Alternatives to ash for Michigan and the Upper Midwest: Planting demonstration and website

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Significance

Emerald ash borer has certainly dominated the press over the past year, and unfortunately, it is going to continue until we become better informed and equipped to arrest its spread and begin the road to recovery. A recent survey indicated that ashes comprised up to 25% of the street trees in some Southeast Michigan cities. In all likelihood the emerald ash borer will eventually kill most of these trees. As trees are lost to emerald ash borer, a large-scale replanting effort is underway. To maintain the long-term health and sustainability of our landscapes and urban forests we need to consider and plant a diversity of species and selections. In the March/April 2003 issue of *The Michigan Landscape* we suggested substitute or alternative selections for ash. We looked at a broad spectrum of selection criteria, such as ornamental appeal, adaptability in the urban and suburban environment and availability. The species/ cultivars suggested are already in production, some of which may not be widely known or used in the landscape. The nursery industry has stepped up production on many of these selections to fill the void left by ash, however, it may be a few years before we see find them in plentiful numbers at the upper landscape sizes. Regardless of the time it takes, the introduction of species diversity into our residential and commercial landscapes will be well worth it.

Thanks to the generosity and assistance of J. Frank Schmidt and Sons Nursery, Carlton Plants, the Michigan Nursery and Landscape Association, and Project GREEEN, a demonstration plantation was installed in May at the Michigan State University

Tree Selections Planted at Ash Alternative Arboretum at Michigan State University Tollgate Extension Center, Novi, Michigan

Common Name	Scientific Name
Hedge Maple	*Acer campestre*
State Street Maple	*Acer miabei* 'State Street'
Emerald Queen Maple	*Acer platanoides* 'Emerald Queen'
Superform Maple	*Acer platanoides* 'Superform'
Tatarian Maple	*Acer tataricum*
Baumannii Horsechestnut	*Aesculus hippocastanum* 'Baumannii'
Yellow Buckeye	*Aesculus octandra*
Red Horsechestnut	*Aesculus* x *carnea* 'Ft. McNair'
Pyramidal Hornbeam	*Carpinus* 'Pyramidal'
European Hornbeam	*Carpinus betulus*
Hackberry	*Celtis occidentalis*
Katsura Tree	*Cercidiphyllum japonica*
Hardy Rubber Tree	*Eucommia ulmoides*
Royal Purple Ash	*Fraxinum americana* 'Royal Purple'
Autumn Purple Ash	*Fraxinus americana* 'Autumn Purple'
Windy City Ash	*Fraxinus americana* 'Windy City'
Summitt Ash	*Fraxinus pennsylvanica* 'Summit'
Urbanite Ash	*Fraxinus pennsylvanica* 'Urbanite'
Autumn Gold Ginkgo	*Ginkgo biloba* 'Autumn Gold'
Magyar Ginkgo	*Ginkgo biloba* 'Magyar'
Skyline Honeylocust	*Gleditsia triacanthos* 'Skyline'
Kentucky Coffetree	*Gymnocladus dioicus*
Amur Corktree	*Maackia amurensis*
Dawn Redwood	*Metasequoia glyptostroboides*
Accolade Cherry	*Prunus* 'Accolade'
Canadian Red Cherry	*Prunus virginiana* 'Canadian Red'
Red Spire Pear	*Pyrus calleryana* 'Red Spire'
Sawtooth Oak	*Quercus accutissima*
Swamp White Oak	*Quercus bicolor*
Scarlet Oak	*Quercus coccinea*
Shingle Oak	*Quercus imbricaria*
Bur Oak	*Quercus macrocarpa*
Chinkapin Oak	*Quercus muehlenbergii*
Japanese Pagodatree	*Sophora* 'Regent'
Greenspire Linden	*Tilia americana* 'Greenspire'
Redmond Linden	*Tilia americana* 'Redmond'
Sentry Linden	*Tilia americana* 'Sentry'

Tollgate Education Center. The Tollgate Education Center is a full-service conference facility owned and operated by MSU, located on the corner of Meadowbrook and 12 Mile roads within the current EAB quarantine area in Novi, MI. Michigan State University owns 60 acres on the site. The Center has meeting facilities and is open for visitors, which facilitates its use for educational programs. Trees were planted on the southwestern corner of the property and form the basis of a future arboretum. Thirty-seven selections (5 trees of each selection) representing thirty species were planted with additional trees being added in the future as they become available. (Photo, color insert, page 1A.)

