



## Overwintering Perennials in Containers

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*The first grant from the New Hampshire Horticulture Endowment Fund was awarded for a UNH project that quantified the effect of different overwintering environments on survival of perennial species grown in containers. This project was based on two years of trials at Van Berkum nursery in Deerfield, NH and a further year of experimentation at the University of New Hampshire, Durham NH. This report summarizes results from the trials, and provides some take-home messages for perennial growers.*

In many New England nurseries, containerized perennials are overwintered under a synthetic cover material, which is placed either outside or inside an unheated tunnel greenhouse. Other growers provide more reliable, but also more expensive, protection inside minimally-heated double-poly greenhouses with a heating setpoint around 28-32°F. Finding the most cost-effective way to prevent winter injury and reduce losses is a challenge. Researchers, including at UNH, have previously run experiments in northern conditions where plant survival has been measured. Results from our previous trials at Van Berkum Nursery in Deerfield NH were reported in *The Plantsman* Aug/Sept 1999 edition.

In 1999-2000 we expanded on past research by measuring plant survival from replicated (i.e. statistically repeated) plots with different coverings at the UNH Woodman Farm. We also recorded complete climatic data (solar radiation, wind speed, air temperature, ground temperature) to compare against the container temperatures. Our goals were (1) To be able to predict the temperature of container media, given the outside air temperature and the amount of cover provided, and (2) To quantify survival of perennial species under different covers.

### Research methods

Five species were tested: *Aquilegia chrysantha* 'Yellow Queen', *Asclepias tuberosa*, *Dicentra eximia*, *Lobelia cardinalis*, and *Phlox paniculata* 'David'. Transplants of each species

were planted individually into 2.5 qt. square plastic pots with Fafard #51 media in Aug. 1999, except for *Aquilegia* which was planted the previous year (Aug. 1998).

After hardening-off plants in an unheated greenhouse at the UNH Woodman Farm in Durham NH during November, on Nov. 29 1999 we placed each plant under one of four blanket treatments:

1. No Blanket
2. Tytar: a single layer of Tytar spun-bound polypropylene
3. Single Foam: a single laminated polyethylene foam (The Winter Blanket™, 3/8 inches thick), or
4. Double Foam: two layers of laminated polyethylene foam (The Winter Blanket™, 3/8 inches thick)

These 6 ft. x 6 ft. blanket treatments were placed either outside on the bare soil, or inside an unheated 34 ft. x 14 ft. high-tunnel greenhouse covered in 4-mil white plastic. Plants were watered 5 days before covering, and were not watered for the remainder of the experiment until they were uncovered on Mar. 21 2000. Covers were lifted once each month to weigh pots and download loggers, and the media did not decrease in average weight (i.e. did not dry out) during the winter period. Whenever we lifted covers, we also replaced snow cover afterwards.

Each of the eight combinations of type of blanket and greenhouse/no greenhouse were repeated three times (i.e. we had three physically

separate outdoor soil areas, and three covered greenhouses). Under each 6 x 6 ft. blanket treatment, there were four pots per species. Small HOBO™ data loggers recorded air and soil temperatures every hour in each environment. A weather station also collected light, air temperature, and wind speed, and we recorded snow depth every week and each time it snowed (which did not happen until Jan. 13). Between Mar. 30 and June 21 2000, every 2-3 weeks we recorded whether each plant had emerged, and its maximum height from the soil.

### Temperatures

Figure 1 shows the lowest (1A) and highest (1B) temperatures recorded over the entire winter in each year. “Air temperature” is shown, along with media temperatures under four levels of protection:

- “No blanket” = outside without cover
- “Single foam” = covered with a single layer of laminated polyethylene foam (The Winter Blanket™, 3/8 “ thick)
- “Double foam” = two layers of laminated polyethylene foam. During 1997-98 and 1998-99 this treatment combined a layer of laminated polyethylene foam and a fleece material, compared with two layers of the laminated polyethylene in 1999-00.
- “Unheated greenhouse + single foam” = inside a greenhouse and covered with one layer of foam).

