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Costs of Overwintering Plants in Tennessee Nurseries Differentiated by System

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ABSTRACT

The objective of this study was to identify the overwintering structures used by Tennessee nurserymen and to estimate their annual costs for overwintering nursery plants. Data were obtained from wholesale nurserymen and nursery suppliers in Tennessee during 1984. Five overwintering system models were synthesized based on production conditions in the McMinnville, Tennessee, area. Capital requirements were identified and costs of overwintering were estimated.

Structureless overwintering systems had the lowest annual cost per square foot, which ranged from $0.22 to $0.28. Polyhut and polyhouse systems covered with a single layer of polyethylene cost $0.34 and $0.44 per square foot, respectively. Annual overwintering costs per one-gallon container ranged from $0.07 to $0.18 for all systems.

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Costs of Overwintering Plants in Tennessee Nurseries Differentiated by System

M.B. Badenhop and J.W. Day*

INTRODUCTION

Container-grown and field-grown plants harvested in the fall for spring sales may be damaged or killed by low temperatures if not properly protected. Losses of plants due to cold and/or costs of overwintering plant materials significantly increase production costs, especially in northern USDA hardiness zones [3]. A recent Ohio study [2] indicated that plastic covered structures (polyhouses) used for overwintering plants account for about 20% of the total capital requirements for establishing a 10-acre container nursery.

Although Tennessee nurserymen use various overwintering structures, including polyhouses, to reduce damage, cost data for overwintering container-grown nursery plants are not available for Tennessee or other southern states. The objective of this study was to identify the overwintering structures used in Tennessee and to estimate their annual costs for overwintering nursery plants.

MATERIALS AND METHODS

Five overwintering systems were synthesized using the conceptual framework of economic engineering wherein "the best proven practice" was included in each model. Each system was synthesized based on production conditions in the McMinnville, Tennessee, area, which should be fairly representative of USDA Climatic Zones 7 and 8. Not all overwintering practices were analyzed. For example, some nurserymen provide no winter protection for hardy plants such as junipers and taxus. Other growers only consolidate plants by pushing them together to provide minimum winter protection. Only overwintering systems common to Tennessee that provide greater overwintering protection than simple consolidation were analyzed.

Data for the study were obtained from wholesale nurserymen and nursery suppliers in Tennessee during 1984. Prices reflect quantities of

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material based on a 10-acre container nursery with 8 acres, or 350,000 square feet (sq. ft.), of growing space. For a nursery of this size, 210,000 sq. ft. of overwintering space would be required.

Overwintering structures used by nurseries vary in size and configuration. In Tennessee, the 14′ x 96′ polyhouse and 6′ x 96′ polyhut have traditionally been used, but recently some growers prefer 21′ x 96′ polyhouses or larger structures. Although these large houses provide greater freedom of movement for workers and easier access for equipment, the traditional 14′ x 96′ and 6′ x 96′ sizes were selected for the purpose of standardizing the models used in this study.

Fixed Costs

Annual fixed costs (with the exception of general overhead and interest on general overhead, interest, and taxes) were composed of depreciation, interest, and insurance and taxes. Depreciation was calculated by dividing initial costs by years of useful life. Interest costs were estimated by multiplying the initial value of materials and labor by 15% per annum. Charges for insurance and taxes were estimated by multiplying the initial value of construction by 2%.

Data from a 1982 study [1] were used to assess general overhead. In the 1982 study, overhead for a 10-acre nursery (8 acres growing space) was $59,286. To account for inflation and rising costs, this value was inflated by 10% to $65,215. General overhead for individual polyhouses, polyhuts, or structureless areas was then determined by dividing the number of structures or areas by $65,215. For example, 156 polyhouses would be required for a 10-acre container nursery. Therefore, 156 was divided by $65,215 to determine the general overhead per structure. One-fourth of the general overhead cost was assigned to overwintering. Interest charges for general overhead, insurance, and taxes were computed for a 6-month average use period at 15% per annum.

