OVERWINTER SYSTEMS FOR HERBACEOUS PERENNIALS

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There has been a substantial increase in the production of herbaceous perennials (here referred to as perennials) in the past several years. Much of this production increase has occurred in container production. In areas where winter temperatures approach or go below 0 °F, perennials require some type of winter protection.

Research in overwintering container perennials has not kept pace with the needs of the industry. There has been limited published research on root and crown hardiness of perennials. Research is needed to determine the minimum soil temperature to which roots of different perennial species can be subjected.

Some research has been done in identifying successful overwintering methods for perennials; however, this area still needs much attention. Various overwintering methods are utilized by growers across the United States and Canada. Most of what is known is based on grower experience. Growers may be providing high priced overwintering measures that provide more protection than necessary. However, until root hardiness of an array of perennials has been determined, growers have no choice but to apply the methods that are available to avoid plant loss.

The objectives of our research were to: (1) determine the cold hardiness of ten species of perennials by controlled freezing studies, and (2) evaluate the effectiveness of various overwintering structures on the survival of container-grown perennials.

CONTROLLED FREEZER STUDY

Ten perennials were selected for the study based on grower suggestions concerning hardiness and public popularity. These plants were: *Achillea filipendulina* 'Parker's Gold', *Lythrum* 'Robert', *Campanula glomerata* var. *acaulis, Coreopsis grandiflora* 'Sunray', *Gaillardia* × *grandiflora* 'Monarch Strain', *Erysimum hieraciifolium, Kniphofia uvaria* Pfitzer's hybrids, *Chrysanthemum coccineum*, and *Geum quellyon* 'Mrs. Bradshaw'.

Plugs of the above species were planted into one-quart containers in September and grown with normal production practices. In December, plants were drenched with Benlate and Daconil 2787.

1. Structureless, single layer thermal blanket covered with a single layer of 4 mil white copolymer film.
2. 12 foot tall hoop poly house covered with 4 mil white copolymer film. Perennials were left uncovered in the house.
3. Structure was identical to #2 except the perennials in this structure were covered with a thermal blanket film and a 4 mil white copolymer film.
4. 12 foot tall hoop poly house covered with 1 layer of 4 mil white copolymer and 1 layer of 4 mil clear copolymer inflated with a squirrel-cage fan. Perennials were left uncovered in this house.
5. Structure was identical to #4 except the perennials were covered with thermal blanket and 4 mil white copolymer film.
6. Control plants were placed in a minimum temperature greenhouse at 32 °F.

The species placed in the storage systems were the same as those utilized in the freezer study.

The plants were drenched with fungicide according to industry practice. Rozol, a rodent bait, was placed in several locations within each treatment. Snarol slug bait was spread around the perimeter of each treatment. The foliage was cut back on the taller growing species to reduce the potential for disease and improve ease of covering. All plants were irrigated to container capacity 24 hours prior to covering.

Copper-constantan thermocouples were placed approximately 2 in. deep in the center of a container in each system to measure soil temperatures. Ambient air temperatures were also recorded.

The plants were covered when night air temperatures remained near 20 °F and were uncovered when night air temperatures were near 30 °F. The quality rating index of survival was the same as used in the freezer study.

The minimum container soil temperature recorded for the winters of 1986 and 1987 are listed in Table 1. Table 2 lists the regrowth evaluations for the ten species of perennials in the six storage systems.

Species subjected to overwintering during 1986 were usually of lower regrowth quality than species tested in 1987. This was due to lower temperatures in 1986. The most effective system in 1986 was the single layer poly house with the perennials covered with a thermal blanket. The poorest quality occurred with plants overwintered in the single layer poly house with no thermal blanket over the perennials.

In the winters of 1988 and 1989, additional systems were added. In 1988 the treatments included the ones from the previous winters plus:

After natural cold acclimation the plants were placed in a cooler maintained at 30 °F until the freezing studies were conducted.

The plants were exposed to the following soil temperatures: 30 °, 27 °, 24 °, 21 °, 18 °, 15 °, 12 °, 9 °, and 6 °F.