Compared to the past two years of trials, 99-00 had similar low winter air temperatures to 1998-99 (Figure 1A). 99-00 also had the highest winter media temperatures (Figure 1B), and the biggest daily range (maximum – minimum temperature (Figure 1C)). This winter showed the greatest variability in temperatures (Figure 2) with both warm and cool periods and also some warm days combined with cool nights.

1999-00 was a fairly good year for an overwintering trial, because of both the potential for freeze/thaw damage, and cool minimum

temperatures. Daily minimum air temperature dropped to below zero Fahrenheit for several days in mid-January (Figure 2), which was more severe and prolonged than in the two previous trial years. Despite the cool January weather, however, continuous cover after January 13 (Figure 2) meant that media temperatures in unprotected (“No blanket”) containers tended to be slightly higher than the past two years (Figure 1).

### Predicting Soil Temperatures Under Different Covers

Using data from all three years, from days where there was no snow cover, we can estimate the minimum daily media temperatures recorded inside unprotected containers, based on minimum daily air temperature (Figure 3). When air temperature was above freezing, media temperature tended to be below minimum air temperature (probably caused by evaporative cooling). In contrast, the insulating property of media and soil water (which buffer temperature change) meant that when air temperature was below freezing, media was slightly warmer than air temperature.

Table 1 predicts minimum daily media temperatures based on temperature data from three years, on days when there was no snow cover. You can use this table as a guide to the temperature that would probably be found in media under different levels of covering, given the minimum air temperature. For example, on days when the outside minimum air temperature was 0°F, our data showed a minimum temperature in unprotected containers of 6°F, and 30°F under single foam.

Our trial data showed that media temperatures can easily be 10°F higher than in Table 1 if media have several inches snow cover, for a given air temperature. In sites exposed to high wind speed, loose covering allowing heat to escape, or where media is dry and is less buffered to change in temperature, media temperatures may drop to a lower temperature than in Table 1.

Table 1. Minimum daily soil temperatures (°F) recorded in relation to minimum daily air temperatures. Data are statistical averages taken from three years of experimentation in New Hampshire (except treatments indicated with an asterisk \*, which are based on 1999-00 only).

Minimum Outside Air Temperature (°F)	No Greenhouse				Inside Unheated Greenhouse			
	No Blanket	Typar*	Single Foam	Double Foam	No Blanket*	Typar*	Single Foam	Double Foam*
-7	-3		26	30			31	
0	6	21	30	31	25	31	31	32
10	17	27	30	31	28	32	32	34
20	25	31	31	32	32	34	33	36
30	31	33	33	34	34	37	34	39
40	35	33	35	38	37	41	37	42

\*1999-00 data only. Air temperature only dropped to a minimum -2°F during 1999-00 on days without snow cover. Media temperatures are therefore not estimated down to -7°F for these cover treatments.

### Plant Growth and Survival

Figure 4 shows the survival under all of the eight blanket/greenhouse combinations. Not surprisingly given the minimum temperatures shown in Table 1, increasing thickness of the blanket had a consistent trend towards higher plant survival. Plants inside the greenhouses under each type of covering tended to show better survival than containers placed outside for the more tender species (*Aquilegia*, *Asclepias*, and *Lobelia*).

Increasing the amount of cover tended to produce larger plants, especially early in the season. For example, on April 27, *Dicentra* and *Phlox* grown inside greenhouses and under single foam were twice the height of plants grown without any cover. These height differences disappeared over time as the plants grown under cooler conditions “caught up”, and by mid-May surviving plants from all treatments were a similar height.

Comparing this winter’s results against the past two winters, survival of *Asclepias* was poor

in both 1998-99 and 1999-00 under all coverings. 1997-98 was a particularly mild winter, and all plant species survived well under single foam, double foam, or an unheated greenhouse. During 1999-00, survival of *Lobelia* was poor under all conditions, whereas survival of *Aquilegia* and *Dicentra* was excellent under cover. *Phlox* had the highest survival of all species (80%) under no cover, and survival increased slightly with increasing cover.

