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PROTECTING CONTAINER-GROWN NURSERY STOCK WITH COVERS DURING SEVERE WINTER CONDITIONS

Introduction

The winter storm that seized the Pacific Northwest early in February, 1989, will long be remembered by nursery and greenhouse operators. In Oregon's Willamette Valley, nurseries reported temperatures below 5°F (the lowest reported temperature was -6°F) accompanied by northerly winds up to 30 MPH. Snow cover ranged from two to 14 inches with the greatest amounts accumulating in the southern and western regions. This freeze event followed a mild December and January with fluctuating temperatures that could have initiated the deacclimation process. A wide range of container-grown and field-grown nursery stock was severely damaged by low temperatures and winter desiccation. In general, container-grown plant material protected with winter covers through February 15 survived the best.

At Hermiston, air temperatures dropped to -13°F

In Oregon's Willamette Valley, extreme winter conditions usually persist for only a few days which necessitates opening the protective coverings for cooling and watering of the plants during warm periods. The most frequently used winter protection system is the quonset-shaped structure covered with a single layer of polyethylene film. Film-coverings with low light transmission, such as white polyethylene or white copolymer, reduce daily temperature fluctuation and result in higher quality plants (Smith, etal., 1977).

Alternative winter protection systems, such as structureless polyethylene film, thermal blankets, and nonwoven fabric covers, are sometimes used by growers (Green and Fuchigami,1985; Smith 1984). In an earlier study, nonwoven fabric covers were reported to have potential for protecting container-grown ornamentals; it was suggested that the overwinter protection potential of nonwoven covers be evaluated under more severe winter conditions (Regan, etal., 1987). To cover plants for a short-term only during conditions when winter damage is likely is another alternative. This practice is labor-intensive, requires additional handling of covers, and mechanization.

Winter protection systems were evaluated during the 1988-89 winter at two sites in Oregon, the North Willamette Experiment Station in **Aurora** and the Hermiston Agricultural Research and Extension Center in **Hermiston**. Hermiston (USDA Hardiness Zone 6) was selected as a trial site because more extreme winter conditions occur there than at Aurora (USDA Hardiness Zone 7).

Air temperatures at the Hermiston station during this recent freeze dropped to -13°F with northeast winds at eight to 15 MPH. Only 112 inch of snow was present offering no protection for container-grown plants.

Materials and methods

Covering Materials: Two poly films (clear poly, white copoly), two nonwoven fabrics (N-Sulate™, Typar™), and one thermal blanket (Microfoam™) were evaluated.

The nonwoven fabrics, **N-Sulate™**and **Typar™** ('*floating row covers'*), are made of lightweight, spunbonded polypropylene (N-Sulate™ 1.25 oz./sq.yd. and Typar™ 1.9 oz./sq.yd.). These white-colored covers are partially permeable to water and air.

The poly films tested were 4-mil **clear polyethylene** and 4-mil **white copolymer**.

Microfoam™ is a layer of flexible, closed-cell polypropylene laminated with 4-mil UVI white polyethylene. The Microfoam™ cover used in this study was 1/4 inch in thickness.

Light Transmission of Covering materials: Clear polyethylene films transmit less than 85 percent of sunlight (Aldrich and Bartok., 1989). The plots covered with N-Sulate™, Typar™, white copoly, or Microfoam™ were darker than those covered with clear poly. Winter protection studies in Ohio indicate that light transmission by white copolymer and Microfoam™ covers is very low (Smith, etal., 1977; Rizzo, etal., 1979).

Test Plants: Plants were potted the spring of 1988 in one gallon containers using half inch minus Douglas-fir bark amended with 20 lbs. North Willamette Container Mix/Cu.Yd.: *Cotoneaster dammeri, Cytisus purgans, Erica herbacea, Euonymus fortunei* 'Colorata', *Ilex cr*enata 'Convexa', *Juniperus horizontalis `Wiltonii', Mahonia aquifolium*, *Rhododendron* `Vulcan', *Thuja occidentalis* Pumila', *Viburnum X burkwoodii* .