Planting day was a comfortable sunny day, one of the few that we had this spring. Thanks to Roy Prentice, Tollgate Farm Manager, and the Tollgate volunteers, we were able to plant all one hundred and eighty-five trees by mid-afternoon. It was an enjoyable day, at times it seemed like a swarm of bees were carrying the trees across the site. After planting, the trees were mulched with a 3-foot ring of wood chips. Personnel from MSU have watered the trees regularly and weed control has been maintained by a combination of hand weeding and spot treatment with glyphosate. Survival of the trees has been good (approximately 80%) despite below normal rainfall for much of the spring and summer. We will monitor growth and development, ornamental traits and pest resistance and publish it in an annual summary. The plantation will be monitored for a minimum of ten years and serve as an ongoing site for educational workshops.

The arboretum will serve as a centerpiece for our outreach and Extension programming on tree selection for EAB restoration in Southeast Michigan. The press in the area has published at least two large feature articles and the tree planting was featured in *The Michigan Landscape*, the trade magazine of the Michigan Nursery and Landscape Association. We are also grateful to J. Frank Schmidt Nursery for the use of photographic images of the alternative selections, many of which are featured on our new ash alternative website (http://www.hrt.msu.edu/ash.alt/). We expect all of our outreach efforts to increase dramatically as the spread of EAB continues and restoration of the effected areas gets into full swing.

Identifying Balsam fir Christmas trees with superior needle retention

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Significance/importance to industry

Numerous consumer surveys have shown that needle retention is a major concern associated with the use of real Christmas trees. Although it is possible to reduce needle loss problems with some species of Christmas trees by delaying harvest, this approach is not very effective if there are unusually warm fall temperatures.

Balsam fir (*Abies balsamea*) is an important Christmas tree in the northeastern portion of the U. S. and eastern Canada. Postharvest studies have shown that there is tremendous tree-to-tree variability in needle loss when most true fir Christmas trees, including balsam fir are displayed dry. Recent work with Nordmann (*A. nordmanniana*) and Canaan (*A. balsamea* var. *phaneroleplsis*) firs has shown that it is possible to identify provenances and/or individual trees with superior needle retention using detached branches. Work with Nordmann fir has also shown that needle retention is under strong genetic control and that there is a highly significant correlation between the needle retention characteristics of maternal trees and their progeny. This research indicates that the Christmas tree industry has the opportunity to significantly reduce the potential for needle loss problems by identifying trees with superior needle retention and then utilize these trees to establish seed orchards.

At Washington State University, a number of projects are underway to identify sources of different species of Christmas trees with superior needle retention. Typically, branches are removed from trees and displayed under controlled conditions for a period of 10 days. As the branches begin to dry, branches from trees with poor needle retention will typically begin to shed green needles within about three to seven days. In an effort to identify balsam fir trees with superior needle retention, a three-year cooperative project involving Washington State University and MSU was initiated in 2002.

Objective

Determine variation in needle retention among a limited number of trees from six sources of balsam fir and one source of Canaan fir.

Methods

The trees used in this study were planted between 1997 and 1998 at a site near McBain, Michigan. During the fall in 2002 and 2003, a pair of two-year-old branches was harvested from 10 trees from six sources of balsam fir (Bracted, Charlotte, Cook, Granville, Lunenberg, and Rangley) and one unidentified source of Canaan fir. In 2002, the branches were harvested on November 29 and in 2003, they were harvested on September 29. Daily maximum and minimum temperature data from September 1 through the dates of branch harvest in 2002 and 2003 were obtained for Lake City, Michigan, which is located approximately 10 miles from the site where the trees are grown.

The branches were tagged, placed in plastic bags and shipped via overnight mail to Washington State University in Puyallup, Washington. Upon arrival at Puyallup, the branches were removed from the plastic bags and placed in racks on a table in a postharvest display room. A single branch from each tree was randomly placed in each of two display racks. The temperature of the room was maintained at 66ºF with about 40-60% relative humidity. The fluorescent lights in the room were left on continuously during the 10-day display period.