Table 2 shows the average survival under four conditions over three years for these two species. Interestingly, there was no advantage between single foam, double foam, or the unheated greenhouse with single foam: all conditions provided around 75% to 80% survival. Our trial during 1999-00 (Figure 4), which had a larger number of samples and covering combinations than in previous years, however, did show a more clear trend in favor of placing plants under greenhouse cover than past trials.

Table 2. Average Percent Survival under four levels of covering over three years in Deerfield NH (1997-98 and 1998-99) and Durham NH (1999-00).

	No blanket	Single foam	Double foam	Unheated greenhouse + single foam
<i>Aquilegia</i>	0	87	93	90
<i>Asclepias</i>	7	48	45	52
<i>Dicentra</i> <sup>1</sup>	42	94	94	82
<i>Lobelia</i>	0	53	72	62
<i>Phlox</i>	48	97	94	91
<b>Average of species</b>	19	76	80	75

<sup>1</sup>*Dicentra* was not trialed during 1998-99.

### Conclusions and Take-Home Messages

Table 1 can be used as a guide to estimate the minimal media temperatures that are likely to arise given the outside air temperature and covering material.

For several perennial species (*Aquilegia*, *Dicentra*, and *Phlox*) survival was excellent under foam cover. In our trials over three years, providing single foam was highly effective at protecting these plants. In locations where air temperatures are likely to fall to  $-10^{\circ}\text{F}$ , or where land is exposed to high winds, consider using a double foam layer or placing plants inside an unheated greenhouse under foam.

Survival of other perennial species that were prone to overwintering losses (*Asclepias* and *Lobelia*) was poor under unheated conditions regardless of the number of foam layers or whether plants were inside an unheated greenhouse. For these crops, consider overwintering in a minimally-heated double-poly greenhouse. Van Berkum Nursery is overwintering of *Asclepias* and *Lobelia* for the first time on a large scale using minimal heat this year, and reliable figures are not yet available for survival under these conditions. When minimally-heating a greenhouse, perennial growers set the heating thermostat in the range of  $28\text{-}32^{\circ}\text{F}$ , and the optimum set point should be trialed for your own crop mix. Ensure that day temperatures are cool enough so that (a) plants do

not develop too rapidly in early spring to the point that they peak early or (b) are susceptible to rotting while still under cover, and design the greenhouse to provide adequate active (fan-driven) or passive ventilation.

For species that are especially tender, consider purchasing plant material in the late winter/early spring so that you avoid needing to overwinter plants. Tina Smith of U.Mass. extension notes that while cost to the producer for these pre-finished plants are high, overwintering costs are avoided and there is minimal risk of plant loss.

Typar was the cheapest material tested ( $\$0.036/\text{square foot}$ ) but provides the least amount of protection of the fabrics tested, and is reusable for about 3 years. Laminated polyethylene foam (The Winter Blanket<sup>TM</sup> was the brand we used in this study) costs around  $\$0.32$  per square foot and can be reused for 4-5 years, according to Chris Laughton of Laughton Nursery. An unheated greenhouse costs around  $\$1.70/\text{square foot}$  for construction, compared with  $\$2.40/\text{square foot}$  for a minimally-heated greenhouse (plus fuel, construction labor, ground preparation and irrigation supply) (figures provided by Bob Rimol Greenhouses).

Note that the total cost of overwintering with each technology is higher than the cost of the fabric or structure alone – there are also costs such as rodent control, fungicides, and labor to build the structure and then move and cover plants. For an

excellent analysis of costs for overwintering technologies, see Beattie (1986).

**When pricing overwintering covers, think in terms of crop insurance and the cost of dead plants, and not just the initial cost of the material.** For example, let's take a scenario where you fit ten two-quart containers under 3 square feet of microfoam (costing \$0.32/sq.ft x 3 = \$0.96). Let's further assume that each quart container is sold wholesale for \$3.20. If using the microfoam results in one more plant surviving that would otherwise have died if left uncovered, you will have more than paid for the overwintering material in one season (and are actually more than \$2 ahead through protecting the ten containers). If you take the same simple approach with each covering technology to calculate the break-even number of dead plants required to pay for each technology, you will find that it is easy to justify providing a high level of winter protection.