Hermiston Experiment: During Fall 1988, dormant plants were randomly selected and moved to the Hermiston site where they were arranged can-tight into four plots comprised of four plants of each species. **Three structureless cover treatments, N-Sulate™, Typar™, and Microfoam™, were pulled on November 1, 1988, and remained in place until March 1, 1989.** One plot remained uncovered for comparison.

Aurora Experiment: At Aurora in Fall 1988, four groups of plants were arranged into 20 plots at the North Willamette Experiment Station. Each plot contained eight *Rhododendron* `Vulcan' and five each of the remaining species. **Structureless N-Sulate™ and Typar™ were pulled snug over the plants and secured with lumber. The poly house was covered with white copoly from November 15, 1988, through February 13,1989. The fourth cover treatment was structureless clear polyethylene which temporarily covered plants during the freeze event from February 2 through February 9.** Microfoam™ structureless covers were not evaluated at Aurora. The unprotected plants were not covered at any time during the study, although 4 inches of snow did accumulate during the first part of the storm. Each of the five treatments were replicated four times in a randomized complete block design.

At both Hermistom and Aurora, temperatures were recorded in the center of each treatment plot. Air temperatures in the plant canopy and container medium temperatures were monitored using thermocouples located at two to three inch depth in the medium and within the plant canopy.

Roots and shoots of all plants at Hermiston were evaluated for cold injury 15 to 65 days after the covers were removed (Table 3): 1 = no visual injury; 2 = up to 33% injury; 3 = up to 67% injury; 4 = up to 100% injury. Plants were temporarily removed from their containers to observe the exterior roots.

On April 19, 1989, plant materials at the Aurora site were evaluated for survival and classified into three groups (Table 4): a) plants showed no visual cold damage symptoms and were in good vigor; b) plants showed some winter damage; or, c) plants were dead.

Results

Temperatures

Although temperatures were recorded for the majority of time the covers were in place, only data during the freeze event are presented. For Hermiston, these data were collected February 3 to February 20, and from February 2 through February 9 for Aurora.

Hermiston: Plant canopy air temperature fluctuated the least under the Microfoam™ cover and the most under the nonwoven fabrics (**Table 1**). The Microfoam™ also had the warmest minimum temperatures with a low of 9ºF. The absolute lowest air canopy temperature recorded was -18°F for the uncovered plants. Mean and absolute maximum temperatures were greatest under the N-Sulate™ cover with a high of 88°F.

Table 1. Effect of covering materials on plant canopy air temperature at Hermiston, February 3 - 20, 1989.

	Temperature Extremes (°F)		Mean Temperatures (°F)	
Treatment	**Max.**	**Min.**	**Max.**	**Min.**
Microfoam™	57	9	36.5	18.9
N-Sulate™	88	-2	57.1	15.6
Typar™	77	-9	52.1	13.2
No Cover	55	-18	37.5	9.6

Container medium temperature was the warmest and fluctuated very little under the Microfoam™ cover with a recorded low of 18°F **(Table 2).**

Container medium temperature was the warmest and fluctuated very little under the Microfoam™ cover Microfoam™ also had the warmest minimum temperatures.

Absolute and mean minimum container temperatures under the Typar™ cover were very similar to the uncovered check; those under N-Sulate™ were slightly warmer. The lowest recorded container temperature, -6°F, occurred in both the Typar™ and uncovered check.

Table 2. Effect of covering materials on temperature of container medium at Hermiston, February 3-20, 1989.

	Temperature Extremes (°F)		Mean Tempera-tures (°F)	
Treatment	**Max.**	**Min.**	**Max.**	**Min.**
Microfoam™	27	18	26.0	25.0
N-SulateT™	28	5	22.9	19.4
Typar™	39	-6	29.3	17.0
No Cover	25	-6	19.0	16.5

Aurora: Mean maximum air and container temperatures were highest under structureless clear poly. Plant canopy air temperature fluctuated the most with clear poly and the least under the white poly house. Mean minimum temperature was the warmest under the white poly house and clear poly with a recorded low of 19 and 22°F, respectively. The lowest recorded plant canopy air temperature was 8°F for the uncovered check. Minimum temperatures under the N-Sulate™.cover were slightly warmer than those recorded under the Typar™.

