Review of Current Practices for Overwintering Container-grown Herbaceous Perennials

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INTRODUCTION

Most container-grown herbaceous perennials require winter protection if they are to survive low temperatures and wide winter temperature fluctuations typical of many regions in the United States and Canada (Iles et al., 1993). Ideally, overwintering systems should insulate plant roots and crowns from undesirable high and low temperatures, and should buffer rapid temperature fluctuation. Over the last 10 years, researchers have studied several freeze-protection methods for container-grown perennials (Iles et al., 1993; Perry, 1990; Still et al., 1987; Still et al., 1989). However, little is known about which methods growers, retailers, and other nursery and landscape professionals actually favor for sheltering container-grown herbaceous perennials from winter injury. Therefore, the primary objective of this study was to identify and investigate the effectiveness of winter protection systems used by landscape and nursery professionals in U.S.D.A. Hardiness Zones 3 through 8.

MATERIALS AND METHODS

Data for this study were collected by using a mail questionnaire. Survey questionnaires were sent by first-class mail on 20 Aug. 1996, to 634 members of the Perennial Plant Association involved in container production of perennials. Mailed questionnaires included a cover letter explaining the objective of the research and instructions for returning the completed questionnaire. Perennial Plant Association members surveyed were assured of the confidentiality of their responses. On 6 Sept. 1996, a follow-up reminder postcard was sent to the 634 firms originally contacted.

The questionnaire contained 13 numbered questions in both closed-end and open-end form, and addressed the following areas: (a) cultural practices performed before overwintering, (b) overwintering method(s) used, (c) approximate dates for covering plants in fall and uncovering in spring, (d) assessment of factors responsible for plant loss, and (e) herbaceous perennials difficult to overwinter.

Completed questionnaires were received from 260 firms (41.0% response rate) in 38 states, the District of Columbia, and five Canadian provinces. Because expected low temperatures in a region have a direct effect on overwintering methods used, respondents were grouped by U.S.D.A. Hardiness Zone for analysis. Incomplete data for questions unanswered were not adjusted, and percentage results presented in tables are based upon actual reported totals.

RESULTS AND DISCUSSION

General Information. A majority of respondents identified their business type as either retail nursery/garden center (39.7%) or production nursery (49.2%). The remaining participants were distributed in the following manner: landscape design/

installation (6.9%), rewholesale nursery (1.5%), and other (2.7%) which included botanic and public gardens. A majority of respondents in U.S.D.A. Hardiness Zones 3, 4, and 5 were retailers, while Zones 6, 7, and 8 were most heavily represented by respondents from production nurseries (Table 1). The largest percentage of respondents (45.0%) were located in Hardiness Zone 5.

Table 1. Reported business type of respondents overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone.

Business type	Hardiness Zone (% response)					
	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Retail	57.1[z]	56.4	44.4	29.6	18.7	27.3
Landscape	---	12.9	7.7	5.6	3.1	---
Rewholesale	---	2.5	2.6	---	---	---
Production	42.9	28.2	41.9	63.0	71.9	72.7
Other	---	---	3.4	1.8	6.3	---
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Percent determined by dividing number of respondents within a business type by total respondents from the respective Hardiness Zone.

Table 2. Reported date of final fertilizer application by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

Date	Hardiness Zone (% response)					
	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Aug. 1	14.3[y]	17.9	13.7	14.8	---	---
Aug. 15	28.6	30.8	19.7	3.7	6.3	9.1
Sept. 1	---	10.3	16.2	20.3	21.9	18.2
Sept. 15	42.8	17.9	22.2	18.5	28.1	18.2
Oct. 1	---	2.6	10.3	16.7	21.9	18.2
Incorp.[x]	---	17.9	12.0	16.7	15.6	9.1
Other	14.3	2.6	3.4	7.4	6.3	27.2
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to when during the growing season do they fertilize their container-grown perennials for the final time.
[y] Percent determined by dividing number of respondents applying fertilizer on a particular date by total respondents from the respective Hardiness Zone.
[x] Fertilizer incorporated into potting medium at planting time.