### Literature cited

Beattie, D.J. (Ed.) 1986. "Principles, practices, and comparative costs of overwintering container-grown landscape plants." South Cooperative Series Bulletin 313. May 1986. The Pennsylvania State University Agricultural Station, University Park, Pennsylvania.

### Acknowledgements

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Also consider the alternative uses of the overwintering structure. For example, an unheated or heated greenhouse can also be used for spring and summer crops, such as bedding plants or greenhouse vegetables. Note that the best type of plastic would differ for overwintering (white) versus production (clear) in an unheated tunnel house.

Temperature is not the only factor that can kill plants during overwintering. Disease and rodents can damage overwintered plants, and plants that are stressed during the fall (excess nutrient salts, severe drought or overwatering) are less able to acclimate to the winter cold. For a very helpful review of practical factors that increase success in overwintering, an article by Tina Smith of University of Massachusetts Extension is available at the following web site:  
[www.umass.edu/umext/programs/agro/floriculture/floral\\_facts/](http://www.umass.edu/umext/programs/agro/floriculture/floral_facts/)

Figure 1. Temperatures recorded during winter 1997-98 and 1998-99 in Deerfield NH, and 1999-2000 in Durham NH. Data include Air temperature, and media temperatures under four levels of cover. (A) and (B) represent the lowest and highest temperatures recorded during the entire winter period (late-Nov to late-March). The range in temperatures (C) represents the maximum minus the minimum temperature for each day, averaged for all days during the winter period. Figure (D) shows the average air or media temperature throughout the winter period.

