Temperate Woody Species as Interior Landscape Plants[1]

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Abstract

The feasibility of employing temperate woody species in the interior landscape was examined. The indoor performance of deciduous and evergreen plants was observed. Selected species of *Taxus, Caragana, Cornus, Ilex, Acer* and *Euonymus* showed potential for indoor use. Condition of plants at the time of introduction to the interior environment was investigated, including adjustment to light level of the plants before indoor placement. Installation of dormant plants was more successful than the installation of actively growing material.

Index words: Dormancy, light, photoperiod, growth

Introduction

The use of plants indoors has become an integral part of interior design in recent years due to fashion trends and a need to produce a working environment to which people can relate (12). Interior landscaping of large buildings, such as shopping malls or office buildings, involves the use of large and small tropical and subtropical specimens. These plants are chosen because they maintain their foliage year-round and can tolerate both low light and low levels of relative humidity. The aesthetic qualities of temperate plants can make them valuable additions to the material currently used in interior landscaping.

A major consideration in the use of temperate species in indoor landscaping is their natural dormancy period. The two major environmental 'triggers' of dormancy are photoperiod and temperature (6, 8, 11). By maintaining long day conditions and constant warm temperature, dormancy can be prevented or postponed in some species. Previous researchers have used long photoperiods and warm temperatures in growth chambers to postpone dormancy in such temperate genera as *Betula, Acer, Cornus, Rhus, Ulmus* and *Populus* (5, 8). Light levels inside shopping malls and office buildings are relatively low (12); however, photoperiods are extended as a result of supplemental lighting.

In a survey of environmental conditions in five shopping malls in the Toronto area it was found that light levels could vary from 1.6 to 190 μmol m^{-2}s^{-1} (10-1200 ft candles) depending on the time of day, season, light source and the presence of windows and skylights. The readings were usually between 20 and 25 μmol m^{-2}s^{-1} (120-150 ft candles) at noon on a clear day. Temperature within the malls was maintained between 18 and 24°C (64-74°F). Relative humidity ranged from 26 to 72%, with the mean approximately 45%.

Another concern is whether an adjustment to light level before installation is necessary. When tropical or subtropical species are moved to interior environments they often exhibit severe leaf drop induced mainly by low light levels. This shock can be reduced by slowly decreasing the light level over a period of several weeks (1, 3).

The objective of this research was to determine if temperate plants can be used as alternatives to tropicals in indoor landscapes, and if so which are most likely to succeed. Greenhouse and outdoor acclimatization were examined as well as the installation of dormant material.

Materials and Methods

All plants were approximately three years old and were obtained from either Annabel Nursery, Unionville, or Sheridan Nursery, Oakville, Ontario. The deciduous plants were potted in a mix of sand:peat:perlite (1:1:1 by vol), and the conifers in bark:peat (3:1) mixture. Kord extra large plastic pots and saucers (35 x 30 cm or 14 x 12 in) were used. Plants were watered as required and fertilized every two weeks during the summer and less frequently during the fall to spring period when watering frequency was lower due to decreased light levels and photoperiod. A 20N-8.6P-16.6K (20-20-20) fertilizer at 444 mg/l was used. Light levels were measured using a Li-Cor model LI-185 meter with a quantum sensor. Relative humidity and temperature were measured using a Psychrodyne model PP100 psychrometer. Three shoots per plant were chosen for shoot elongation measurements. They were measured using a flexible tape from the base of the terminal bud to the line of pruning paint marking the old growth. Five locations in buildings at the University of Guelph were selected to simulate interior mall conditions. At all sites the presence of incandescent lights provided an extended photoperiod.

Experiment 1. Plants of *Betula pendula, Gleditsia triacanthos* var. *inermis, Cornus sericea, Taxus* x *media* 'Hicksii' and *Cupressus macrocarpa* 'Goldcrest,' were installed dormant on January 22, 1983 at three locations. These areas received light levels ranging between 55 and 325 μmol m^{-2}s^{-1} (340-2000 ft candles) depending

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on the time of day and season. The temperature ranged from 18°C (66°F) to 21.5°C (71°F) and the relative humidity was fairly constant at 44%. Shoot elongation was measured every 4 weeks. Plants were randomly relocated every 2 weeks within each location to minimize any possible position effect. Insect and disease problems were treated as they arose.