To obtain information on rates of moisture loss during the test, branches from three trees of each source were selected at random in 2002 and small shoots were removed from each branch upon set up and after 3, 7, and 10 days of display to determine changes in their percent moisture content. Moisture content measurements were made on branches from the same trees in 2003. Needles loss from all of the branches was assessed after 3, 7 and 10 days of display by gently rubbing the current season and one-year-old needles on each branch and rating the extent of loss on a 0 to 7 scale, where 0 = none, 1 = <1%, 2 = 1-5%, 3 = 6-15%, 4 = 16-33%, 5 = 34-66%, 6 = 67-90% and 7 = >90%. (Photo, color insert, page 3A.)

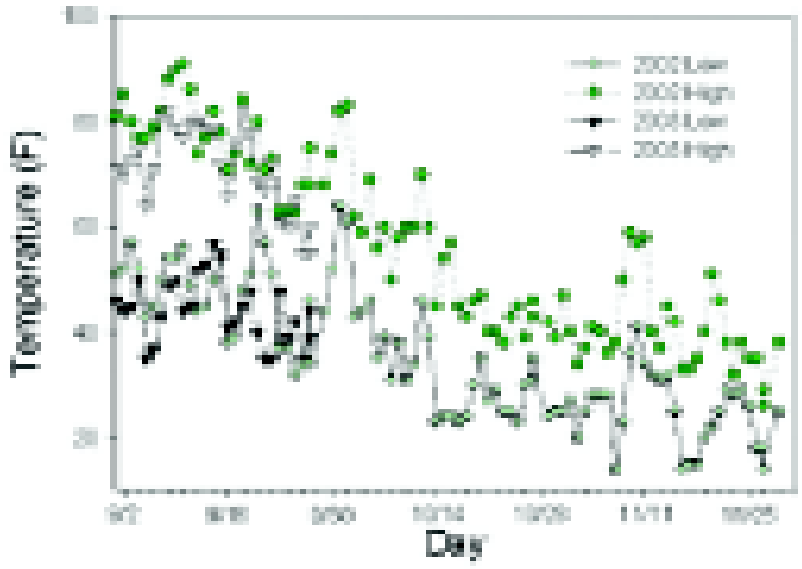

Figure 1. Daily maximum and minimum temperature from September 1 through the date branches were harvested from trees in 2002 and 2003

Results

Temperatures prior to harvest – Given the much later harvest of branches in 2002, the trees were exposed to colder temperatures prior to branch harvest in 2002 than in 2003 (Figure 1). The lowest temperature in 2002 was 14ºF, while the lowest temperature in 2003 was 35ºF. In 2002, there were 46 days with low temperatures $\leq$ 32ºF and 57 days with low temperatures $\leq$ 40ºF. In 2003, there were no days where the low temperatures where $\leq$ 32ºF and only 8 days with low temperatures $\leq$ 40ºF.

Moisture loss – In 2002, the initial moisture content of the branches at the time of setup in Puyallup ranged from 117.2 to 130.4%. These decreased to 57 to 78.4% after 10 days display. In 2003, the initial moisture contents for the branches ranged from 129.7 to 146.9%. These decreased to 51.4 to 102.5% by the end of the test. Given the low number of trees sampled from each source and the extent of tree-to-tree variation in moisture loss, it has not been possible to determine if there were significant differences in the rates of moisture loss between the different sources of trees.

Needle loss – In 2002, no needle loss was evident on any of the branches after 3 days of display. Branches from five (7.4%) of the 70 trees had needle loss ratings of 1 to 5 by the seventh day. By the day 10, branches from 19 (27.1%) of the trees exhibited some level of needle loss. During the 2003 test, which was conducted two months earlier than the 2002 test, needle loss ratings were much higher (Table 1). Branches from two (2.9%) trees had needle loss ratings of 1 to 5 after 3 days. Branches from 55 (78.6%) of the trees had

ratings of 1 to 7 by day 7. By the tenth day, branches from 66 (94.3%) of the trees had needle loss ratings of 1 to 7.

There was considerable variation in the extent of needle loss among the trees included in this test (Table 1). The percentage of trees from the different sources with needle loss ranged from 10 to 60% during 2002 and 80 to 100% during 2003 (Table 1). In most cases, the needle loss ratings for individual trees were ≤ 1 in 2002. Only 6 (8.6%) of the trees had ratings of 2 to 7. In 2003, about two thirds of the trees had needle loss ratings ≥ 4 by the end of the test. Even though branches from most of the trees had very high levels of needle loss, 4 (5.7%) of the trees that had no loss and 13 (18.6%) of the 70 trees had needle loss rating ≤ 1.