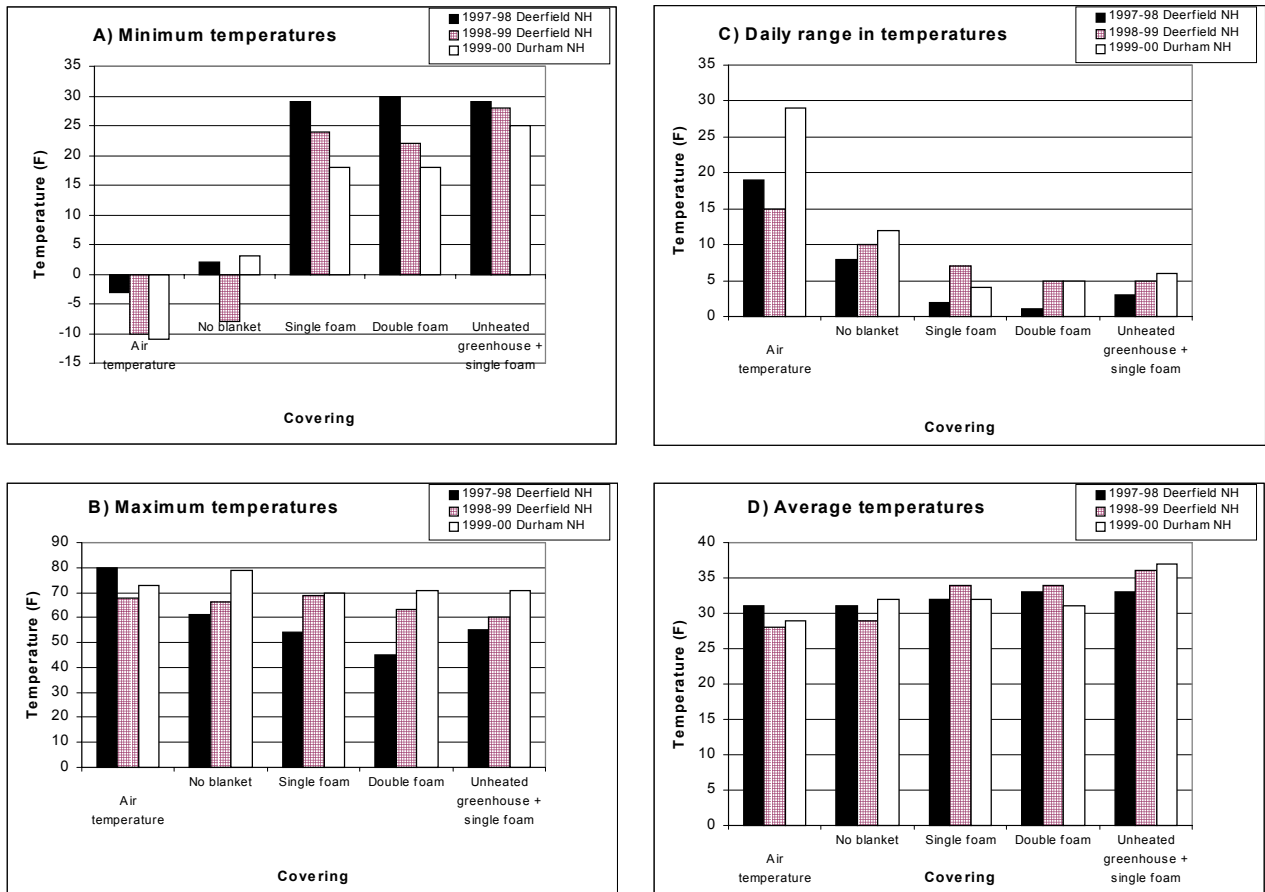


Figure 2. Minimum daily media temperature (No blanket), air temperature, and snow depth (inches) during winter 1999-2000.