Experiment 2. Three plants of each of the following were installed dormant May 12, 1983: *Acer palmatum, Acer platanoides, Cornus sericea, Cupressus macrocarpa* 'Goldcrest,' *Euonymus fortunei* 'Emerald Gaiety,' *Gleditsia triacanthos* var. *inermis, Ostrya virginiana,* and *Taxus* x *media* 'Hicksii.' Shoot elongation was measured every two weeks. Plant appearance was evaluated using an index of 0 to 5 with 0 = dormant, 1 = poor, 3 = good and 5 = excellent, based on condition of foliage and presence of disease or pests. A rating of 3 or better corresponded to an acceptable appearance for use in a commercial situation.

Experiment 3. Three plants each of *Caragana arborescens, Ginkgo biloba, Ilex* x *meserve* 'Blue Prince,' *Rhus aromatica, Thuja occidentalis, Juglans nigra,* and *Gymnocladus dioicus* were brought into the greenhouse September 16, 1983, and placed under a 24 hour photoperiod provided by high pressure sodium lamps. The plants were moved indoors November 11, 1983. Shoot elongation was measured weekly and plant appearance was evaluated as described in the previous experiment.

Experiment 4. Twelve dormant plants each of *Betula pendula* and *Gleditsia triacanthos* var. *inermis* were placed under 3 light levels in the greenhouse January 14, 1983 for acclimatization. The light levels were provided by 73% and 47% Propex woven polypropylene shade cloth and full light. Four plants of each species received each treatment. Stem elongation was measured every 4 weeks. The plants were transferred to the Don Mills Shopping Center May 18, 1983 for continued observation.

Experiment 5. Three plants each of *Acer platanoides, Euonymus fortunei* 'Emerald Gaiety,' *Gleditsia triacanthos* var *inermis, Ostrya virginiana,* and *Potentilla fruticosa* were placed under 50% shade provided by an outdoor lathhouse. Three plants of each were also placed outside in full sunlight. They remained in these treatments from May 12 until July 28, 1983 at which time they were moved indoors. Elongation was measured at 2 week intervals.

All experiments were in completely randomized designs except Experiment 1 which contained 3 blocks (3 locations). Experiment 4 was analyzed as a 2 x 3 factorial. The rest were analyzed using a one-way analysis of variance with repeated measurements over time. Significant differences were determined at $p < 5\%$, unless otherwise noted, according to a Least Squares Means multiple range test. Growth rates were obtained by performing a regression analysis on elongation with time.

Results and Discussion

Experiments 1 and 2. The *Betula* plants were able to generate new leaves as old ones were lost due to pest damage. Both *Gleditsia* and *Betula* put on a great deal of new growth; however, the *Gleditsia* grew for the shortest period in both experiments, and did not break dormancy by the end of the experiments. This inability to break dormancy without some special treatment makes its use indoors less promising, despite its very attractive appearance in leaf. The *Cornus* generated new growth, especially in the formation of long suckers from the base. It flowered repeatedly indoors and was able to generate new leaves when some defoliation occurred.

Betula and *Taxus* had higher growth rates than the other plants (Table 1). Both *Taxus* and *Cupressus* performed very well, showing no disease or pest problems. *Taxus* grew for the longest period in Experiment 1 (34 weeks) while *Cupressus* grew for 30 weeks, the longest growth period in Experiment 2 (Table 2).

Both species of *Acer* developed brittle, brown discolored leaves by the end of December in Experiment 2. Bud break occurred in mid-February in the lateral buds of *Acer palmatum.* By April its appearance was acceptable again. The *Acer platanoides* developed leaf discoloration somewhat earlier, in November, at which time the buds also became swollen and bright green. Bud break occurred in February but in only a few buds per tree. *Acer platanoides* required a longer period to reach acceptable appearance. It is interesting and encouraging that *Acer* plants were able to break dormancy without treatment with cold temperatures or growth regulators. *Ostrya* defoliated by September and did not break bud again. Canker was a problem with all the *Cornus* plants. The appearance of these plants was very poor in the months of November and December. However, new shoots developed quickly and by January their appearance was acceptable.

Of the temperate plants *Euonymus* grew for the long-

Table 1. Growth[z] of temperate plants indoors (Experiment 1).