In 2002 and 2003, individual trees were ranked for potential needle loss based on their current season and one-year-old needle loss ratings. Based on an analysis of these rankings (Spearman Rank Correlation), there was a highly significant correlation in 2002 ($R= 0.975$, $P<0.001$) and 2003 ($R=0.909$, $P<0.001$) between rankings based on current season vs. one-year-old needle loss ratings. Even though trees had much higher needle loss ratings in 2003 than 2002, there was also a significant ($R = 0.305$, $P = 0.003$) correlation between the needle loss rankings of trees in 2002 and 2003 based on an average of their overall current season and one-year-old needle loss ratings.

Conclusions

Data collected during the first two years of this study, clearly show the effect of harvest date (exposure to cold temperatures) on the overall extent of needle loss that can occur when balsam and Canaan fir are allowed to dry during display. These data also confirm that even when harvested after exposure to 46 days with low temperatures ≤ 32ºF, there was high enough levels of needle loss that would probably not be acceptable to consumers with about 8% of the trees.

Although growers would not normally harvest trees in late September, testing branches harvested at this time of year provides a better opportunity to identify trees that have superior needle retention characteristics than harvesting them later in the fall. About 6% of the trees harvested on September 29, 2003 had no needle loss and about 19% of the tree had needle loss ratings ≤ 1. The correlation between the needle loss rankings in 2002 and 2003, indicate that trees that had high needle loss ratings in 2002 also tended to have high needle loss ratings in 2003.

Additional testing next year will be conducted to confirm the results from these experiments. Although it may not be possible to determine if there are differences in needle retention between the different sources of trees included in this test because of the relatively small number of trees being tested, it should be possible to identify individual balsam fir trees with superior needle retention characteristics.

Table 1. Number of trees with needle loss and average needle loss rating for trees that lost needles after 10-day test

	2002 test			2003 test		
Source	No. with NL[1]	NL rating[2]	No. with NL < 1[3]	No. with NL	NL rating	No. with NL < 1
Canaan fir	3	1.2	8	8	2.6	3
Bracted balsam fir	6	1.0	8	9	2.6	3
Cook balsam fir	3	0.4	10	9	2.4	2
Charlotte balsam fir	2	3.8	9	10	2.8	2
Rangley balsam fir	2	0.6	10	10	3.4	2
Lunenberg balsam fir	3	0.4	10	10	3.8	1
Granville balsam fir	1	1.8	9	10	3.9	0

[1]Number of trees out of 10 with some needle loss

[2]Average of the current season and one-year-old needle loss ratings for the trees with needle loss.

[3]Number of trees with current season and one-year-old needle loss ratings < 1.

Resistance to emerald ash borer: Evaluation of Asian and North American ash trees

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Bailey Nurseries, Inc., St. Paul, Minnesota, Michigan Nursery and Landscape Association

A replicated ash planting was established at the MSU Tollgate Education Center in Novi, Michigan in May 2003 to 1) compare resistance of native and Asian ashes to emerald ash borer, 2) identify mechanisms of resistance and susceptibility by quantifying biochemical and physical responses of phloem to wounding, and 3) determine the effects of drought and other stress on borer susceptibility.

The planting includes white (*Fraxinus americana*) and green ash (*F. pennsylvanica*), Manchurian ash (*F. mandshurica*) with which emerald ash borer shares an evolutionary history in Asia, and 'Northern Treasure' ash (*F.* x 'Northern Treasure'), which is a hybrid between native black ash (*F. nigra*) and Manchurian ash. The inclusion of this hybrid may provide insight into patterns of inheritance of resistance genes and facilitate their identification. Our prior hypothesis is that the Asian ash is most resistant because of natural defenses resulting from coevolution. Identification of resistant genotypes will be critical for reforestation, as well as maintaining market demand for ash in the nursery industry. Identification of resistance mechanisms and their relationship to whole tree physiology will facilitate screening, selection, and/or breeding of resistant trees, as well as silvicultural management of emerald ash borer in urban natural forests.

