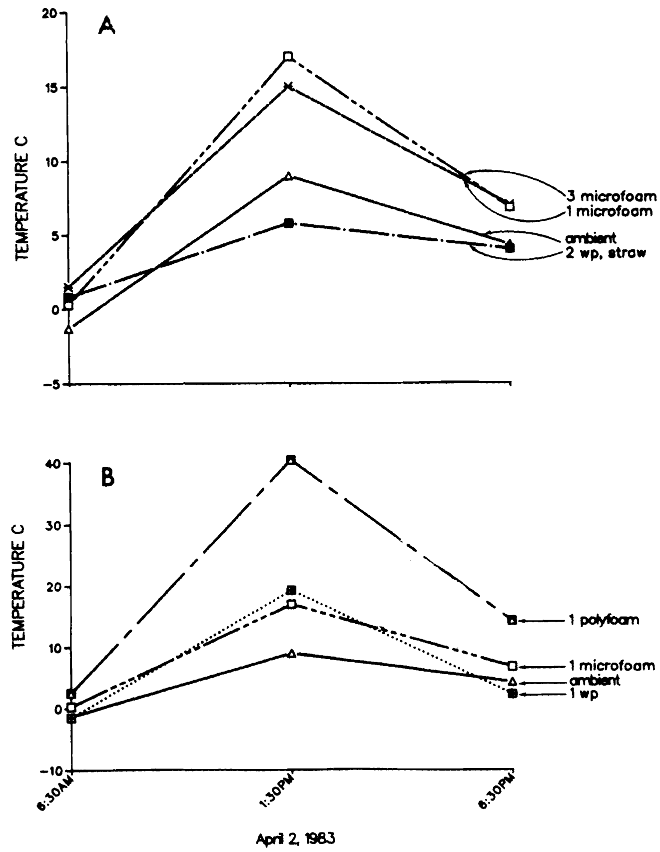

Fig. 4. Comparison of ambient temperatures in early spring with air temperatures under: (A) 1 or 3 layers of microfoam (1 or 3 microfoam) covered by white poly, 30 cm high (12 in) straw between 2 layers of white poly (2 wp, straw) and, (B) one layer of polyfoam, 1 layer of microfoam covered by white poly (1 microfoam), and 1 layer of white poly (1 wp). Containers were tipped on side and covered.

cover were unacceptably high. The Guilbond® polyfoam insulating blanket mentioned earlier, has a bonded white poly film on the surface which may reflect light and prevent the high spring temperatures.

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