Genera	Growth rate (cm/wk)	Growth (cm)	Growing time[y] (wk)
Betula pendula	2.1 ± 2.1 a[x]	51.3 ± 12.0 a	28.5 ± 0.4 b
Cornus sericea	0.7 ± 0.4 b	17.4 ± 2.3 cd	28.0 ± 0.2 b
Cupressus macrocarpa 'Goldcrest'	0.6 ± 0.2 b	11.7 ± 0.8 d	27.8 ± 0.5 b
Gleditsia triacanthos var. *inermis*	0.9 ± 0.9 b	27.1 ± 4.9 bc	16.5 ± 0.7 c
Taxus x *media* 'Hicksii'	1.9 ± 1.6 a	36.9 ± 5.0 ab	34.0 ±0.3 a

[z]Means of 3 observations per plant, 3 plants per species with standard error.

[y]Time in weeks until shoot elongation ceased.

[x]Means within a column followed by the same letter or letters are not significantly different at the 5% level using least squares means.

Table 2. Growth period and appearance of plants held indoors for 11 months (Experiment 2).

Plants	Growing time[z] (wk)	Appearance[y] (Dec. '83)	Appearance[y] (Apr '84)
Acer platanoides	7.4 ± 0.7 c[x]	1.3 ± 0.7 b	0.7 ± 0.3 de
Acer palmatum	9.4 ± 2.6 bc	0.3 ± 0.3 b	3.0 ± 0.0 bc
Cornus sericea	6.0 ± 1.2 c	1.3 ± 0.7 b	3.0 ± 0.9 bc
Cupressus macrocarpa 'Goldcrest'	30.6 ± 5.2 a	5.0 ± 0.0 a	5.0 ± 0.0 a
Euonymus fortunei 'Emerald Gaiety'	17.4 ± 4.6 b	1.5 ± 1.0 b	2.0 ± 1.2 cd
Gleditsia triacanthos var. *inermis*	6.0 ± 1.2 c	0 ± 0.0 b	0 ± 0.0 e
Ostrya virginiana	7.4 ± 2.6 c	0 ± 0.0 b	0 ± 0.0 e
Taxus x *media* 'Hicksii'	12.6 ± 4.8 bc	4.5 ± 0.3 a	4.5 ± 0.3 ab

[z]Time until shoot elongation ceased, means of 3 observations per plant, 3 plants per species, with standard error.

[y]Grade of plant appearance with standard error based on 3 observations per species at specified time. 0 = dormant, 1 = poor, 3 = good, 5 = excellent.

[x]Means within a column followed by the same letter or letters are not significantly different at the 5% level using least squares means.

est period before dormancy occurred. *Acer palmatum* had a slightly longer growing period than the other deciduous species.

The results of the grading index for December (Table 2) showed that *Cupressus* and *Taxus* were the only species to have an acceptable appearance at this point. By April *Acer palmatum* and *Cornus* had also reached acceptable levels of appearance.

The results of these 2 experiments showed that select species of *Taxus, Cornus, Acer* and *Euonymus* could be used indoors for at least a year. Further work is needed to determine how long these temperate species could survive with an acceptable appearance indoors, and whether this would prove long enough to be economically competitive with tropical species.

Experiment 3. Juglans nigra defoliated while still in the greenhouse and so was not transferred indoors. All *Ginkgo* plants held their foliage until late December at which time the leaves yellowed and abscised. The *Gymnocladus* leaves abscised 1 week after transfer indoors and had not refoliated by May. These species cannot be ruled out as possibilities for interior use based on this trial alone. Perhaps if brought indoors before dormancy initiation, defoliation would not occur.

Of the deciduous plants, *Caragana* and *Rhus* performed best. The *Caragana* retained their foliage and in January and February formed flowers and fruit. Their appearance was acceptable throughout the winter though shoot elongation was minimal. The *Rhus* maintained at least 50% of their foliage throughout the winter and began new growth in April. The evergreens performed very well (Table 3). The *Ilex* produced new growth and flowers through the winter. The new leaves were noticeably larger in area and thinner than those produced while outdoors. Conover (2) and Conover and Poole (3) reported that shade tolerant plants grown under high light intensities such as are found outdoors tended to have thicker smaller leaves. *Thuja* also performed well (Table 3); however, some yellowing and browning of the interior canopy occurred which detracted from its appearance.

Experiment 4. There was no significant interaction between species and light levels. *Betula* had a significantly ($p < 10\%$) greater growth rate and longer growing time than *Gleditsia* (Table 4). The acclimatization period under shade in the greenhouse appeared to be beneficial to the survival of *Betula* and *Gleditsia.* The

Table 3. Growth period and appearance of plants brought indoors in September, 1983 (Experiment 3).