There were 3 replications of each species within each of the nine temperature treatments repeated over 4 blocks (weeks) of time. After exposure to the treatment temperatures the plants were placed in a greenhouse for forcing at a temperature of 70 °F. A qualitative analysis was done by a panel of 4 judges to rate the saleable quality on a scale of 1 to 5 with 1 being dead, 2 alive but unsaleable, and 3-5 saleable, with 5 the highest quality. Plants were judged after 4 weeks of regrowth.

The controlled freezing study showed great variation in the hardiness levels among the different species. Saleable plants were found to occur from temperatures of 12 °F for a hardy species to 27 °F for the most tender species. There was a direct relationship between temperature and regrowth quality.

Of the ten species, *Achillea, Lythrum*, and *Gaillardia* survived the lowest temperature. All three were of saleable quality after exposure to soil temperatures of 12 °F. These three species would be most likely to survive in any type of overwintering protection.

Species surviving intermediate temperatures included *Campanula* and *Coreopsis*. Saleable plants of *Campanula* occurred at exposures of 15 °F whereas plants of *Coreopsis* were saleable at exposures of 18 °F.

The following five species are considered tender species in this research. The temperatures at which saleable plants were found are listed to the right of each species.

Chrysanthemum coccineum, 21 °F
Erysimum hieraciifolium, 21 °F
Digitalis × mertonensis, 24 °F
Geum quellyon 'Mrs. Bradshaw,' 24 °F
Kniphofia uvaria Pfitzer's hybrids, 27 °F

Several of the above five species are ones that growers often have had problems overwintering. This is especially true with *Kniphofia* which is often placed in a minimum heat storage (30 °F) to prevent winter damage.

OVERWINTERING STUDY

The overwintering study to evaluate the effectiveness of various overwintering structures on survival of container-grown perennials was conducted over a four-year period (1985-1989). In the first two years the following overwintering systems were studied:

Table 1. Minimum container soil temperature recorded for the winters of 1985-1986 and 1986-1987 in six different overwintering systems

System	1985-1986	1986-1987
Minimum heat (MH)	0.5°C (33°F)	1.1°C (34°F)
Single layer poly house with no thermal blanket covering the plants (SU)	-7.1°C (19°F)	-3.3°C (26°F)
Single layer poly house with thermal blanket and milky poly covering the plants (SC)	0.5°C (33°F)	-1.6°C (29°F)
Double layer poly house with no thermal blanket covering the plants (DU)	-1.6°C (29°F)	-1.6°C (29°F)
Double layer poly house with thermal blanket and milky poly covering the plants (DC)	0.5°C (33°F)	-3.3°C (26°F)
Thermal blanket and milky poly covering the plants (TB)	-4.9°C (23°F)	-1.1°C (30°F)

1. A structureless system composed of a single layer of 4 mil white copolymer film over the perennials.
2. A structureless system of a 12 in. layer of wheat straw between 2 layers of 4 mil white copolymer film.
3. No cover on perennials stored outside.

Seven perennials were overwintered in 1988 and are listed in Table 4.

The lowest temperature recorded in 1988 occurred on January 6 (Table 3 lists the air temperatures and soil temperatures of containers in each system). The lowest soil temperatures were recorded in containers stored in single layer poly systems, either in a hoop house or structureless system. The temperatures in these two systems show the same trend as the single layer system in the first two winters.

Table 2. Regrowth ratings[z] for 10 species of herbaceous perennials after overwintering in six different systems[y] during two winters

	Regrowth ratings											
	1985-1986[x]						1986-1987[x]					
Species[w]	MH	SU	SC	DU	DC	TB	MH	SU	SC	DU	DC	TB
Achillea	4.1 BCD	4.0 CD	4.2 ABCD	4.5 ABCD	3.8 D	4.8 AB	5.0 A	4.6 ABC	4.7 ABC	4.7 ABC	4.7 ABC	5.0 A
Gaillardia	4.1 ABC	1.5 F	3.5 CD	1.6 F	2.5 E	2.9 DE	4.7 AB	3.5 CD	4.5 AB	3.9 BC	4.5 AB	4.9 A
Lythrum	4.8 AB	4.4 B	4.5 AB	5.0 A	5.0 A	4.4 B	4.9 AB	4.9 AB	4.9 A	4.7 AB	4.9 AB	4.8 AB
Coreopsis S.R.	—	—	—	—	—	—	4.8 AB	3.3 D	4.2 CD	4.9 A	4.1 C	4.8 A
Coreopsis B.S.	4.6 AB	1.5 C	3.5 ABC	5.0 A	3.4 ABC	2.4 BC	—	—	—	—	—	—
Erysimum	—	—	—	—	—	—	4.9 A	4.6 A	4.5 A	4.9 A	5.0 A	4.5 A
Digitalis	5.0 A	2.6 C	4.8 A	3.7 B	5.0 A	3.5 B	5.0 A	3.5 B	5.0 A	4.8 A	4.9 A	4.3 AB
Geum	4.0 BC	1.0 E	3.5 CD	1.7 E	2.8 D	1.7 E	4.7 AB	4.4 AB	4.9 AB	4.6 AB	5.0 A	4.9 A
Kniphofia	—	—	—	—	—	—	4.7 A	3.3 B	4.9 A	3.2 B	4.4 A	4.6 A