Emerald ash borer adult foliage-feeding on July 28, 2003. We observed many adult emerald ash borers and lot of leaf –notching in July. On July 28 we counted the number of leaflets on each tree with at least one leaf notch from emerald ash borer feeding. Only leaves within reach when standing were counted. One leaf from the middle of the lowest branch on the N, S, E, and W side of the tree was observed first. More were counted from the next layer of branches above, if necessary. All the leaflets on each leaf were counted. Counting continued until 50 leaflets were observed.

No data was collected on attacks by emerald ash borer in the first year (2003), because the trunk diameter was too small to attract females for egg laying. One third of the trees of each species will be left untreated in 2004 so we can compare susceptibility/resistance among species. The remaining 2/3 of the trees will be treated with imidacloprid to protect them emerald ash borer in the first year, so they will be available for research the following years. We are going to take advantage of this by putting in a timing study on imidacloprid with the following treatments:

1. Merit soil drench November 7, 2003
2. Merit soil drench April 15, 2004
3. Merit soil drench June 5, 2004
4. Control

In this way we hope to determine when is the best time to apply Merit to the soil for protection against emerald ash borer. We will be sacrificing trees and counting galleries next September or October.

Experiment I: Ash grown in containers before planting. Data are mean leaflets (out of 50) with notching from emerald ash borer. Anova F = 11.0, P = 0.0002

Treatment	n	Mean	SD
F. pennsylvanica (Green ash)	20	32.0 a	11.7
F. mandshurica (Mandchurian ash)	20	33.4 a	7.2
F. americana (White ash)	20	44.1 b	5.0

Experiment II: Ash trees arrived as bare root trees. Data are mean leaflets (out of 50) with notching from emerald ash borer. Anova F = 12.0, P = 0.0001

Treatment	n	Mean	SD
F. mandshurica X *F. nigra* 'Northern Treasure'	20	27.9	9.2
F. pennsylvanica (Green ash)	20	35.0	9.6
F. americana (White ash)	20	40.2	8.4

Which flowering shrubs could retailers market as indoor flowering potted plants?

Authors

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Funding and industry partners

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New or improved products can profitably restart sales of a product in the mature or declining stage of the product life cycle. However, launching new or redesigned products into a market creates challenges relative to existing product choices. Consumers may have preconceived notions that will affect the sale and acceptance of repositioned products. Their experiences with similar or related products may have created expectations and perceptions that need to be addressed along with product changes. As a choice set, consumers perceive some products as similar; these products may be considered substitutes for each other. Products perceived with virtually no substitutes may occupy distinctly unique spaces in consumers' minds. Gaining a better understanding of customers' product perceptions and preferences can help marketers anticipate necessary changes, and may also give marketers pricing and promotional ideas. What new products might be introduced to restart sales of flowering potted plants?

Commercial greenhouse growers now have the capability to program poinsettias, chrysanthemums, and other plants to flower on specific dates, within relatively concise limits. Growth in the wholesale value of flowering potted plants has been mediocre at best. Wholesale value increased from $210 million in 1980 to $684 million in 1996 and to $832 million in 2001, or 3.6% (2.2% when adjusted for inflation) growth annually over the last 21 years, slowing to a mere 1.4% annual growth over the last five years (adjusted for inflation using Consumer Price Index, 2002). The introduction of "new" flowering plants will help improve growth and profitability of this important floriculture segment. We wanted to see if several indoor flowering shrubs could be repositioned as indoor flowering potted plants that could possibly be installed in the garden at a later date.

We chose 15 flowering plants based on their differences in use (indoor or outdoor), plant habit or form and flower-color. Three plants were traditional flowering potted plants: azalea (*Rhododendron* hybrids), florist hibiscus (*Hibiscus rosa-sinensis*), and florist hydrangea (*Hydrangea macrophylla*). Six plants were herbaceous perennials: campanula 'Cherry Bells' (*Campanula punctata*), delphinium (*Delphinium grandiflorum*), euphorbia (*Euphorbia milii*), geum (*Geum coccineum*), laurentia (*Laurentia axillaris*), and sisyrinchium (*Sisyrinchium tinctorium*). Six plants were flowering shrubs: hibiscus (*Hibiscus syriacus*), hydrangea (*Hydrangea paniculata*), itea (*Itea virginica*), weigela Wine and Roses® (*Weigela florida*), and two lilacs (*Syringa x hyacinthiflora* and *Syringa meyeri*)

Plants were photographed in flower and adjusted with Adobe Photoshop. Adjusting the photographs gave us the ability to show plants in their ideal state. The photographs showed the plants in a green container against a black background. The pictures were shown in a frame on the web page when a link was clicked to elicit a response by comparing two different plants.