Minimum container medium temperature under structureless clear poly and whitepoly house did not drop below 28°F The lowest recorded temperature was 14°F for uncovered containers. There were no differences between minimum temperatures in containers covered by N-Sulate™. and Typar™.; they were only slightly warmer than uncovered plants.

Plant canopy air temperature fluctuated the most with clear poly.

Plant Injury and Survival

Hermiston: Plants covered by the Microfoam™ had the least amount of root and shoot injury (Table 3). N-Sulate™ and Typar™ were not effective in protecting the cold sensitive plants tested.

Plants covered by Microfoam™ had the least amount of root and shoot injury. N-Sulate™ and Typar™ were not effective.

Juniperus horizontalis 'Wiltonii' and *Thuja occidentalis* `Pumila' were not severely damaged under any of the covers or the uncovered check.

Table 3: Shoot and root injury ratings, Hermiston, 1988-1989

	INJURY RATING [Z]							
	Microfoam™		**N-Sulate™**		**Typar™**		**No Cover**	
PLANT	*shoot*	*root*	*shoot*	*root*	*shoot*	*root*	*shoot*	*root*
Cotoneaster	2.0	3.5	4.0	4.0	4.0	4.0	4.0	4.0
Cytisus	1.0	2.0	2.2	3.8	4.0	4.0	4.0	4.0
Erica	1.5	1.8	4.0	4.0	4.0	4.0	4.0	4.0
Euonymus	1.2	3.0	3.2	4.0	4.0	4.0	4.0	4.0
Ilex	2.2	3.8	4.0	4.0	4.0	4.0	4.0	4.0
Juniperus	1.0	1.5	1.0	2.2	1.0	1.8	1.0	1.8
Mahonia	1.8	3.0	4.0	4.0	4.0	4.0	4.0	4.0
Rhododendron	1.2	1.8	3.0	4.0	4.0	4.0	4.0	4.0
Thuja	1.0	1.2	1.0	1.2	1.0	1.2	1.0	1.2
Viburnum	1.0	1.8	4.0	4.0	4.0	4.0	4.0	4.0

[z]Root and shoot injury was rated on April 5, 1989. 1 = *no* injury; 2 up to 33% injury; 3 = 33-67% injury; 4 = 67-100% injury

Plant survival was not recorded at Hermiston, but it was estimated that at least 95% of the plants under the Microfoam™ cover suffered no winter damage or loss in vigor. Plant loss under the nonwoven covers and uncovered check was nearly 100%, except *Juniperus horizontalis* 'Wiltonii' and *Thuja occidentalis* `Pumila.

Aurora: Plant survival was affected by the different cover materials tested at this site (Table 4).

Table 4. Effect of cover treatments on plant survival at Aurora, 1988/89.

	SURVIVAL PERCENTAGE[Z]				
Plant	**Poly House**	**Clear Poly**	**N-Sul-ate™**	**Typar™**	**No Cover**
Cotoneaster	85.9c[y]	71.7 c	36.0 b	5.0 a	0.0 a
Cytisus	100.0 c	100.0 c	70.8 b	65.8 b	0.0 a
Erica	90.0 d	95.8 d	48.3 c	25.0 b	0.0 a
Euonymus	100.0 b	90.0 b	65.0 b	20.0 a	0.0 a
Ilex	78.8 b	75.0 b	20.0 a	5.0 a	0.0 a
Juniperus	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
Mahonia	90.0 d	75.0 cd	60.8 c	27.5 b	0.0 a
Rhododendron	68.5 c	62.5 c	31.2 b	22.0 b	0.0 a
Thuja	100.0 a	85.0 a	95.0 a	90.0 a	100.0 a
Viburnum	95.8c	95.0c	60.8bc	30.8ab	0.0a

[Z] Percent of plants surviving with no visual damage symptoms and in good vigor 70 - 105 days after freezing.
[Y] Mean separation within columns by Duncan's multiple range test, 5% level.