Variable Costs

Annual variable costs included hourly labor, polyethylene, thermal blankets, bait blocks, chemicals, straw, and miscellaneous costs depending on the particular system.

Hourly Labor. Labor costs were estimated using a base wage of $4.00 per hour. An additional 20% was added to account for taxes and fringe benefits such as the employer's share of pension, insurance, and other agreed upon payments; payment for time not worked; service awards; suggestion awards; and special payments. These taxes and benefits totaled $0.80 per hour for an hourly wage of $4.80.

Polyethylene. Tennessee nurserymen normally use 4- or 6-mil polyethylene film, which is either clear, white, or black. Clear or white

polyethylene is used as the single layer on polyhouses and polyhuts. Black polyethylene is usually placed on the ground to help control weeds and improve walking surfaces in wet areas. For this study, white, 4-mil polyethylene was used.

Thermal Blankets. Thermal blankets are available in various types, shapes, and sizes. The type budgeted for this study was the standard form with no additional covering. However, a covering of polyethylene over a thermal blanket provides additional winter protection and helps protect the thermal blanket from adverse weather.

Thermal blankets with a layer of polyethylene bonded directly to the thermal material are used by some nurserymen. They require less labor than a thermal blanket plus a single layer of polyethylene but are more expensive than the type budgeted here. Standard sizes of thermal blankets are either 8′ wide x 225′ long or 5′ wide x 225′ long. It was assumed in this study that three 5′ x 100′ blankets were used in the structureless 14′ x 96′ area. The blankets were assumed to last three years; however, their useful life-span could be increased with proper handling and storage.

Bait Blocks. Eaton bait blocks are effective in controlling mice within overwintering areas. The blocks are normally placed about 10′ apart and are replaced once during the overwintering season. In addition to bait blocks placed directly within the overwintering areas, poisoned grain may be placed between areas.

Chemicals. Chemicals are used to control fungi during overwintering. In structureless systems and polyhuts, plants are sprayed once with a mixture of Benlate and Captan or other suitable material after being consolidated. Plants overwintered in polyhouses are usually sprayed with Benlate at the beginning of the overwintering season. After houses are covered, a fumigant bond of Exotherm Termil is applied. A second Termil bomb is used at some point during the winter.

Straw. Straw is used by some growers around consolidated container plants in single structureless systems to provide insulation, especially for plants on the perimeter. In this study, straw was charged at $1.50 per bale, which included transportation.

Miscellaneous. Tie-down straps, furring strips and nails to secure plastic coverings, poisoned grain for placement between overwintering areas, mulch for straw enclosures, and other minor items were included in the miscellaneous category.

Construction Costs

Construction costs included all labor and materials required for building structures such as concrete reinforcement mesh, gravel for holding down plastic, and labor. Construction costs did not include ground preparation, irrigation fixtures, or the cost of polycovers. It was determined that ground preparation and irrigation fixtures would be charged to "growing on"

rather than overwintering. Polycovers are considered variable rather than construction costs.

OVERWINTERING SYSTEMS

The five overwintering systems analyzed were: 1) a 14′ x 96′ structureless system where plants are consolidated and covered directly with a single layer of polyethylene film; 2) a 14′ x 96′ structureless system where plants are consolidated, covered with a thermal blanket placed directly over the plants, and then covered with a single layer of polyethylene; 3) a 14′ x 96′ structureless system where plants are consolidated, mulched with sawdust or other suitable material, and surrounded with bales of straw; 4) a 6′ x 96′ polyhut structure, 3′ to 4′ high, covered with a single layer of polyethylene without additional covering of the plants (Figure 1); and 5) a 14′ x 96′ polyhouse structure, 8′ to 9′ high, covered with a single layer of polyethylene without additional covering of the plants (Figure 2).