We constructed an Internet survey, which was established on the Texas A&M University Horticulture Department Web server. The survey consisted of 36 plant comparison questions, four questions regarding plant preferences, and 15 demographic and gardening questions. Participants were asked to compare two different plants that were shown in a side frame on the web page. (Photo, color insert, page 1A). We asked participants to choose which plants they would most likely use in an outdoor garden bed, which plants they would most likely use for decoration in the home, which flower colors they preferred, and which they would most likely purchase to give as a gift to a friend. The demographic questions included gender, age, education level, income category, number of adults and children in the household, and whether they rented or owned their home.

Survey Sampling, a professional sampling company, randomly selected 5000 e-mail addresses from their ELITe database and invited those individuals to participate in the study. Their ELITe database was collected through a variety of permission-based marketing sources. As a screening question, each potential participant was asked: (a) were they over age 18 and (b) had they purchased a flowering plant to enjoy indoors or to give as a gift in the last year? If they answered yes to both questions, they were invited to participate in the survey. The survey was conducted in June 2002 and 239 responses were obtained for Survey 1 and 282 responses for Survey 2.

Survey 1 participants were mainly women in their

early forties few of whom had some college education with a middle-household income. **Survey 2** participants were composed of women in their mid-thirties who had a college education and middle-household income. The two samples were different in only one of five demographic characteristics (education level), and could be considered comparable. The samples also appear similar to the profile of Americans who participated in flower gardening in 2002 which was described as being 56% female, with 43% between the ages of 35 and 54; 43% were college educated, 24% earned $50,000 to $75,000; 58% were married.

All of the participants had purchased indoor flowering potted plants in the past year since this was a screening question to make them eligible to participate in the study. Participants were asked about their plant preferences for indoors and outdoors. Participants were able to make multiple choices per question. **Survey 1** contained three traditional flowering potted plants Azalea (*Rhododendron* hybrids), florist's hibiscus (*Hibiscus rosa-sinensis*), and florist hydrangea (*Hydrangea macrophylla*), three flowering shrubs: hibiscus (*Hibiscus syriacus*), weigela Wine and Roses® (*Weigela florida*), and syringa (*Syringa meyeri*) and three perennials: Delphinium (*Delphinium grandiflorum*), Euphorbia (*Euphorbia milii*), and Laurentia (*Laurentia axillaries*). Of the participants who expressed a favorite plant(s), the top choices to place solely outdoors were: syringa (72%), hydrangea (66%), and florist's hydrangea (59%). The highest rated plants that participants would use only in their home were Euphorbia (62%), weigela 'Wine and Roses'® (37%), and azalea (33%). Azaleas are typically used both indoors and out, but the weigela 'Wine and Roses'® has been exclusively a landscape plant. This study identifies weigela as one flowering shrub to potentially be repositioned as an indoor flowering potted plant. Some of the participants selected plants to be used indoors and outdoors. The top four plants that were perceived as dual use products were: azalea (28%), weigela (27%), and laurentia and hibiscus (26% each). The participants' favorite two colors were pink (azalea, 28%) and blue (delphinium, 28% and laurentia, 25%). The top three plants that the participant would give as a gift were azalea, florist's hibiscus and weigela 'Wine and Roses'®.

The same three florist's plants were used in **Survey 2** (azalea, florist's hibiscus, and florist's hydrangea) to which were added three flowering shrubs (hibiscus, itea, and syringa) and three herbaceous perennials (campanula, geum, and sisyrinchium). Of the participants' favorite plants, the top choices for outdoor use only were hibiscus (65%), syringa (64%), and sisyrinchium (60%). Of their preferred plants for indoor decoration, geum (49%), itea (38%), and florist's hibiscus (35%) were most often chosen. Of those who said they would use it for both in and outdoors, azalea was among the most preferred with 33% of the total participants indicating their preference for its dual use, followed by florist's hydrangea at 28%. Florist's hibiscus was third with a 26% of the participants. Another blue campanula, *Campanula carpatica*, was highly preferred in both indoor and outdoor use in a previous study. A previous study also showed two blue flowering plants as most favorite, followed by a

Table 1. Of those who responded to the question, the percentage of Survey 1 respondents who expressed a preference for use location for each plant.