Acclimating Perennials for Storage. Research findings do not support the widely held belief that late season fertilizer application decreases plant cold hardiness (Pellett and Carter, 1981), however, many nursery operators are reluctant to fertilize nursery stock in September and October. In this study, respondents were asked when during the growing season do they fertilize container-grown perennials for the final time. Although trends were difficult to identify, a majority of respondents reported final fertilizer applications are made on or before 15 Sept. (Table 2). Those that do fertilize perennials after 15 Sept. are primarily located in Hardiness Zones 5, 6, 7, and 8. Several respondents in every zone except Zone 3 reported fertilizing only at potting when slow or controlled-release fertilizer is incorporated into the medium.

Water stress has been shown to enhance cold hardiness of many plants (Levitt, 1980). But in this study, a majority of respondents (54.0%) reported they do not make a conscious effort to reduce the amount of water given to container-grown perennials in the fall. Only in Hardiness Zone 7 did a majority of respondents (53.1%) indicate they purposely reduced fall irrigation to improve cold hardiness (Table 3).

Table 3. Reported fall irrigation practices by firms overwintering container-grown herbaceous perennials with respect to USDA Hardiness Zone[z].

	Hardiness Zone (% response)					
Practice	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Reduce water	42.9[y]	43.6	44.4	44.4	53.1	45.5
Don't reduce water	57.1	53.8	53.0	55.6	46.9	54.5
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to whether they limit or reduce the amount of water given to their container-grown herbaceous perennials in the fall in preparation for winter.

[y] Percent determined by dividing number of respondents reporting a particular irrigation practice by total respondents from the respective Hardiness Zone.

Cultural Practices. Cultural practices performed at time of covering are often as important to plant survival as the overwintering system itself. A majority and equal number of respondents in Hardiness Zones 3 and 4 said they remove dead or dying foliage from plants and apply a rodenticide before winter protection is put in place (Table 4). Removing foliage was the most important cultural practice before overwintering for respondents in Zones 5 and 6, followed by applying a rodenticide and irrigating plants. In Zones 7 and 8, irrigating plants before providing winter protection was most important to respondents. Other cultural tasks mentioned by respondents included, tipping plants on their side, weeding, transplanting to the

next largest-sized container, and applying slug bait.

Table 4. Reported cultural tasks performed before providing winter protection by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

Cultural task	Hardiness Zone (% response)					
	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Irrigate	28.6[y]	66.7	63.2	40.7	68.8	36.4
Fertilize	---	5.1	5.1	7.4	9.4	9.1
Fungicide	14.3	15.4	39.3	40.7	43.8	9.1
Rodenticide	71.4	69.2	70.1	51.9	40.6	---
Remove foliage	71.4	69.2	85.5	68.5	56.3	27.3
Other	28.6	12.8	6.0	5.6	6.3	---
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to what cultural practices they performed before storing container-grown herbaceous perennials for winter.

[y] Percent determined by dividing number of respondents performing a cultural task by total respondents from the respective Hardiness Zone.

Overwintering Systems. Respondents in this study used a wide variety of systems to overwinter their container-grown herbaceous perennials. But in Hardiness Zones 3 and 4, a majority of respondents reported using only one method or system to protect their container-grown stock. By comparison, a majority of respondents in Zones 5, 6, 7, and 8 reported using two or more systems for winter protection.

Protecting plants with so-called structureless systems may be the simplest and least expensive method for overwintering nursery stock (Beattie, 1986). With these systems, plants are consolidated container-to-container and covered with a sheet(s) of material having insulating qualities. Over two-thirds (72.7%) of the respondents in this study reported using a type of structureless overwintering system (Table 5). Covering plants with a thermal blanket and an additional layer of white polyethylene film was the method preferred by the largest percentage of respondents in Zones 3, 4, and 5, while firms in warmer zones were more apt to use single layer coverings, or depend solely on consolidating plants pot-to-pot for low temperature protection. Other structureless methods used by respondents included covering consolidated perennials with spunbonded fabrics (either alone or in combination with other insulating materials), utilizing several variations of the "sandwich" technique (poly-straw-poly for example), surrounding plants with bales of peat, and creating an artificial blanket of snow.