Structureless Systems 1 and 2 are most effective when use is restricted to the more hardy plants such as junipers and taxus and particularly where sales are not anticipated for one additional growing season. System 3 is generally effective in protecting hardy, field-grown crops harvested in the fall or early winter for spring sales, and System 4 is highly effective for propagating and overwintering hardy, bed-grown liners. System 5 is the most commonly used system for overwintering container-grown plants in Tennessee. Additional protection for plants could be provided in this system by covering plants in the structure with a single layer of polyethylene.

RESULTS AND DISCUSSION

The cost of each overwintering system is presented separately. Complete cost data are shown in Tables 1-3. Total annual costs are summarized in Table 4.

System 1. 14′ x 96′ Structureless System With Plants Covered by a Single Layer of Polyethylene

System 1 provided the lowest cost overwintering protection of all systems. Total annual costs were $291.11 (Table 1), with $116.44 being fixed (40%) and $174.67 variable (60%). The per sq. ft. cost was $0.22, or $0.07 per one-gallon container and $0.13 per two-gallon container. System 1 costs less than half the price of System 5 (14′ x 96′ polyhouse covered by a single layer of polyethylene).

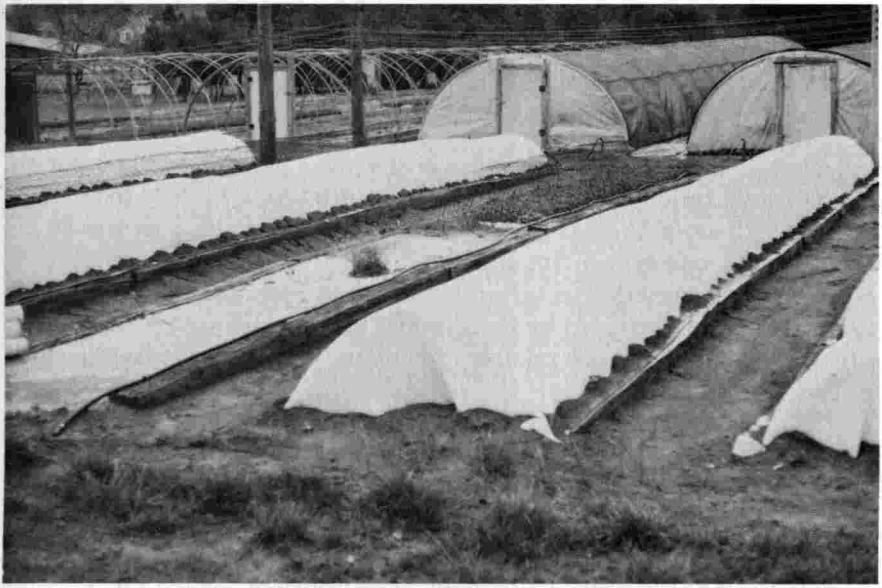

Figure 1. Polyhut structures (6′ x 96′)

Figure 2. Polyhouse structures (14′ x 96′)

System 2. 14′ x 96′ Structureless System with Plants Covered by a Thermal Blanket and a Single Layer of Polyethylene

System 2 was only slightly more costly than System 1 ($0.03 per sq. ft.). The total annual costs were $331.21, comprised of $116.44 fixed (35%) and $214.77 variable costs (65%) (Table 1). The per sq. ft. cost was $0.25, or $0.08 per one-gallon container and $0.15 per two-gallon container. System 2 may provide greater protection than System 1 due to the additional insulation provided by the thermal blanket. However, no data are presently available on the relative effectiveness of the systems presented in this study.

System 3. 14′ x 96′ Structureless System with Plants Consolidated, Mulched, and Surrounded by Bales of Straw

System 3 was the most costly of all structureless systems. The total annual cost was $379.58, comprised of $116.44 fixed (31%) and $263.14 variable costs (69%) (Table 1). The per sq. ft. cost was $0.28, or $0.10 per one-gallon container and $0.17 per two-gallon container. The cost of straw used in System 3 ($109.50) was a major expense contributing to the total cost.

