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Drought-tolerant Small Trees for Maine Landscapes

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ACKNOWLEDGMENTS

The image on the cover is a picture of a flowering *Maackia amurensis* from the Lyle E. Littlefield Ornamentals Trial Garden at The University of Maine. The drawings used throughout this bulletin were drawn by Margery Read, a Master Gardener in The University of Maine Cooperative Extension's Master Gardener program.

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INTRODUCTION

There is a great deal of interest these days in the smaller deciduous trees, plants that mature to 30 feet or less in height. Too small to be considered shade trees, the best of these "courtyard" or "patio" trees should have characteristics that make them ornamental features of the small landscape throughout the year. The ideal representative of this group would combine seasonal flower display with attractive foliage, rich autumn leaf color, interesting bark character, attractive branching habit, and resistance to insects and diseases. In addition, there would no messy fruit to clean up. From a production point of view this plant must be easy to propagate. And, of course, for northern regions the likely candidate must also have extreme cold hardiness. Finally, non-native plants selected for use in managed landscapes should not be invasive. We don't ask for much!

Actually there are a few tree species of small stature that come close to meeting these demanding requirements. For the past five years I have been growing several species of small trees in a replicated trial at The University of Maine, Orono. This publication, the first published results from this effort, describes five species that have proven to be reliably cold hardy in Orono (USDA Zone 5a) and that meet many, if not all, of the criteria for exceptional landscape trees. In addition, these five species are currently uncommon in Maine landscapes and thus represent potentially new products and new opportunities for the Maine landscape and nursery industries.

THE TREES

Tables 1 and 2 give basic information and cultural requirements, respectively, for the five species. The following descriptions are taken from my lecture notes for the woody landscape plants courses at The University of Maine.

Acer miyabei, Miyabe Maple

Discovery of this rare tree occurred by accident. In the nineteenth century, Professor C. S. Sargent of the Arnold Arboretum, while waiting for a train in Yezo, Japan, strayed from the station and into a grove of trees on the border of a stream where he found *A. miyabei* in fruit. He later obtained seed from the trees, leading to the commercial introduction of *A. miyabei* to the U.S. in 1892.

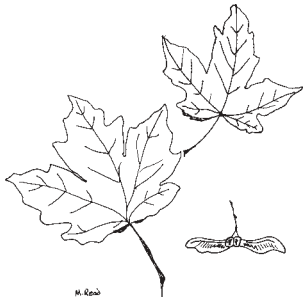
My first encounter with *Acer miyabei* (Miyabe Maple) was a single tree growing in a courtyard at Smith College Arboretum in

Table 1. Species of small flowering trees evaluated in this study.

Botanical Name	Common Name	Native Range	USDA Hardiness	Mature Height	Mature Width	Growth Rate
Acer miyabei	Miyabe Maple	Northern Japan	Zone 4	20 to 25’	15 to 20’	Slow to medium
Acer triflorum	Three-flower Maple	Manchuria and Korea	Zone 3B	15 to 25’	15 to 25’	Slow to medium
Cercis canadensis	Eastern Redbud	Southeast and central U.S.	Zone 4B	20 to 30’	15 to 25’	fast
Maackia amurensis	Amur Maackia	Manchuria	Zone 3	20 to 35’	15 to 25’	slow
Prunus sargentii	Sargent Cherry	Japan	Zone 5	25 to 40’	25 to 40’	fast

Table 2. Cultural requirements for the five species of small flowering trees.