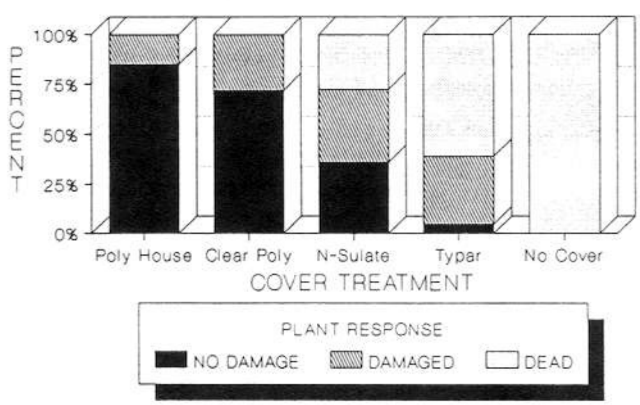
At Aurora, the poly house and clear poly cover treatments were superior in protecting those species that did not survive in the uncovered check. Although overall plant survival was better under the nonwoven fabrics compared to the uncovered control, most of the percentages were significantly lower than the poly films. N-Sulate™' protected *Cotoneaster dammeri*, *Erica herbacea, Euonymus fortunei* 'Colorata', and *Mahonia aquifolium* better than did Typar™.

Discussion

Cover treatments did influence the amount of plant injury of the species used in this study during extreme winter conditions. At Aurora, the poly house covered with white copolymer and short-term covering with clear polyethylene protected plants better than the nonwoven fabric covers. At Hermiston, the structureless Microfoam™ provided greater protection than did structureless N-Sulate™ or Typar™.

Differences in the amount of winter injury among plant species can, for the most part, be explained by their respective root killing temperatures and degree of protection under the various covers.

Figure 1. Effect of cover treatment on survival of *Cotoneaster dammeri*.

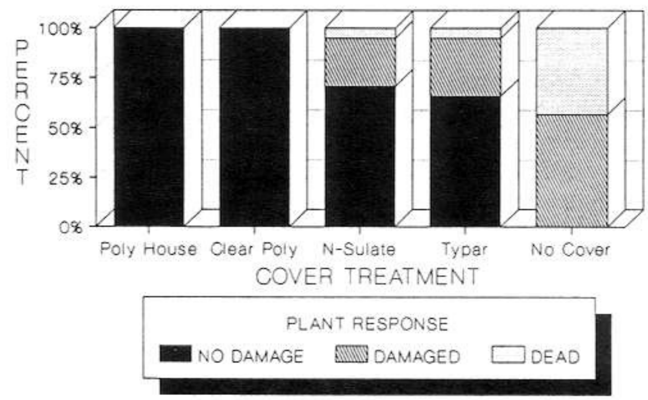


Cotoneaster dammeri was dramatically affected by cover type **(Figure 1).** The root killing temperature for *Cotoneaster dammeri* is reported to be about 23°F (Green, 1988). Container medium temperature during the freeze at Aurora under no cover was below 20°F for 62 hours, killing 100% of the *Cotoneaster.* Survival was significantly greater when protected by the poly house or clear poly treatments where there were as few as four hours under 20°F The nonwoven fabric covers were not very effective in protecting *Cotoneaster dammeri.*

At Aurora, the nonwoven fabrics did significantly increase the survival *of Cytisus purgans* (**Figure 2**). The root killing temperature for this species is not listed (Green, 1988), although *Cytisus praecox* is reported to be 16°F The lowest recorded minimum container medium temperature for both N-Sulate™' and Typar™' was 17°F

Root and shoot hardiness at the time of a freeze event will affect the plants ability to survive cold injury. Warm temperatures and those that fluctuate widely can initiate the deacclimation process. If this occurs, plants can be damaged at a higher temperature than if they were at full hardiness. Although there is little information about the effect of winter protection systems on plant hardiness, covers in this study did differ regarding this aspect.

Figure 2. Effect of cover treatment on survival of *Cytisus purgans.*



If used for long-term protection, the warm, fluctuating temperatures under the clear poly cover should be of concern to growers. Microfoam™ and poly films with lower light transmittance, such as white copolymer, should offer greater safety in case the cover must remain in place for a longer period of time.

Summary

The type of winter protection system used will influence the amount of plant damage. This study showed that nonwoven fabric covers were not very effective in protecting susceptible plant species under extreme winter conditions. The most effective systems and covers evaluated were structureless Microfoam™ (evaluated at Hermiston only) and the poly house covered with white copolymer and temporary, structureless clear polyethylene (evaluated at Aurora only).

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