EFFECT OF FALL PLANTING AND OVERWINTERING TECHNIQUES ON GROWTH OF TRANSPLANTED PEKING COTONEASTER[1]

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Considerable emphasis has recently been given to fall planting of woody ornamentals. Media campaigns by the nursery industry have extolled the virtues of fall planting. Fall planting offers convenience to the consumer and a market advantage to nurserymen and arborists. Increased autumn sales extends the sales season and cash flow and reduces the number of plants to be overwintered. A primary limiting factor in widespread acceptance of fall planting is consumer fear of "losing the plant" (Good and Corell, 1982).

Fall has long been an acceptable and recommended planting time. Soil moisture is usually adequate and soil temperatures remain in the range for root growth well into early to mid-winter, depending on locality. Root growth was found to continue after dormancy of the upper portion of *Prunus cerasifera* when soil temperatures were greater than 3°C (Hilton and Khatamian, 1974). Temperature and moisture stress are also reduced during autumn as temperatures moderate and moisture demand by the plant are reduced (Chadwick, 1983).

Ideal planting times depend on the environmental conditions of the particular locality as well as plant species. Some plants, such as *Cornus florida, Magnolia* sp., *Rhododendrun* sp. and others are preferentially planted in the spring (Pirone, 1978). Successful fall planting of bare root conifers is more variable than spring planting (Ryker, 1977). Evaluation of numerous factors favored spring planting of these species in the inland Northwest. Dickinson and Whitcomb (1977 and 1978) have recommended fall planting of container species in numerous publications. These recommendations are based on a single study during a mild winter in Oklahoma. Increased root and shoot growth was generally found for *Pinus thumbergii, Quercus macrocarpa* and *Quercus acutissima* after one growing season (11 months for fall-planted and 7 months for spring-planted species). Greater root growth was found for spring-planted *Juniperus chinesis* 'Pfitzeriana' and there was significantly greater top growth by *Pinus pinaster* when spring planted. There was no significant difference in either root or shoot growth by *Pistacia chinensis* as a result of planting time and 50% of the *Ilex cornuta* 'Dwarf Burford' planted in the fall died before spring.

Swanson (1977) compared survival and growth of thirty woody species planted in late October and early May in Colorado. Survival of fall-planted conifers was poor and 85% of all species tested had as good or better survival and sustained less injury when planted bare root or in containers in spring rather than fall. Swanson concluded spring transplanting is superior to fall transplanting in areas of cold, open winters with dry winds and low relative humidity. This same recommendation is also found in various Extension publications and other literature on transplanting (Lieberman, 1972).

Good and Corell (1982) found fall planting successful for a number of species in Long Island, New York, if they were planted approximately four weeks before the soil temperature dropped below 4°C. Soil temperatures below 4°C inhibited root growth. The authors felt this recommendation generally applied to any plants that are hardy in a given area and where no unusual problems were associated with transplanting.

The objective of this study was to examine sur-

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vival and growth of Peking cotoneaster *(Cotoneaster acutifolius)* after fall planting and spring planting following overwintering utilizing two common methods.

Materials and Methods

One-year-old Peking cotoneaster grown in plastic, one-gallon containers from cuttings were planted in a Haynie very fine sandy loam soil on September 10, 1981, and irrigated immediately following planting. Two other groups of the species were placed in either a fiberglass greenhouse or under a thermo-blanket material (6.4 mm thick with a plastic coating) for overwintering on December 22, 1981. Overwintered plants were watered well and the foliage sprayed with a fungicide prior to enclosure to prevent grey mold during storage. Greenhouse overwintered plants were placed "pot to pot" vertically while those under the thermo-blanket were overwintered with pots laid horizontally. Greenhouse overwintered plants were watered as necessary. All overwintered plants were planted among the fall planting treatments in late April 1982. Each planting treatment contained 16 plants and was replicated four times in a randomized complete block design.

Above-ground portions of eight randomly selected individuals from each treatment were harvested on November 23, 1981, June 15, and September 3, 1982. Shoot dry weights were determined after drying for 120 hours at 80°C.

The height and width of each plant within the study was measured on June 15 and September 3, 1982. All living plants were also evaluated for visual quality using a 1-5 scale (1 = 10-15% of the top alive, 2 = poor, unacceptable appearance; 3 = fair but minimally acceptable appearance; 4 = good and commercially acceptable appearance; and 5 = excellent growth, color and appearance). Relative growth rate (RGR) was calculated using methods described by Randolph and Wiest (1980) as a representative measurement of plant growth potential. All data were analyzed statistically.

Results

Survival of fall-planted cotoneaster was excellent and significantly greater than spring planting after overwintering in a fiberglass greenhouse (Table 1). Survival of plants overwintered under a thermo-blanket was reduced but not significantly compared to fall planting. Quality of fall-planted plants was significantly greater than either spring-planted treatment when measured in June, 1981 (Table 1). Plant quality of all treatments improved in September but that of the thermo-blanket-overwintered plants remained less than the greenhouse-overwintered or fall-planted treatments.

Heights, widths, and dry weights of fall-planted cotoneaster were significantly greater during both measurement periods (Table 1). The heights, but not widths, of the thermo-blanket-overwintered plants were statistically less than those of the greenhouse-overwintered plants. Relative growth rate was the same for the plants between June and September, regardless of planting treatment (Table 1).