System 4. 6′ x 96′ Polyhut Covered by a Single Layer of Polyethylene

Total annual costs of this system were $193.04, comprised of $74.07 fixed (38%) and $118.97 variable costs (62%) (Table 2). The per sq. ft. cost was $0.34, or $0.11 per one-gallon container and $0.20 per two-gallon container. However, this system is used primarily for propagating and overwintering plants during propagation. Therefore, because large numbers of rooted cuttings can be produced in a 6′ x 96′ polyhut, the cost per rooted cutting would be substantially reduced (est. cost < $.01).

System 5. 14′ x 96′ Polyhouse Covered by a Single Layer of Polyethylene

System 5 is the most costly of the overwintering systems presented in this study. The total annual cost was $597.98, comprised of $387.38 fixed. (65%) and $210.60 variable costs (35%) (Table 3). The per sq. ft. cost was $0.44, or $0.18 per one-gallon container and $0.31 per two-gallon container. Polyhouses, although the most costly of the overwintering structures studied, are the primary structures used by wholesale nurserymen in Tennessee. They provide satisfactory protection of plants and other

benefits such as the necessary vertical space for marketable plants and easy access by workers and machinery.

The costs per container are based on a conservative spacing of containers. For example, the annual cost for a one-gallon container in a 14' x 96' polyhouse (1,152 sq. ft. spaced used) is $0.18. This figure is based on 3,368 containers per polyhouse. The number of containers actually placed in a house is determined by size of container, spacing, width of aisle(s), and type and size of plants. Cost per plant varies depending on the number of plants actually placed within a structure. The cost per plant is easily determined by dividing the plants per house by the total annual costs. For example, the total annual cost per plant in a 14' x 96' polyhouse equals $597.98 (total annual cost) divided by 3,368 (total plants placed within polyhouse), or $0.18.

SUMMARY

Five systems for overwintering plants in nurseries were delineated. Annual costs per sq. ft. of overwintering space ranged from $0.22 to $0.44. Structureless systems provided the lowest cost protection and ranged from $0.22 to $0.28 per sq. ft. Polyhut and polyhouse systems covered with a single layer of polyethylene cost $0.34 and $0.44, respectively. Overwintering costs per one-gallon container ranged from $0.07 to $0.18 for all systems.

All overwintering systems presented in this study provide some degree of winter protection. However, the relative effectiveness of these systems is unknown. More data are needed on the actual degree of protection provided by the various systems used by nurserymen.

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TABLES

Table 1. Annual costs for overwintering plants in a 14′ x 96′ structureless enclosure differentiated by system, Tennessee, 1984[a,b]

Item	Description	Unit	Cost per unit (dollars)	Quantity	Total cost (dollars)
	Costs common to all structureless systems				
Annual fixed costs					
General overhead[c]	¼ of total nursery overhead was assigned to overwintering				104.51
Interest on general overhead	Compounded at 15% per annum for 6 months				7.84
Subtotal (common annual fixed costs)					112.35
Annual variable costs					
Bait blocks[d]	Eaton	blocks	.16	20	3.20
Chemicals[d]	Benlate 50WP (fungicide)	pounds	13.30	0.05	.67
	Captan 50WP (fungicide)	pounds	2.10	0.10	.22
Subtotal (common annual variable costs)					4.09
Total annual common costs					116.44
	SYSTEM 1 Plants consolidated - covered with one layer polyethylene				
Total annual common costs					116.44
Additional annual variable costs					
Polyethylene	4 mil white, 20′ x 100′	1,000 sq. ft.	16.00	2	32.00
Labor[e]	Hired	hours	4.80	24	115.20