Botanical Name	Light Requirement	Soil Tolerance	Drought Tolerance	Salt Tolerance	Pests and Diseases	Propagation
Acer miyabei	Full sun	Adapts to a broad range of soil types.	High	High	Excellent resistance	Softwood cuttings, budding or tissue culture
Acer triflorum	Full sun to partial shade	Tolerant of clay, loam or sand; prefers acid or slightly alkaline and well-drained soils.	Moderate	Moderate	Excellent resistance	By seed, but with very low rates of germination; can be grafted onto other trifoliate maple rootstock.
Cercis canadensis	Full sun in northern landscapes; partial shade in the south.	Adapts to a broad range of soil types. Prefers well-drained, acidic or slightly alkaline soils.	High	Poor	Usually not bothered by insect pests. Susceptible to *Verticillium* wilt and canker.	By seed
Maackia amurensis	Full sun	Adapts to a broad range of soil types and pH. Prefers well-drained soils.	High	Unknown	No pests or diseases are normally seen on this tree.	By seed
Prunus sargentii	Full sun	Adapts to a broad range of soil types and pH. Prefers well-drained soils.	High	Moderate	Less susceptible to disease than other cherries; long-term health usually not affected by pests.	By seed and cuttings



Northampton, MA. Its short-trunked habit, the framework of its strongly ascending branches, and its mottled gray and tan bark, all produced a unique winter character that was enhanced by a dusting of new snow. I returned the following summer to find a tree with rounded habit and dense crown, the leaves five-lobed, each lobe tapering to a point that is blunt at its tip. In autumn the foliage turned to golden-yellow.

I have seen several specimens of this species since that first encounter and they all presented the same characteristics except for a great deal of seedling variation in growth habit. This has led to the development of State Street® ('Morton'), a recent selection from the collections of The Morton Arboretum, Lisle, IL, and introduced by the Chicagoland Grows Plant Introduction Program. The parent tree, planted in 1929, has thrived, developing a uniform crown with ascending branches and a broad-pyramidal habit. The growth rate is slow to medium after establishment, 6 to 12 inches per year.

Acer miyabei is a rare tree in New England landscapes, although there is little doubt as to its hardiness. Dirr (1998) reports it hardy to Zone 4, citing a specimen thriving at the Minnesota Landscape Arboretum where winter temperatures drop to –30 °F. Considered more drought tolerant than *Acer platanoides* (Norway Maple), *A. miyabei* would make an excellent substitute for this nonnative invasive species in New England landscapes.

***Acer triflorum,* Three-flower Maple**

Discovered in 1896 in Manchuria, this species was introduced to the United States in 1923. While considered an extremely desirable small maple, difficulties with propagation have restricted its availability. Like *Acer griseum*, it is a trifoliate maple, each leaflet with a few course teeth or sublobes. The fall foliage color of this maple is one of its best ornamental features, described as brilliant red to yellow-pink or salmon-pink, the most beautiful of the trifoliate maples. The

foliage of a specimen growing in Littlefield Garden (University of Maine, Orono) turned to a brilliant orange in the past three autumns.

Three-flower Maple produces three greenish-yellow flowers clustered together in spring and followed by 1- to 1.5-inch-long winged seeds that persist on the tree. The flowers are inconspicuous and not showy while the fruits, tan at maturity, are more noticeable.

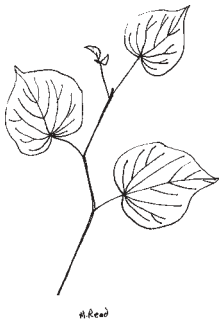
Another highly ornamental feature of this tree is its finely scaly bark that curls in coils to give the trunk a handsome rugged look and accounting for an alternate common name, rough-barked maple. This feature is particularly striking in multi-trunked trees and, in fact, *A. triflorum* is routinely grown with multiple trunks or with a single short trunk that divides within a few inches of the ground into multiple leaders.

Typically considered a small tree, I witnessed an old tree at the Arnold Arboretum that must be at least 60 feet tall. Most trees in cultivation, however, seldom exceed 25 feet in height.

***Cercis canadensis,* Eastern Redbud**

One cannot grow up in the South, as I did, and not be aware of this small flowering tree. With the flowering dogwood (*Cornus florida*), it is a herald of spring. I have fond memories of old trees growing along the riverbank at Mulberry Plantation in Charleston, SC, their leafless late winter crowns strewn with long gray strands of Spanish moss blowing in the breeze. They reminded me of old men. And the Spanish moss (not truly a moss but an epiphyte, a member of the pineapple family) was the perfect foil for the purple-pink flowers that covered the early spring branches before the leaves emerged. After flowering the heart-shaped leaves emerged, dark green for summer, then a soft yellow in autumn.