Discussion

The winter of 1981-82 was colder than "normal" in Kansas as it was for much of the nation. Extended periods of extreme cold were experienced in January, with lows of −20°, −21° and −26°C recorded in Manhattan, and February had recorded lows of −19°, −20° and −23°C with moderate to scattered snowcover (Agricultural Experiment Station Weather Data Library, Kansas State University, Manhattan, Kansas). Unfortunately, no temperature recording equipment was available to monitor temperatures experienced by the overwintered plants or inside the root systems.

Temperatures of container-grown plants during overwintering have been studied by various researchers. Considerable but variable protection is afforded by several common types of overwintering systems (Smith, 1977). Some systems, such as single-layer polyethylene structures, offer only marginal protection for overwintering nursery stock in areas where ambient air temperatures below −30°C are experienced (Wiest, Good and Steponkus, 1976).

A structureless thermo-blanket system has been recommended for overwintering container grown plants with primary root killing temperatures above −12°C (Gouin, 1977). Container nursery stock is commonly overwintered in polyethylene structures in the Midwest with increasing numbers of nurserymen and arborists beginning to utilize thermo-blanket systems.

Although the relative root hardiness for *Cotoneaster acutifolius* has not been determined, root killing temperatures have been measured for several other *Cotoneaster* species (Table 2). *Cotoneaster acutifolius* is of a similar U.S.D.A. hardiness zone as these species and it is conceivable that the root hardiness should fall within a similar range. It is also conceivable that the temperatures of the root zone of the overwintered plants reached temperatures sufficiently low to cause death and/or considerable damage to the root system. This would somewhat explain the mortality experienced by the overwintering treatments. The root systems of fall-planted plants were sufficiently buffered by the soil to avert serious damage resulting in no loss of the plants. The thermo-blanket apparently afforded somewhat greater root protection than the unheated greenhouse environment resulting in increased, but not statistically different survival.

Root damage of surviving overwintered plants was sufficient to result in reduction of quality and growth during the subsequent growing season. Quality of surviving spring-planted *C. acutifolius* was severely reduced during the first evaluation, but visual ratings for the greenhouse-overwintered plants increased to approximately that of the fall-planted individuals by September. The quality of the thermo-blanket-overwintered plants also increased but was still significantly less than that of the other two treatments. Although protection by this system was apparently sufficient to avert death, the root system was injured to an extent that growth and landscape quality of the plants were diminished.

Early height growth was most affected in the

Table 1. Survival, quality and growth of *Cotoneaster acutifolius* after fall planting and spring planting following overwintering in an unheated greenhouse and under a thermo-blanket.

Treatment	*Survival* [z] *(%)*	*Quality*[y] *6/81*	*9/81*	*Height (cm) 6/81*	*9/81*	*Width (cm) 6/81*	*9/81*	*RGR*[x]	*Dry weights (g) 6/81*	*9/81*
Fall Planted	100.0a[w]	4.1 a	4.7a	44.5 a	74.7 a	36.4 a	67.8 a	.53 a	139 a	334 a
Spring Planted										
Thermo-blanket overwintered	84.4 ab	2.5 b	3.8 b	32.0 b	60.9 c	27.6 b	57.4 b	.59 a	96 b	195 b
Greenhouse overwintered	61.0 b	2.5 b	4.3 a	41.5 a	64.5 b	29.5 b	58.6 b	.45 a	79 b	193 b

[z] As of June, 1981.
[y] Living plants only, based on a 1 to 5 scale with 1 = poor, less than 15% alive and 5 = excellent.
[x] Relative Growth Rate.
[w] Mean separation by Tukey-*w* procedure (5%). Means followed by the same letter are not significantly different.

Table 2. Root killing temperatures of several *Cotoneaster* species.

Species	*Killing temperature (C°) Mature roots*	*Immature roots*	*Source*
Cotoneaster microphyllus	−13.0	−4.0	Studer et al.
Cotoneaster dameri	− 8.0	−5.0	Studer et al.
Cotoneaster dameri 'Skogsholmen'	−11.0	−7.0	Studer et al.
Cotoneaster horizontalis	− 9.4	—	Havis
Cotoneaster adpressa praecox	−12.2	—	Havis

thermo-blanket-overwintered plants. These remained significantly smaller than fall-planted or greenhouse-overwintered plants. Heights of the greenhouse-overwintered plants were essentially the same as those fall-planted when measured in June but the plants were significantly smaller than fall-planted by the end of the growing season. The growth potential for fall-planted cotoneaster, as measured by RGR, was greater, but not statistically greater, than greenhouse-overwintered plants.

Studer, et al. (1981) found that survival of young roots may not be crucial to survival of the entire plant but loss of water absorptive and nutrient uptake capacity of young roots may decrease top growth and may be a serious problem if rapid growth following overwintering is desirable. In this study, the damage to the entire root system may have been adequate to reduce the water absorptive capacity and thus subsequent growth of these plants. Randolph and Wiest (1981) indicate that reduction of the root system of container grown holly *(Ilex crenata)* resulted in water deficits which quantitatively accounted for reduced shoot growth.

Fall planting of *Cotoneaster acutifolius* did not adversely affect survival, quality, or growth and was preferable to overwintering under a thermoblanket or in an unheated fiberglass greenhouse during the winter of 1982. Less severe conditions, greater overwintering protection or use of another, more root-hardy plant species would undoubtedly change the results. These results indicate, however, that fall planting was feasible for semi-sensitive species under these conditions.

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