Genera	Growing time[z] (wk)	Appearance[y] (Apr '84)
Caragana arborescens	3.4 ± 0.7 b[x]	2.8 ± 0.4 c
Ginkgo biloba	2.0 ± 0.0 c	0 ± 0.0 d
Ilex x *meserve* 'Blue Prince'	14.0 ± 0.0 a	5.0 ± 0.0 a
Rhus aromatica	2.0 ± 0.0 c	3.7 ± 0.3 b
Thuja occidentalis	14.0 ± 0.0 a	3.8 ± 0.2 b

[z]Time until shoot elongation ceased, 3 observations per plant, 3 plants per species, with standard error.

[y]Grade of plant appearance with standard error, based on 3 observations per species, April, 1984. 0 = dormant, 1 = poor, 3 = good, 5 = excellent.

[x]Means within a column followed by the same letter are not significantly different at the 5% level using least squares means.

Table 4. Growth of plants under three light levels in a greenhouse, then moved to Don Mills Shopping Center (Experiment 4).

Genera/Light level	Growth rate (cm/wk)	Growing time[z] (wk)
Betula pendula	2.0 ± 0.6[y] a[x]	20.3 ± 1.0 a
Gleditsia triacanthos var. *inermis*	0.3 ± 0.2 b	13.7 ± 1.0 ab
0% shade	1.3 ± 0.9[w] a	12.0 ± 1.1 b
47% shade	1.4 ± 0.8 a	13.2 ± 0.9 ab
73% shade	0.7 ± 0.5 a	16.6 ± 1.05 a

[z]Time until shoot elongation ceased.

[y]Values are an average of 3 observations per plant, 8 plants per light level, and 3 light levels, with standard error.

[x]Species or light level means within a column followed by the same letter are not significantly different at the 10% level using least squares means.

[w]Values are an average of 3 observations per plant, 12 plants per species, with standard error.

Table 5. Growth of plants brought indoors after exposure to two outdoor light levels (Experiment 5).

Genera	Growth (cm)	Growing time[z] (wk)	Growth rate (cm/wk)	
			Shade	Sun
Acer platanoides	14.1 ± 2.8[y] a[x]	3.0 ± 0.4 b	0.2 ± 0.1 c	0.2 ± 0.2 c
Euonymus fortunei 'Emerald Gaiety'	5.0 ± 0.9 b	9.0 ± 1.4 a	0.7 ± 0.2 bc	0.2 ± 0.2 c
Gleditsia triacanthos var. *inermis*	15.1 ± 3.1 a	8.6 ± 2.0 a	1.0 ± 0.5 bc	3.6 ± 1.3 a
Ostrya virginiana	7.7 ± 1.1 b	7.7 ± 0.8 a	0.3 ± 0.2 c	0.3 ± 0.1 c
Potentilla fruticosa	7.7 ± 2.0 b	8.0 ± 0.0 a	1.9 ± 0.8 b	0.9 ± 0.1 bc

[z]Time until shoot elongation ceased.

[y]Based on 3 observations per plant, 3 plants per species, per light treatment averaged over 2 light treatments with standard error.

[x]Means separated within a row or column followed by the same letter are not significantly different at the 5% level using least squares means.

73% shade treatment resulted in a significantly longer growing period than the 0% treatment (Table 4).

Spider mites were a problem while the plants were in the shopping center. Weekly treatment with Pentac controlled the mites until late November and December. At this time treatment had to stop due to extended shopping hours and the presence of large Christmas displays which made spraying impossible. By January, the plants were coated with webs and had to be removed due to their unsightliness. The *Betula* had maintained some of their foliage until this time with the full sun plants having lost more of their foliage than those from the shade treatments. The full sun *Gleditsia* had defoliated by June, while the shade treated plants maintained good appearance until September.

From this study it appears that low light treatment increased the foliage retention and quality of these 2 species. A major problem to be overcome in this project was spider mite infestation. Future studies could examine the possibility of employing predator mites which do not affect the plants but have been found to control the destructive mite population in greenhouse situations (10).

Experiment 5. Of the 5 genera observed after transfer indoors only the *Euonymus* and *Acer* had retained their foliage by April, 1984. The others defoliated before December. The *Euonymus* plants put on new growth while indoors, while *Acer* stopped growth in July. This had been the case with all the specimens of *Acer platanoides* observed. According to Critchfield (4) *Acer platanoides* is one of the few maple species in which the shoots are mostly preformed in the bud. As a result, despite favorable environmental conditions, the amount of growth that will take place may be predetermined before dormancy is broken. The leaves began to exhibit pronounced discoloration and brittleness by February. By June, only 1 of the 6 *Acer* had broken bud. The bud break was sporadic and occurred only at the lateral buds. The lack of terminal bud break has also been reported by others (7, 9).