Table 5. Reported use of structureless systems by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Structureless system	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Plants consolidated	---	5.1[y]	6.8	5.6	34.4	36.4
Plants surrounded with Kraft paper	---	---	---	1.9	---	---
Plants surrounded with straw bales	---	15.4	5.1	7.4	3.1	9.1
Plants covered with white poly	---	5.1	5.1	22.2	18.8	9.1
Plants covered with thermal blanket[x]	---	15.4	21.4	37.0	18.8	18.2
Plants covered with thermal blanket and white poly	28.6	35.9	30.8	16.6	9.4	9.1
Other	42.9	28.2	17.1	9.3	9.4	9.1
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Total respondents using structureless overwintering systems (189/260 = 72.7%).
[y] Percent determined by dividing number of respondents using a structureless system by total number of respondents from the respective Hardiness Zone.
[x] Thermal blanket defined as .25 inch thick microfoam, or 1-mil polyethylene bonded to .25-in. thick microfoam.

Polyhuts are low-profile, white polyethylene-covered hoop houses used principally for overwintering herbaceous perennials, groundcovers, or low-growing woody plants (Beattie, 1986). Surprisingly, only 34 respondents (13.1%) reported using polyhuts for winter protection, with the majority of those located in Zone 5 (Table 6). Among all respondents using polyhuts, most (70.6%) consolidated plants within the structure without any additional covering.

Large, quonset-type polyethylene-covered structures, commonly called polyhouses, were used by just over one-half (51.5%) of the respondents in this study (Table 7). Consolidating plants within the polyhouse with no additional protection, and covering consolidated plants with a thermal blanket were the most common ways to overwinter perennials in these structures.

Growers and retailers requiring maximum insulation from low temperature frequently overwinter their perennials in polyhouses with inflated double polyethylene covers. In this study, 81 respondents (31.2%) reported using polyhouses with inflated double-poly, and a majority of those (75.3%) used heaters to maintain root zone temperatures just above freezing (Table 8). Because these structures are more costly to build and operate than those previously mentioned, space within them is usually reserved for very small plants in plug trays, flats, and/or cell packs, cold-sensitive species, or high-value perennials.

Table 6. Reported use of polyhuts by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Polyhut system	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Plants consolidated	---	---	12.0[y]	13.0	3.1	18.2
Plants covered with white poly	---	---	0.8	---	3.1	---
Plants covered with thermal blanket[x]	---	5.1	5.1	3.7	3.1	---
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Total respondents using polyhuts as overwintering systems (34/260 = 13.1%).
[y] Percent determined by dividing number of respondents using a polyhut system by total number of respondents from the respective Hardiness Zone.
[x] Thermal blanket defined as .25-in. thick microfoam, or 1-mil polyethylene bonded to .25-in. thick microfoam.

COVERING AND UNCOVERING

Determining the optimal date for covering and uncovering herbaceous perennials is a difficult management decision. In the fall, plants should be covered as late as possible, but before root or crown damage occurs. In spring, covers should be removed as early as possible so that heat buildup under the covers does not result in excessive or etiolated growth, but late enough to avoid low temperatures that could cause root or shoot damage. A majority of respondents in Zones 4 and 5 cover their perennials sometime in November (Table 9). Covering in mid November to mid December is more common in Zones 6, 7, and 8. Several respondents remarked that date of covering is largely dependent upon the species to be protected; the least hardy are covered first. Others stated the date of covering is dependent upon the system(s) being used. In general and irrespective of Hardiness Zone, polyhouses or polyhuts are covered first, with insulating blankets within these structures applied later. Plants to be protected by structureless systems are covered last. In spring the order is reversed as structureless systems are dismantled first.