Miscellaneous	Tie-down materials, treated grain, etc.				15.00
Interest on operating capital[f]	Computed at 15% on an annual basis for 6 months	percent	7.5 (0.075)	166.29	12.47
Total annual costs					291.11
	SYSTEM 2				
	Plants consolidated - covered with thermal blanket and one layer polyethylene				
Total annual common costs					116.44
Additional annual variable costs					
Polyethylene	4 mil white, 20′ x 100′	1,000 sq. ft.	16.00	2.00	32.00
Thermal blanket[g]	¼″ - 15′ x 100′	1,000 sq. ft.	65.00	⅓(1.5)	32.50
Labor[e]	Hired	hours	4.80	25.00	120.00
Miscellaneous	Tie-down materials Mulch, treated grain, etc.				15.00
Interest on operating capital[f]	Computed on 15% on an annual basis for 6 months	percent	7.5 (0.075)	203.59	15.27
Total annual costs					331.21
	SYSTEM 3				
	Plants consolidated - mulched and surrounded with bales of straw				
Total annual common costs					116.44
Additional annual variable costs					
Straw	3′ length	each	1.50	73.00	109.50
Labor[e]	Hired	hour	4.80	25.00	120.00
Miscellaneous	Mulch, treated grain, sawdust, etc.				15.00
Interest on operating capital[f]	Computed at 15% on an annual basis for 6 months	percent	7.5 (0.075)	248.59	18.64

Table 1 continued

Table 1. (continued)

Item	Description	Unit	Cost per unit (dollars)	Quantity	Total cost (dollars)
Total annual costs					379.58

[a]Based on a container nursery of 10 acres with 350,000 sq. ft. of growing space, 210,000 sq. ft. of structureless enclosure space, and 156 (14′ x 96′) structureless enclosures.

[b]One-gallon containers would occupy 0.342 sq. ft.; two-gallon containers, 0.592 sq. ft.

[c]General overhead was estimated by taking figures developed in 1982 for container nurseries with 350,000 sq. ft. of growing space and inflating them by 10% [1]. Twenty-five percent of the determined amount was then assigned to overwintering. The overwintering figure was then divided by 156 to reflect the cost per enclosure that would be necessary for overwintering plants grown in the nurseries.

1982 figures	Inflated by 10%	Overwintering portion (25%)	Cost per enclosure
$59,286	$65,215	$16,304	$104.51

[d]The use of trade names is for illustration only and does not constitute an endorsement of any product.

[e]Basic wage before withholding taxes and fringe benefits was $4.00. Taxes and fringe benefits added 20%, or $0.80, for a total hourly wage of $4.80. Labor requirements per enclosure were estimated as follows:

Consolidation of plants prior to overwintering	- 10 hours
Spacing after overwintering	- 10 hours
Spraying and miscellaneous	- 1 hour
Placing and removing either polyethylene or thermal blanket	- 3 hours
Using both polyethylene and thermal blanket (additional labor)	- 1 hour
Placing and removing straw	- 4 hours

[f]Interest on operating capital was computed by adding the annual variable costs common to all systems to the variable costs specific to a given system and then multiplying the total by the factor 0.075.

[g]Thermal blankets would be used for three years. When computing annual cost, ⅓ of the cost budgeted was assigned for a given year.

Table 2. Annual costs for overwintering plants in a 6′ x 96′ polyhut structure (System 4), Tennessee, 1984[a,b]

Item	Description	Unit	Useful life (years)	Cost per unit (dollars)	Quantity	Total cost (dollars)
		Construction costs				
Polyhut framework						
6′ x 96′ concrete reenforcement mesh						
6″ x 6″ - 10 gauge wire[c]	5′ x 10′ sections	each	10	14	3.00	42.00
Gravel for holding down plastic		ton	10	0.25	4.60	1.15
Labor requirements[d]		hours	10	11	4.80	52.80
Total construction cost						95.95
		Fixed costs				
Annual fixed costs						
Depreciation	10% of construction cost					9.60
Interest	Compounded at 15% per annum					14.39
Insurance and taxes	2% of construction cost					1.92
General overhead[e]	¼ of total nursery overhead was assigned to overwintering					44.67
Interest on general overhead, insurance, and taxes	Compounded at 15% per annum for 6 months					3.49
Subtotal (annual fixed costs)						74.07