[z] 1 = dead, 2 = unsaleable, 3-5 = saleable with 5 of highest quality

[y] MH Minimum heat
SU Single layer poly house with no thermal blanket and milky poly covering the plants
SC Single layer poly house with no thermal blanket covering the plants
DU Double layer poly house with no thermal blanket covering the plants
DC Double layer poly house with thermal blanket covering and milky poly covering the plants
TB Thermal blanket and milky poly covering the plants

[x] 1985-1986 mean of 16 plants per system
1986-1987 mean of 24 plants per system

[w] *Achillea* = *Achillea filipendulina* 'Parker's Gold'
Digitalis = *Digitalis* × *mertonensis*
Gaillardia = *Gaillardia* × *grandiflora* 'Monarch Strain'
Geum = *Geum quellyon* 'Mrs. Bradshaw'
Lythrum = *Lythrum* 'Robert'
Chrysanthemum = *Chrysanthemum coccineum*
Erysimum = *Erysimum hieraciifolium*
Coreopsis S.R = *Coreopsis grandiflora* 'Sunray'
Coreopsis B S = *Coreopsis lanceolata* 'Baby Sun'
Kniphofia = *Kniphofia uvaria* Pfitzer's hybrids

[v] Mean separation within species only

Table 3. Air temperatures in various storage systems and soil temperatures in containers on January 6, 1988.

Air temp	-2 °F
Air-single layer polyhouse	9 °F
Air-double layer polyhouse	19 °F
Soil temp —Double layer polyhouse with thermal blanket	32 °F
Soil temp.—Double layer polyhouse with no thermal blanket	32 °F
Soil temp.—Single layer polyhouse with thermal blanket	32 °F
Soil temp —Single layer polyhouse with no thermal blanket	22 °F
Soil temp.—Thermal Blanket	25 °F
Soil temp —Poly covering	19 °F
Soil temp —Straw sandwich	29 °F
Soil temp —No cover	5 °F

The quality data for the species in 1988 (rated 1-5, 5 best) are shown in Tables 4 and 5. In the structureless system (Table 4) the poorest quality occurred in the no cover system, which was to be expected. *Kniphofia* and *Geum* also had poor regrowth quality when stored under single layer poly. The overall average of all species was also lowest under no cover and the single layer poly system.

Table 4. The effect of four different structureless winter storage systems on the regrowth quality of seven perennials in the 1988 winter study.

	Structureless systems			
Plant	Single layer poly	Thermal Blanket + poly	Straw sandwich	No cover
Achillea filipendulina 'Parker's Variety'	4 20*	4.20	3.73	2 53
Geum quellyon 'Mrs. Bradshaw'	2 93	4 20	3 60	1 00
Lythrum 'Robert'	4 33	4 13	4 60	1 07
Kniphofia uvaria Pfitzer's hybrids	2 27	4 13	3 20	1 00
Chrysanthemum × *superbum* 'Alaska'	3 47	4.20	4 47	1 07
Coreopsis grandiflora 'Sunray'	4.80	4 93	4 73	3.67
Gaillardia × *grandiflora* 'Dazzle'	3 33	3 20	2 73	2 07
Average	3 62	4 14	3 87	1 77

*1 = dead
2 = alive, not saleable
3-5 = saleable, 5 = highest quality

In the polyhouse systems (Table 5), plants stores in the single layer polyhouse with no additional cover over the plants had the lowest regrowth quality. (3.19). *Kniphofia* which is a tender species had high quality ratings except in the single layer no cover system. Table 6 lists the plant quality across all species as influenced by overwintering systems. The poorest regrowth quality occurred in the systems with only a single layer of milky copolymer.