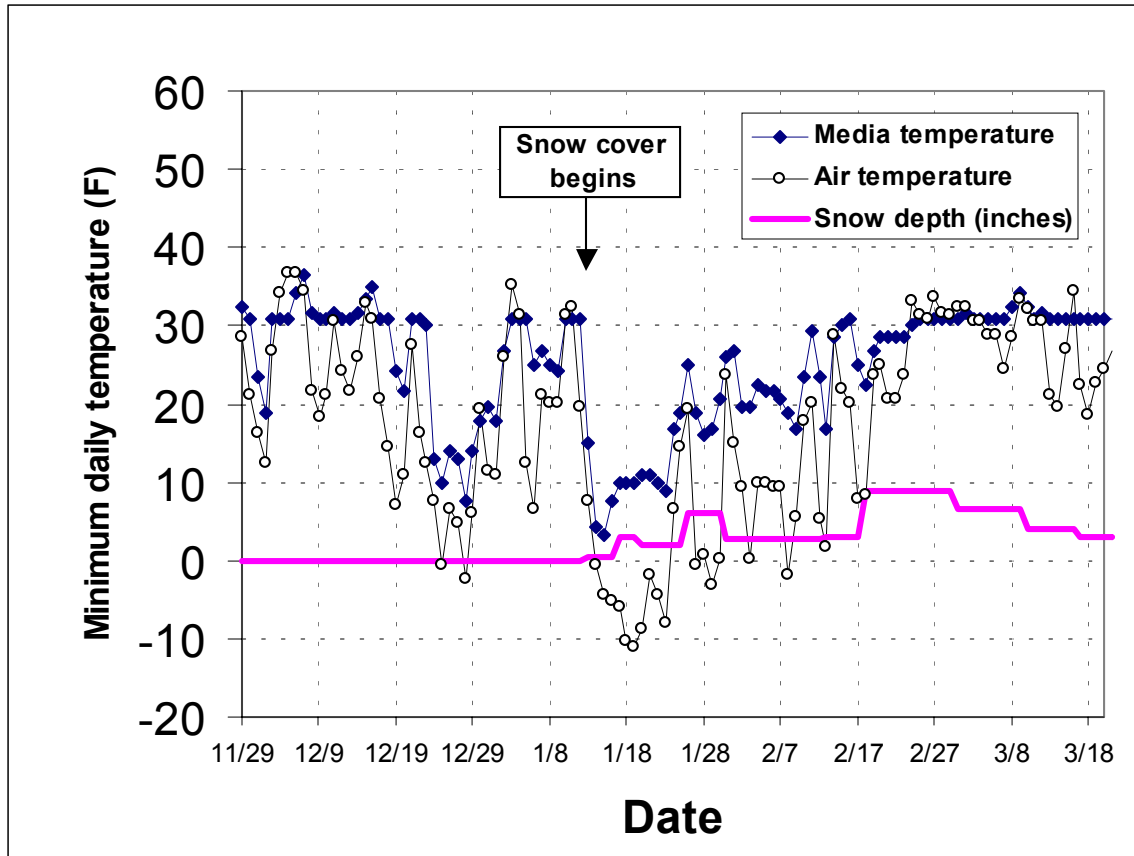


Figure 3. Comparison between the minimum daily air temperature and the minimum daily media temperature inside an unprotected container from three years of data in Deerfield NH (1997-98 and 1998-99) and Durham NH (1999-00). The solid line represents a statistically-fit curve to the observed temperatures (symbols).

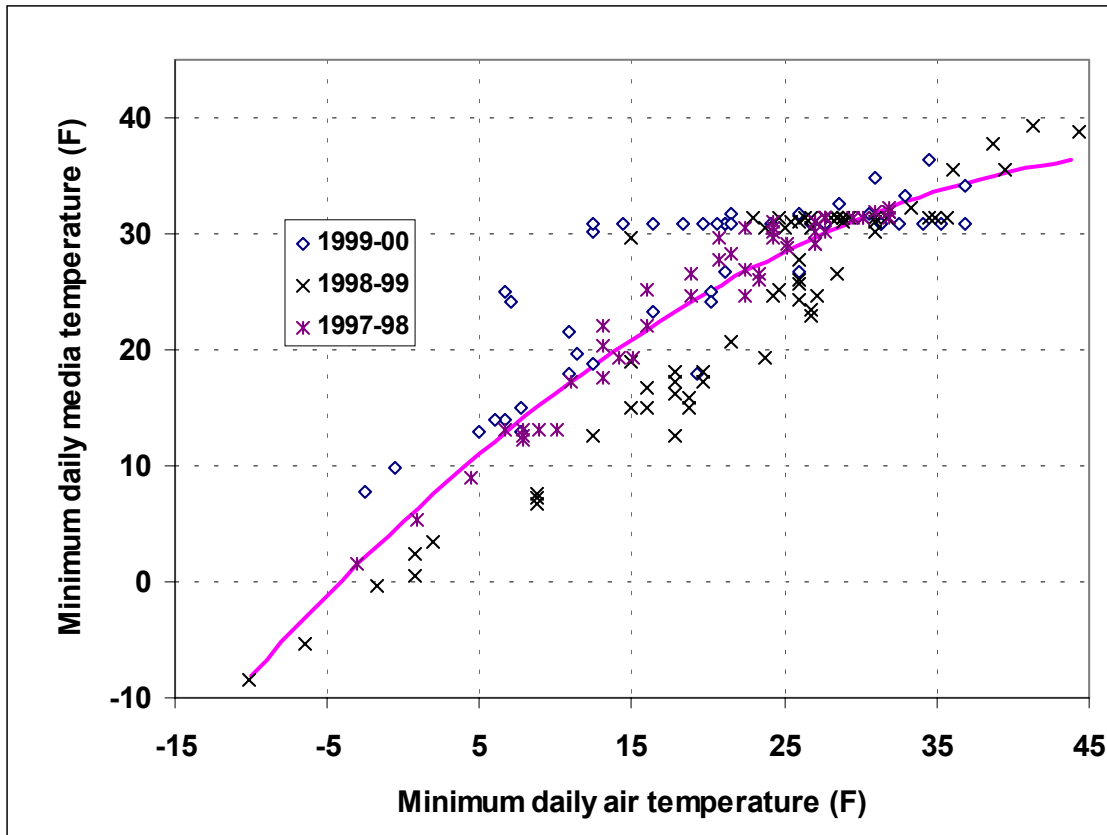


Figure 4. Percent survival of five perennial species under combinations of four blanket treatments inside or outside an unheated greenhouse during 1999-00 at Durham NH.