Growing in the open, *C. canadensis* can be a relatively large tree, perhaps 30 feet or more in height. Most redbuds found in the woodland understory and in managed landscapes are smaller, typically 20 feet high. They have an irregular growth habit when young, but assume a graceful flat-topped vase habit as they mature. Trees usually branch very low to the ground, resulting in multi-trunked specimens. Whether allowed to grow in this manner or trained to a single trunk, redbuds require pruning to develop a



strong structure. Branches with narrow ("V"-shaped) branching angles relative to the main trunk should be completely removed in favor of branches with a wider ("U"-shaped) angle. Also, branches should be spaced about 6 to 10 inches apart along the main trunk.

Redbud flower buds are not as cold hardy as the vegetative buds and can often be damaged by extreme cold. In the past, this has prevented the use of redbuds in northern New England landscapes. However, for the past five winters I have been evaluating a promising strain of *C. canadensis* that was introduced by Bailey Nurseries of Minnesota as their "Minnesota Strain," seedlings from a tree growing at the Minnesota Landscape Arboretum. I learned from Ed Haselkus, Longenecker Arboretum at University of Wisconsin, Madison, that this strain originated as a selection from a wild population growing in Illinois. Plants propagated from the original selection were subsequently grown and flowered successfully at Longenecker. In the early 1990s, Bailey Nurseries gave plants of the "Minnesota Strain" to Dr. Paul Cappiello, my predecessor, and they were planted in the nursery at The University of Maine, Orono. I transplanted five of these trees to the Small Tree Evaluation Trials in May 2000.

Maackia amurensis, Amur Maackia

Maackia amurensis, the Amur Maackia, is a small, vase-shaped and round-headed tree of considerable ornamental character. I have photographed and studied this species throughout New England and while every arboretum and college campus seems to have at least one Amur Maackia, I have yet to see one in a residential landscape or along a city street! It is not a common tree in New England.

The basis for this lack of popularity eludes me. Amur Maackia's mature size, 20 to 30 feet high, is ideally suited to small residential gardens, city streets and even planters. Its shiny, dark amber, outer bark peels into loose flakes and curls, revealing small sharp-angled patches of inner bark. The rich color of its trunk and branches coated in new snow will add warmth to any winter landscape.

In spring, Amur Maackia's emerging foliage is a soft gray-green due to pubescence on the leaves. Summer foliage, however, is a bold, rich green. Each compound leaf is composed of five to seven leaflets, each about 1 to 3 inches long. The one shortcoming of Amur Maackia

is lack of good fall color, the leaflets falling as they turn yellow-brown.

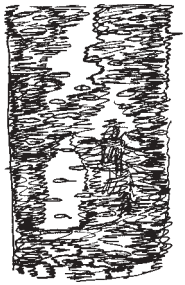
Maackia amurensis belongs to the bean family, the Fabaceae, and is closely related to *Cladrastis kentukea* or American Yellowwood (the difference being that the leaf buds of *Maackia* are solitary and not hidden by the base of the petiole). Family ties are evident in the off-white pea-like flowers that occur in early to mid-July (Maine) in 4- to 6-inch-long terminal racemes, smelling like new mown grass and typically alive with bumblebees. The fruit is a 2- to 3-inch-long pod. While it is maturing, the pod is a lighter shade of green than the foliage, providing a very appealing contrast in color and texture. The pod matures to brown and lingers after the leaves have dropped.

Amur Maackia also passes the test of durability. Lacking any serious pest or disease problems, it is extremely cold hardy, growing successfully in Zone 3. I did receive one report from New Hampshire of serious Japanese beetle infestation on Amur Maackia. I found this surprising, as none of the several trees I have visited in Massachusetts or Maine have shown signs of insect feeding.