Table 2 continued

Table 2 (continued)

Item	Description	Unit	Useful life (years)	Cost per unit (dollars)	Quantity	Total cost (dollars)
	Variable costs					
Annual variable costs						
Polyethylene	4 mil white, 12′ x 105′	1,000 sq.ft.		16.00	1.26	20.16
Bait blocks[f]	Eaton	blocks		.16	10.00	1.60
Chemicals[f]	Benlate 50WP	pounds		13.50	0.02	.27
	Captan 50WP	pounds		2.15	0.04	.09
Labor[d]	Hired	hours		4.80	17	81.60
Miscellaneous	Tie-down materials, treated grain					6.50
Interest on operating capital	Computed at 15% on an annual basis for 6 months	percent		7.5 (0.075)	116.72	8.75
Subtotal (annual variable)						118.97
Total annual cost						193.04

[a]Based on a nursery containing 10 acres with 350,000 sq. ft. of growing space, 210,000 sq. ft. of polyhut space, and 365 (6′ x 96′) polyhuts.

[b]One-gallon containers would occupy 0.342 sq. ft.; two-gallon containers, 0.592 sq. ft.

[c]Purchased in rolls of 5′ x 150′. Rolls would be cut into 10′ sections to make 6′ wide hoops. Each section would therefore be 5′ long. Approximately 2′ of space would be left between sections to facilitate service.

[d]Average basic wage before withholding taxes and fringe benefits was $4.00. Taxes and fringe benefits added 20%, or $0.80, for a total of $4.80.

[e]General overhead was estimated by taking figures developed in 1982 for container nurseries in plant hardiness zones 7 and 8 with 350,000 sq. ft. of growing space and inflating them by 10% [1]. Twenty-five percent of the determined amount was then assigned to overwintering. The overwintering figures were then divided by 365 to reflect the cost per polyhut that would be necessary for overwintering plants grown in the nurseries. Figures were determined as follows:

1982 figure	Inflated by 10%	Overwintering portion (25%)	Cost per polyhut
$59,286	$65,215	$16,304	$44.67

[f]The use of trade names is for illustration only and does not constitute an endorsement of any product.

Table 3. Annual costs for overwintering plants in a 14′ x 96′ polyhouse structure (System 5), Tennessee, 1984[a]

Item	Description	Unit	Useful life (years)	Quantity	Cost per unit (dollars)	Total cost (dollars)	Percent of total cost
		Construction costs					
Galvanized steel pipe							
Inserts - 34	1½″ x 3″	ft.	10	102	1.60	163.20	16
Ridge line including couplings - 5	¾″ x 21′	ft.	10	96	.78	74.88	7
Arches, 1″ waterpipe - 17	1″ x 21′	ft.	10	357	1.04	371.28	37
End braces - 4	¾″ x 21′	ft.	10	84	.78	65.52	7
Subtotal						674.88	67
Wood-pressure treated							
Baseboards	3″ x 4″ x 8′	ft.	10	192	.23	44.16	4
Door frame - upright - 4	4″ x 4″ x 8′	ft.	10	32	.54	17.28	2
Door frame brace - 4	1″ x 4″ x 6′	ft.	10	24	.23	5.52	1
Door sill plate - 4	2″ x 4″ x 3′	ft.	10	12	.23	2.76	
Doors (3′ x 6′) - 2 plywood	4′ x 8′ x ½″	each	10	2	14.57	29.14	3
Subtotal						98.86	10
Hardware							
Joiners (for baseboards)	3′ x 6′	each	10	18	.40	7.20	1
Roofing nails	1¼″	pounds	10	0.25	.80	.20	
Carriage bolts	4″ x ¼″	each	10	4	.15	.60	
Carriage bolts	3″ x ¼″	each	10	32	.12	3.84	