A majority of firms in Zones 6, 7, and 8 reported uncovering perennials by early to mid March (Table 10), however, several respondents stated that periodic warm spells often make it necessary for them to uncover or vent several times throughout the winter. In the colder Zones (3, 4, and 5) most respondents uncover plants from mid March to mid April.

Table 7. Reported use of polyhouses by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Polyhouse system	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Plants consolidated	14.3[y]	5.1	28.2	55.6	62.5	27.3
Plants covered with white poly	---	2.6	6.8	5.6	12.5	---
Plants covered with thermal blanket[x]	14.3	10.3	23.9	16.7	9.4	---
Plants covered with thermal blanket and white poly	---	5.1	6.0	1.9	---	---
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Total respondents using polyhouses as overwintering systems (134/260 = 51.5%).
[y] Percent determined by dividing number of respondents using a polyhouse system by total number of respondents from the respective Hardiness Zone.
[x] Thermal blanket defined as .25-in. thick microfoam, or 1-mil polyethylene bonded to .25-in. thick microfoam.

PLANT LOSS

A majority of the respondents in this study reported minimal plant losses (0% to 10%) as a result of their winter protection methods (Table 11). In fact, only 45 respondents (17.3%) reported losses ≥11%.

The largest percentage of respondents in each Hardiness Zone said excessive moisture inside the overwintering environment was most responsible for plant loss in their overwintering system (Table 12). Respondents cited low temperatures and damage from animals as the second and third most likely factors responsible for plant loss.

Among those reporting losses ≥11%, an equal number (53.3%) stated low temperature and overly wet conditions were most responsible for plant loss. A majority of these respondents (66.7%) also reported using structureless overwintering systems in which ventilation is usually poor and plants at the perimeter are often subject to injurious low temperatures.

Table 8. Reported use of polyhouses with inflated double-poly by firms overwintering container-grown herbaceous perennials with respect to USDA Hardiness Zone[z].

	Hardiness Zone (% response)					
Double-poly system	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Plants consolidated	---	2.6[y]	15.4	14.8	12.5	---
Plants covered with white poly	---	---	2.6	---	3.1	---
Plants covered with thermal blanket[x]	14.3	7.7	5.1	3.7	3.1	---
Plants covered with thermal blanket and white poly	---	---	---	---	---	---
House heated	42.9	12.8	28.2	22.2	21.9	9.1
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Total respondents using polyhouses with inflated double-poly as overwintering systems (81/260 = 31.2%).
[y] Percent determined by dividing number of respondents using a double-poly system by total number of respondents from the respective Hardiness Zone.
[x] Thermal blanket defined as .25 inch thick microfoam, or 1-mil polyethylene bonded to .25 inch thick microfoam.

PERENNIALS DIFFICULT TO OVERWINTER

Certain herbaceous perennials are more difficult to overwinter than others. The 15 genera most difficult to overwinter as reported by respondents in this study are listed below. In addition, 26 respondents mentioned ornamental grasses as being difficult to overwinter.

Iris (n=38)
Delphinium (n=27)
Papaver (n=26)
Lavandula (n=25)
Phlox (n=21)
Lupinus (n=20)
Asclepias (n=18)
Coreopsis (n=18)
Dianthus (n=18)
Anemone (n=14)
Campanula (n=13)
Gaillardia (n=13)
Hosta (n=13)
Scabiosa (n=11)
Perovskia (n=10)

Table 9. Reported approximate target period for covering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Period	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
15-30 Sept.	---	---	0.8[y]	---	---	---
1-15 Oct.	14.3	7.7	1.7	5.6	3.1	---
16-31 Oct.	28.6	7.7	5.1	5.6	6.3	---
1-15 Nov.	14.3	59.0	41.0	18.5	12.5	---
16-30 Nov.	14.3	17.9	32.0	22.2	18.8	27.3
1-15 Dec.	---	5.1	11.1	27.8	31.3	36.4
16-31 Dec.	---	---	1.7	5.6	15.6	---
Other	28.6	2.6	5.1	1.9	12.5	18.2
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to their approximate target period for covering or protecting container-grown herbaceous perennials.
[y] Percent determined by dividing number of respondents covering their container-grown herbaceous perennials during a particular period divided by total respondents from the respective Hardiness Zone.