There was little apparent difference between full sun and shade treated plants. A significant interaction between light treatment and species was detected on the basis of growth in *Gleditsia* (Table 5), but there was little difference in appearance between the treatments. *Gleditsia* and *Euonymus* put on significantly more growth but *Gleditsia* ceased elongation earlier than the other species (Table 5). Perhaps a higher percent shade would have given more definite results. However, it is interesting that those plants which retained their leaves appeared to do equally well whether from the shade or full sun treatment.

From these experiments it appears that there is potential for the use of some temperate species indoors as alternatives to tropicals. *Gleditsia* can be ruled out unless some treatment with growth regulators would enable the plants to either maintain their foliage or break dormancy after defoliation had occurred. Gibberellic acid and cytokinins are known to be effective in overcoming bud dormancy in many species (6, 13).

Betula could lend a north temperate atmosphere to the interior landscape, but its susceptibility to spider mites may preclude its use for this purpose. Also, leaf hoppers on *Gleditsia,* birch leaf miners, and canker on *Cornus* could be problems.

The evergreens *Taxus, Ilex* and *Cupressus* were promising for easy incorporation into an indoor design. The variety of color, leaf form and growth habit together with lack of disease and pest problems make these plants worthy candidates as additions to the interior landscape. *Thuja* is a less desirable plant for indoor use because of its susceptibility to mites.

Temperate deciduous species appear to have a place in many interior designs because of their form, texture and availability. This is evident by the popularity of *Ficus benjamina* and *F. retusa* 'Nitida,' tropical species often used in large indoor plantings at least partly because of their resemblance to temperate species. *Caragana* seemed to be the best choice as an interior deciduous species, exhibiting no symptoms of disease or insect problems, and maintaining its foliage throughout the year. The two species of *Acer* observed showed potential also. They could be incorporated with the expectation of a short dormancy period without foliage. Another possibility is treatment with growth regulators to prevent or postpone this dormancy period. *Rhus aromatica* also kept its foliage through the winter. However, by April it had an unthrifty appearance until the new spring growth was established. This species could also be incorporated into the interior landscape successfully. *Cornus sericea* maintained growth and appearance while indoors and is a promising prospect except for the problem with canker fungus infection. *Potentilla* did not perform well in these trials and is not recommended for interior use. *Ginkgo, Gymnocladus,* and *Juglans* may be useful if brought indoors while dormant or before short days and low temperatures outdoors have initiated the processes involved in dormancy.

Temperate species should be seen as possibilities for the enhancement of interior designs in conjunction with the use of tropical and sub-tropical species. Their availability, ease of propagation, and variety of physical attributes including bark color, leaf form and growth habit will add interest to the interior landscape. In order to be economically feasible an interior plant should probably last 3 or more years with good cultural practices. While the cultural practices employed in the present study were similar to those used by interior landscapers, a long-term study is necessary to determine whether the successful plants such as *Ilex, Taxus* and *Caragana* will be sustained for the desired period or will require more frequent replacement. Further research to examine longevity and long-term maintenance requirements is necessary to determine the economic feasibility of the use of temperate plants in the interior landscape.

Significance to the Nursery Industry

Temperate plants which maintained their appearance through the winter without requiring a dormancy period have immediate promise for the interior landscaping industry. These included selected species of *Caragana, Cornus, Rhus, Ilex, Taxus,* and *Euonymus*. Species of *Acer* such as *A. platanoides* and *A. palmatum* which underwent a short dormancy period are also potential interior plants. Placement in a large planting would make their dormant period less noticeable, and attractive leafless forms could add to rather than detract from the landscape. Gibberellic acid and cytokinins have both been used to postpone and break dormancy successfully (6, 13, 14). Perhaps such hormones could be employed in the plant maintenance program to avoid or shorten the dormancy period in these species. This information can be used by nursery and interior landscapers to provide temperate plants suitable for interior landscapes. These plants need to be aesthetically pleasing; therefore, nurseries need to prepare for this new market by providing well-shaped plants of a reasonable size for interior use. Architects can use this information to create the best possible interior conditions for the survival of these plants.

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