With such impressive credentials, I scratch my head and continue to wonder why *Maackia amurensis* is not used more frequently. Could it be problems with propagation, the nemesis of many otherwise good landscape plants? According to the experts, Amur Maackia is easily grown from freshly collected seed that is either soaked in hot (190 °F) water or acid scarified. In fact, several students in The University of Maine Landscape Horticulture Program have grown *Maackia amurensis* from seed collected off the tree in Littlefield Garden. So the mystery remains.

***Prunus sargentii,* Sargent Cherry**

This is the hardiest (Zone 4) of the taller Japanese cherries and one of the finest of all cherry trees. It is named for Charles Sprague Sargent (1841–1927), noted horticulturalist and plant hunter. Blooming in mid-May in Orono, before the foliage, the flowers are single, pink to deep pink, on slender pedicels. The bitter cherries are small (3/8 inch) and ovoid, ripening to dark purple in summer when the birds quickly devour them. The bark, particularly attractive in winter, is brown



to red-bronze and marked with horizontal lenticels. The foliage is a colorful bronze in early spring, turning deep green during summer and orange to red in fall.

The habit of Sargent Cherry is upright with a rounded top. It grows rapidly to a height of 40 to 50 feet with a comparable width, casting dense shade. The oldest specimen in America, grown from seed sown in 1890 at the Arnold Arboretum, had to be taken down because of storm damage. The record tree in cultivation, growing in Puyallup, WA, is 45 feet high, although the species will grow to 80 feet in the wild.

Sargent Cherry makes an excellent street tree in areas that can accommodate its spreading canopy. No other cherry is as stress tolerant. It can also be used in the tree lawn area between the curb and sidewalk or as a specimen tree in the lawn. During its relative short life expectancy, about 20 years, it will grace any landscape with beauty throughout the year.

EVALUATION METHODS

Cultural Methods

Table 3 presents information on sources and planting dates for each of the five species. For *Maackia amurensis* both the variety *buergeri* and a cultivar, 'Starburst' were evaluated. For *Prunus sargentii*, the white-flowering cultivar 'Princeton Snowcloud' was evaluated. Both the *M. amurensis* 'Starburst' and the *P. sargentii* 'Princeton Snowcloud' were planted bareroot as received from the supplier. The *C. canadensis* was transplanted from a holding nursery adjacent to the trial plots. All other trees were planted from containers.

Five trees of each species and cultivar were planted in a full sun research plot at the Lyle E. Littlefield Ornamentals Trial Garden (Orono, Maine) using standard landscape installation practices. Each tree was randomly assigned to one of 98 available planting locations in a completely randomized block experimental design. Trees were planted in rows spaced 4.6 meters (15 feet) apart with 3 meters (10 feet) between trees in each row. Soil tests on five separate samples collected across the planting area indicated a sandy loam soil ranging in pH from 5.7 to 6.0. Organic matter ranged from 6.8% to 8.0% while levels of P, K, Ca, and Mg all ranged from medium to optimum. No soil amendments were added to the backfill at planting and no fertilizer was applied throughout the study. All trees were watered weekly, as needed to supplement

Table 3. Sources and planting dates for the five species of small flowering trees.

Botanical Name	Source	Planting Date
Acer miyabei	Heritage Seedlings (Salem, OR)	May 1999
Acer triflorum	Heritage Seedlings (Salem, OR)	May 1999
Cercis canadensis "Minnesota Strain"	Bailey Nursery(St. Paul, MN)	May 2000
Maackia amurensis var. buergeri	Seed from tree in Littlefield Garden, Univ. of Maine, Orono	June 2000
Maackia amurensis 'Starburst'	Princeton Nursery(Princeton, NJ)	May 2000
Prunus sargentii 'Princeton Snowcloud'	Princeton Nursery (Princeton, NJ)	May 2000

rainfall, during the first year to ensure successful establishment; in subsequent years, no irrigation was used to supplement rainfall. Trees were monitored for insect and disease problems, but no chemical controls were applied. Pruning, including removal of dead, damaged, diseased, and crowded branches, was conducted in the second and subsequent years to develop scaffold branching systems and maintain tree health.