Table 5. The effect of four different polyhouse winter storage systems on the regrowth quality of seven perennials in the 1988 winter study.

	Polyhouse systems			
Plant	Double layer layer thermoblanket	Double layer no cover	Single layer no cover	Single layer thermoblanket
Achillea filipendulina 'Parker's Gold'	3 67*	3 20	3.07	3.20
Geum quellyon 'Mrs Bradshaw'	4 67	4.40	3 80	4.07
Lythrum 'Robert'	4.47	4.13	4 60	4.93
Kniphofia uvaria Pfitzer's hybrids	4 67	4 93	3.20	4.80
Chrysanthemum × *superbum* 'Alaska'	3 80	4 00	4.00	4 33
Coreopsis grandiflora 'Sunray'	4 00	4 67	4.27	4 40
Gaillardia × *grandiflora* 'Dazzle'	3 33	3 53	3.60	3 33
Average	4.03	4 12	3 19	4 15

*1 = dead
2 = alive, not saleable
3-5 = saleable, 5 = highest quality

In 1989, two additional structureless systems were added and several new species were evaluated (Table 7). The new systems evaluated were (1) 6 to 12 in. of salt hay over the containers with a 4 mil milky copolymer covering the hay and (2) two layers of remay (a tobacco cloth-like material) over the containers with a 4 mil milky copolymer covering the remay.

Table 6. Average plant quality rating across seven species of perennials stored in various winter storage systems in 1988.

System	Plant evaluation
Polyhouse Single layer with thermal blanket	4.15
Structureless thermal blanket	4.14
Polyhouse Double layer—no thermal blanket	4 12
Polyhouse Double layer—with thermal blanket	4 03
Structureless Straw Sandwich	3 87
Polyhouse Single layer—no thermal blanket	3.79
Structureless Single layer poly	3 62
Structureless No cover	1.77

The minimum air temperature in the winter of 1989 was 9 °F. Consequently, the soil temperatures of the systems did not go as low as in previous years. However, the trends of previous years were still manifested by several of the less hardy species. Data in Table 7 show this trend. In the single layer poly cover, *Kniphofia, Aster* 'Mönch', and *Verbena rigida* had poor regrowth quality. These three species are considered by many growers to be species that are hard to overwinter.

Table 7. The effect of six different storage systems on the regrowth quality of 12 perennials in the 1989 winter

	Structureless Systems					
Plant	Single layer poly	Thermo-blanket	Straw	Salt hay	Tobacco cloth	No cover
Achillea filipendulina 'Parker's Gold'	4 2	4.1	4 3	4 7	4.6	2 4
Achillea millefolium 'Paprika'	4 9	4 7	4 7	4.7	4 9	3 7
Alchemilla mollis	5.0	4 7	4.8	4.9	4.7	2.3
Aster 'Mönch'	3 6	4 2	3.9	3 7	4.1	1.1
Coreopsis lanceolata	4 9	4 9	4 9	4 8	4 8	4 1
Digitalis × *mertonensis* 'Temple Bells'	4 9	4 9	4.7	4 6	4.9	1.6
Gaillardia aristata	4 3	4 3	3 3	4.1	4 4	3 3
Geum quellyon 'Mrs Bradshaw'	4.6	4 8	4 8	4 9	4 8	1.0
Kniphofia 'Royal Castle'	3 1	4 7	4.0	4 3	3 5	1.0
Pennisetum setaceum 'Hameln'	3 6	4 4	4.4	4 6	4.2	1 0
Phlox divaricata	4 5	4 6	4.8	4 8	4 4	3 4
Verbena rigida	2.8	3.7	3 2	3.1	3 0	1 0
Average	4.2	4.5	4 3	4 3	4 4	2.0

The winter of 1989 was not a good year to evaluate the remay cloth system. Growers in southern zones have successfully used remay cloth for frost protection in the spring and for winter protection. It needs to be examined further before any recommendations can be given for its use in northern areas.