Table 10. Reported approximate target period for uncovering container-grown herbaceous perennials with respect to USDA Hardiness Zone[z].

	Hardiness Zone (% response)					
Period	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
1-15 Feb.	---	---	2.6[y]	3.7	18.8	27.3
16-28 Feb.	---	---	0.8	7.4	---	9.1
1-15 Mar.	14.3	7.7	26.5	40.7	37.5	27.3
16-31 Mar.	42.9	17.9	17.1	11.1	3.1	---
1-15 Apr.	28.6	51.3	36.8	18.5	18.8	---
16-30 Apr.	14.3	7.7	1.7	1.9	6.3	---
1-15 May	---	2.6	4.3	1.9	3.1	---
Other	---	12.8	7.7	5.6	15.6	18.2
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to their approximate target period for uncovering or removing protection from container-grown herbaceous perennials.
[y] Percent determined by dividing number of respondents uncovering their container-grown herbaceous perennials during a particular period divided by total respondents from the respective Hardiness Zone.

Table 11. Reported plant loss resulting from winter protection methods used by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Plant loss	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
No loss	---	---	0.8[y]	1.9	9.4	9.1
1-10% loss	71.4	76.9	79.5	79.6	78.1	72.7
11-25% loss	28.6	17.9	16.2	14.8	9.4	9.1
26-50% loss	---	5.1	1.7	1.9	---	---
>50% loss	---	---	---	---	---	---
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried about plant losses attributable to their overwintering methods.
[y] Percent determined by dividing number of respondents reporting a particular plant loss category divided by total respondents from the respective Hardiness Zone.

Table 12. Reported factors responsible for plant loss by firms overwintering container-grown herbaceous perennials with respect to U.S.D.A. Hardiness Zone[z].

	Hardiness Zone (% response)					
Loss factor	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
Low temp.	14.3[y]	43.6	31.6	31.5	40.6	36.4
Too wet	71.4	51.3	51.3	46.3	56.3	45.5
Too dry	---	17.9	18.8	13.0	9.4	---
Late getting covers on	---	10.3	6.8	13.0	3.1	---
Late getting covers off	---	17.9	11.1	1.9	3.1	---
Animal damage	28.6	38.5	36.8	33.3	25.0	9.1
Disease	14.3	10.3	23.1	22.2	31.3	9.1
Other	14.3	23.1	12.0	20.4	18.8	9.1
	n=7	n=39	n=117	n=54	n=32	n=11

[z] Respondents were queried as to which factor(s) unique to their overwintering method was most responsible for plant loss.
[y] Percent determined by dividing number of respondents reporting a particular loss factor divided by total respondents from the respective Hardiness Zone.

CONCLUSIONS

Overwintering systems must be tailored to the local climate, production system, and take into account the cold hardiness of species to be protected. Systems appropriate for U.S.D.A. Hardiness Zones 4 and 5 may be totally inappropriate for warmer zones. And even within a particular zone, several different winter protection systems may be necessary to protect an inventory of plants having varying degrees of cold hardiness and at various stages of development.

Plant loss can be minimized when plants are carefully matched to an appropriate overwintering system. Perennial species sensitive to excessive moisture should be protected within a well-ventilated overwintering environment. Cold-sensitive species should not be overwintered at the "edges" of polyhuts, polyhouses, or structureless systems. Protective measures must be taken to exclude, deter, or eradicate rodents and other destructive animals. And decisions about when to cover and uncover must be fluid and continually evaluated.

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