Measurements of Tree Growth

Plant height was measured immediately after planting and on June 1, 2003. Plant width at the widest point and trunk diameter 15 centimeters from the ground was also measured on June 1, 2003. The *C. canadensis* were received from the supplier and planted prior to the start of this study and there were no records of initial tree height.

Climate Data

Temperature and rainfall data were obtained from Maine State Climate Office records for Bangor, Maine.

RESULTS

Table 4 presents winter temperature and monthly precipitation data for Bangor, ME, located approximately six miles from the evaluation site. Lowest annual minimum temperatures for the four winters of this study ranged from –12 °F (-24 °C, 2002) to –22 °F (-30 °C, 2000). A plant hardiness zone map for Maine, based on average annual minimum temperature data for the period 1974 to 1986 (Lois Berg-Stack, University of Maine Cooperative Extension Bulletin #2242), positions the Bangor-Orono area in USDA Hardiness Zone 5a. The average annual minimum temperature for the four-year period of this study was –18 °F (-28 °C), consistent with this Zone 5a ranking.

The period of this study, May 1999 to March 2003, was below average in total precipitation. The second year of the study, 2001, was the driest year on record (15.61 inches below normal), while August 2002 and January 2003 were the driest and third driest months on record, respectively. For the growing seasons (April through September) of 2000, 2001 and 2002, rainfall amounts were below normal. During the growing season of 2001, total precipitation was 65% of the 30-year mean.

Table 5 shows changes in tree height during the study period as well as measurements of tree width and trunk caliper at the end of the study period. Mean growth rates were calculated from the differences in mean tree height. Tree size at planting for the *C. canadensis* was unknown and thus a growth rate for this species could not be determined. Most trees, including all *A. triflorum* and *P. sargentii* 'Princeton Snowcloud', survived and grew during the study period. One tree each for the remaining three species and *M. amurensis* var. *buergeri* did not survive. One *C. canadensis* did not survive transplanting from the nursery and was removed on June 6, 2000. An errant vehicle destroyed a *M. amurensis* 'Starburst'. Reasons for the other losses were not obvious.

Prunus sargentii 'Princeton Snowcloud' lived up to its reputation as a fast-growing tree, averaging 75 centimeters (30 inches) increase in height per year. While *Maackia* are considered slow-growing trees, the *M. amurensis* 'Starburst' averaged an increase in height of 51 centimeters (20 inches) per year in this study, second only in growth rate to *P. sargentii* 'Princeton Snowcloud'. The *M. amurensis* var. *buergeri*, however, averaged only 12 centimeters (5 inches) increase in height per year. The two maples were comparable in growth rate during the study period with *A. miyabei* showing a slightly higher rate of growth (Table 5). This difference was due to one exceptional *A. miyabei* tree (#4 in Table 5) that had

Table 4. Lowest minimum winter temperatures (LowTMin, °F), monthly precipitation amounts (Prcp, inches), annual precipitation totals, and growing season (April – September) precipitation totals for the period January 2000 until March 2003. For comparison, 30-year precipitation means are included.

Year	Month	LowTMin	Prcp	Prcp (30-yr. Mean)
2000	January	-22	3.82	3.34
	February	-18	2.36	2.54
	March	2	3.71	3.44
	April		5.63	3.32
	May		4.24	3.40
	June		2.63	3.41
	July		2.08	3.24
	August		2.03	2.99
	September		1.35	3.39
	October		3.28	3.46
	November		2.83	3.69
	December	-2	3.75	3.33
	Annual Total		37.71	39.57
	Growing Season Total		17.96	19.75
2001	January	-13	1.51	3.34
	February	-9	1.87	2.54
	March	-16	2.84	3.44
	April		0.77	3.32
	May		1.51	3.40
	June		1.54	3.41
	July		3.18	3.24
	August		1.72	2.99
	September		4.04	3.39
	October		1.22	3.46
	November		1.93	3.69
	December	2	1.83	3.33
	Annual Mean		23.96	39.57
	Growing Season Mean		12.76	19.75
2002	January	-6	3.35	3.34
	February	-12	3.43	2.54
	March	11	3.33	3.44
	April		5.68	3.32
	May		2.51	3.40
	June		3.56	3.41
	July		2.24	3.24
	August		0.73	2.99

Table 4. Continued.