Carriage bolts	2″ x ¼″	each	10	32	.06	1.92	
Hinges	3″ rustproof	each	10	4	1.20	4.80	1
Door latch	Hasp	each	10	2	2.00	4.00	
Nails	10d	pounds	10	0.5	1.40	.70	
Subtotal						23.26	2
Labor requirements[b]		hours	10	45	4.80	216.00	21
Total						1,013.00	100
		Fixed costs					
Annual fixed costs							
Depreciation	10% of construction cost					101.30	
Interest	Compounded at 15% per annum					151.95	
Insurance and taxes	2% of construction cost					20.26	
General overhead[c]	¼ of total nursery overhead was assigned to overwintering					104.51	
Interest on general overhead	Compounded at 15% per annum for 6 months					9.36	
Subtotal (annual fixed costs)						387.38	
		Variable costs					
Annual variable costs							
Polyethylene cover	4 mil white, 24′ x 110′	1,000 sq. ft.		16.00	2.64	42.24	
Bait blocks[d]	Eaton	blocks		.16	20	3.20	
Chemicals[d]	Termil (fungicide)	canister		1.66	2.00	3.32	
	Benlate 50WP (fungicide)	pounds		13.30	0.05	.67	
Labor[b]	Hired	hours		4.80	25	120.00	
Interest on operating capital[e]	Computed at 15% on an annum basis for 6 months	percent		7.5 (0.075)	215.55	16.17	

Table 3 continued

Table 3 (continued)

Item	Description	Unit	Useful life (years)	Quantity	Cost per unit (dollars)	Total cost (dollars)	Percent of total cost
Miscellaneous	Tie-down materials, furring strips, nails, etc.					25.00	
Subtotal (annual variable costs)						210.60	
Total annual costs						597.98	

[a]Based on a container nursery of 10 acres with 350,000 sq. ft. of growing space, 210,000 sq. ft. of polyhouse space, and 156 (14′ x 96′) polyhouses.

[b]Average basic wage before withholding taxes and fringe benefits was $4.00. Taxes and fringe benefits added 20%, or $0.80, for a total of $4.80.

[c]General overhead was estimated by taking the figure $59,286 developed in an earlier study using 1982 figures for the appropriate sized nursery and inflating it by 10% to $65,215 [1]. Twenty-five percent, or $16,304, was assigned to overwintering. This figure was then divided by 156 polyhouses to obtain a cost of $104.51 per polyhouse.

[d]The use of trade names is for illustration only and does not constitute an endorsement of any product.

[e]Interest on operating capital was computed by adding common variable to variable costs specific to a given system and multiplying the total by the factor 0.075.

Table 4. Summary of annual total costs of five overwintering systems, Tennessee, 1984

System	Total annual cost (dollars)	Cost per sq. ft. (cents)	Cost per container	
			1-gallon (cents)	2-gallon (cents)
Structureless (14′ x 96′)[a]				
1. Plants consolidated and covered with 1 layer of polyethylene	291.11	22	7	13
2. Plants consolidated and covered with a thermal blanket plus a single layer of polethylene	331.21	25	8	15
3. Plants consolidated, mulched, and surrounded by bales of straw	379.58	28	10	17
Polyhut (6′ x 96′)[b]				
4. Polyhut covered with 1 layer of polyethylene	193.04	34	11	20
Polyhouse (14′ x 96′)[b]				
5. Polyhouse covered with 1 layer of polyethylene	597.98	44	18	31

[a]A 14′ x 96′ enclosure equals 1,344 sq. ft. and would accommodate 3,926 1-gallon or 2,270 2-gallon containers.

[b]The 6′ x 96′ polyhut equals 576 sq. ft. and would accommodate 1,682 1-gallon and 972 2-gallon containers. The 14′ x 96′ polyhouse would have a 2 ft. aisle down the center and thus only 1,152 sq. ft. It would accommodate 3,368 1-gallon or 1,950 2-gallon containers.

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