Year	Month	LowTMin	Prcp	Prcp (30-yr. Mean)
2002	September		4.19	3.39
	October		3.19	3.46
	November		4.64	3.69
	December	-2	3.94	3.33
	Annual Mean		40.79	39.57
	Growing Season Mean		18.91	19.75
2003	January	-17	0.94	3.34
	February	-21	2.65	2.54
	March	-10	4.08	3.44

an individual growth rate much higher than the species mean. This same tree developed a trunk caliper twice as large as the other *A. miyabei*.

An infestation of Japanese beetles on *P. sargentii* 'Princeton Snowcloud' was the only serious pest problem during the course of this study, occurring in the summer of 2000. All five trees were affected, each losing most of the foliage. The leaves were replaced in late August, however, and the trees survived the following winter without dieback. Japanese beetles were not a problem on these trees in subsequent years.

During the extreme drought of summer 2001, the foliage of *M. amurensis* var. *buergeri* turned brown in mid-summer and all trees were defoliated by August. This early leaf loss did not affect subsequent winter survival, but it may have affected mean growth rates for the study period. The larger *M. amurensis* 'Starburst' did not experience this problem.

CONCLUSIONS

The five tree species described in this study have proven to be winter hardy in the Bangor-Orono area (Zone 5a), drought tolerant and relatively pest free, three factors that recommend them for increased use in Maine landscapes. Over the four years of this study, the trees were exposed to winter temperatures as low as –22 °F, as well as desiccating winter winds, without apparent damage to overwintering buds.

Table 5. Measurements of tree height at planting and measurements of tree height, width and trunk caliper on June 1, 2003. Measurements in cm (inches). A (*) indicates that the tree did not survive.

Botanical Name	Tree Number	Tree Height at planting	Tree Height on June 1, 2003	Mean Growth Rate cm (in)/year	Tree Width (at widest point) on 6/1/2003	Trunk caliper (at 15 cm above the ground) on 6/1/2003
Acer miyabei	1	41 (16)	94 (37)	13 (5)	41 (16)	1.3 (0.5)
	2	46 (18)	216 (85)	43 (17)	91 (36)	1.9 (0.8)
	3	35 (14)	61 (24)	7 (3)	58 (23)	1.9 (0.8)
	4	62 (24)	284 (112)	56 (22)	56 (22)	3.8 (1.5)
	5	33 (13)	*	*	*	*
	Mean (n=4)	43 (17)	164 (65)	30 (12)	62 (24)	2.2 (2.0)
Acer triflorum	1	80 (31)	178 (70)	25 (10)	89 (35)	1.9 (0.8)
	2	91 (36)	142 (56)	13 (5)	91 (36)	1.9 (0.8)
	3	70 (28)	168 (66)	25 (10)	61 (24)	2.5 (1.0)
	4	82 (32)	185 (73)	26 (10)	51 (20)	1.9 (0.8)
	5	79 (31)	213 (84)	34 (13)	91 (36)	2.5 (1.0)
	Mean (n=5)	80 (32)	177 (70)	24 (10)	77 (30)	2.1 (0.9)
Cercis canadensis						
"Minnesota Strain"	1	Not known	241 (95)	-	183 (72)	3.2 (1.3)
	2	"	291 (115)	-	244 (96)	6.4 (2.5)
	3	"	309 (122)	-	247 (97)	5 (2.0)
	4	"	276 (109)	-	221 (87)	4.4 (1.7)
	5	"	*	-	*	*
	Mean (n=4)		279 (110)		224 (88)	4.8 (1.9)

Table 5. Continued.

Botanical Name	Tree Number	Tree Height at planting	Tree Height on June 1, 2003	Mean Growth Rate cm (in)/year	Tree Width (at widest point) on 6/1/2003	Trunk caliper (at 15 cm above the ground) on 6/1/2003
Maackia amurensis						
var. buergeri	1	19 (7)	51 (20)	11 (4)	15 (6)	1.0 (0.4)
	2	21 (8)	61 (24)	13 (5)	25 (10)	1.0 (0.4)
	3	25 (10)	58 (23)	11 (4)	20 (8)	1.3 (0.5)
	4	26 (10)	*	*	*	*
	5	29 (11)	64 (25)	15 (6)	15 (6)	1.0 (0.4)
	Mean (n=4)	24 (9)	59 (23)	12 (5)	19 (8)	1.1 (0.4)
Maackia amurensis						
'Starburst'	1	140 (55)	311 (122)	57 (22)	118 (46)	3.2 (1.3)
	2	135 (53)	281 (111)	49 (19)	115 (45)	3.8 (1.5)
	3	130 (51)	*	*	*	*
	4	145 (57)	314 (124)	56 (22)	122 (48)	3.8 (1.5)
	5	135 (53)	259 (102)	41 (16)	102 (40)	3.8 (1.5)
	Mean (n=4)	139 (55)	291 (115)	51 (20)	114 (45)	3.7 (1.5)
Prunus sargentii						
'Princeton Snowcloud'	1	106 (42)	352 (139)	82 (32)	not measured	5.1 (2.0)
	2	195 (77)	344 (135)	50 (19)	"	5.1 (2.0)
	3	90 (35)	375 (148)	95 (38)	"	5.1 (2.0)
	4	97 (38)	309 (122)	71 (28)	"	5.1 (2.0)
	5	120 (47)	359 (141)	75 (30)	"	5.1 (2.0)
	Mean (n=5)	122 (48)	348 (137)	75 (30)	*	5.1 (2.0)

Of particular importance to Maine growers and landscapers is the flower bud winter hardiness of the *Cercis canadensis* strain used in this study. Of the original twenty or more plants of this strain given to Dr. Cappiello by Bailey Nurseries, the five trees in this study represent the hardiest of the group, flowering above the snow line each year of the study. In addition to these five trees, there are three trees from the same Bailey shipment that were transplanted to the ornamentals display area of Littlefield Garden in May 2000. These three trees have also flowered consistently above the snow line each year. These eight trees were propagated from seed collected from a single tree growing at the Minnesota Landscape Arboretum, indicating that their superior winter hardiness is a trait that can be sustained through seed propagation. The "Minnesota Strain" continues to be available from Bailey Nurseries; however, I believe it is time to start collecting seed from the trees in this study and propagating an "Orono Strain".

The summer droughts of the past few years have increased interest in drought-tolerant trees for Maine landscapes. The five species recommended by this study survived the driest summer on record (2001) without supplemental irrigation. Although all of the growing seasons after planting were below normal in precipitation, these trees not only survived, they thrived. The drought tolerance of *Prunus sargentii*, as evidenced by the performance of 'Princeton Snowcloud' in this study, is also evident in the performance of several trees of the species on The University of Maine Orono campus. Similarly, the *Maackia amurensis* var. *buergeri* from which seed was collected to propagate the trees used in this study has continued to flourish in Littlefield Garden during the recent drought, as has a single specimen of *Acer triflorum*.

I have yet to encounter either of the two maples of this study, *A. triflorum* and *A. miyabei*, in a Maine landscape. Both are readily available, so I have to conclude that they are simply in need of greater recognition as attractive, winter-hardy and drought-tolerant landscape trees. Based on the results of this study, landscape designers should be encouraged to use these two maples.

None of the tree species in this study are native to Maine and only one, *C. canadensis*, is native to North America. In recommending non-native trees for use in managed landscapes, the invasive potential of each species should be evaluated in order to avoid the use of non-native invasive tree species such as Norway Maple (*Acer platanoides*) that escape from cultivation and threaten the integrity of natural areas. At this time the five tree species recommended by this study show no invasive potential. For example, *A. miyabei*

has been under observation at The Morton Arboretum since 1929 without any indication of invasive potential. This fact, along with the demonstrated drought tolerance of Miyabe Maple, makes it an excellent replacement for Norway Maple in future landscapes.

LITERATURE CITED

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