	Use location		
Plant	**outdoors**	**indoors**	**both places**
Rhododendron *hybrid*	39%	33%	28%
Weigela florida 'Wine and Roses'™	36%	37%	27%
Laurentia axillaries	52%	22%	26%
Hibiscus Rosa-sinensis	44%	31%	26%
Delphinium grandiflorum	49%	28%	23%
Hydrangea macrophylla	59%	24%	18%
Euphorbia milii	21%	62%	18%
Syringa meyeri	72%	13%	15%
Hydrangea paniculata	66%	25%	9%

Table 2. Of those who responded to the question, the percentage of Survey 2 respondents who expressed a preference for use location for each plant.

	Use location		
Plant	**outdoors**	**indoors**	**both places**
Rhododendron *hybrid*	35%	32%	33%
Hydrangea macrophylla	41%	31%	28%
Hibiscus Rosa-sinensis	39%	35%	26%
Campanula carpitaca	46%	30%	25%
Geum coccineum	33%	49%	18%
Itea virginica	44%	38%	18%
Syringa x *hyacinthiflora*	64%	18%	18%
Hibiscus syriacus	65%	20%	15%
Sisyrinchium tinctorium	60%	26%	14%

pink flowered azalea (Moore, 1999). The blue flowering plant that was highly favored in this study was syringa (23%). Pink flowering plants that were highly favored were the campanula (21%) and the azalea (20%). The top three plants that the participant would give as a gift were azalea (43%) and florist's hibiscus (39%). Campanula (42%) was the third favorite choice.

Survey participants were predominately females who had purchased a flowering plant in the year prior to the survey. Consumers may be willing to pay more for the ability to use the former both inside and out over using the latter once indoors. Euphorbia, azalea, and weigela 'Wine and Roses' were the highest rated plants that participants would use in their home. Azaleas are typically used both indoors and out, but the weigela 'Wine and Roses' is not. This identifies weigela as one flowering shrub to potentially be repositioned as an indoor flowering potted plant. Another plant, which may be repositioned is the lilac. The addition of fragrance from the lilac might be an added value for which some consumers are willing to pay. Although some plants in the survey like sisyrinchium do not appear to have near substitutes, this could be a marketing advantage (if consumers are willing to pay for the distinction) or it may be a disadvantage (if consumers have no idea how to place the plant in their garden). Results of this research identify some flowering shrubs as better candidates for repositioning than others.

Evaluation of potential plant species for green roofs

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Significance

In addition to their aesthetic qualities, green roofs provide insulation for buildings, reduce the amount of runoff entering municipal stormwater management systems; and increase the life span of a typical roof by protecting the various roof components from damaging UV rays, extreme temperatures, and rapid temperature fluctuations. However, obtaining these benefits can sometimes be difficult. A rooftop is an extreme environment with strong and variable wind patterns and little or no protection from the sun's intense heat and ultraviolet radiation. Climatic conditions, especially the amount and distribution of rainfall and temperature extremes, will eliminate the use of certain species or will dictate the need for irrigation. Selection of plant material is crucial for success.

Project goal

Even though green roofs are relatively popular in Germany and the rest of Europe, the concept is just now being introduced in the United States. If we are to realize the benefits they provide, then we must develop a better understanding of what specific species will survive and prosper under harsh rooftop conditions. What works in Germany is not necessarily what is best for Michigan or the rest of the U.S. because of our greater extremes in winter and summer temperatures. Therefore the overall objectives of our research are to evaluate plant species, propagation and establishment methods, substrates, water and nutrient requirements, and water quality and quantity of runoff. The specific objective of this experiment was to evaluate potential plant species for green roof applications.

Project description

The green roof research program at MSU was initiated in collaboration with Ford Motor Company in an effort to advise them on the installation of a 450,000 square feet green roof that was recently installed on a new assembly plant in Dearborn. Numerous experiments are currently being conducted on 48 model scale roof platforms measuring 8 ft x 8 ft at MSU. The site is equipped with a weather station, thermocouples measuring temperatures at various depths in the growing substrates, and electronic tipping buckets that record the volume and rate of stormwater runoff from the individual platforms. Measurements are taken every five minutes, 24 hours a day, and are recorded on a Campbell Scientific datalogger.

Over the past three years we conducted a study

comparing nine species and cultivars of *Sedum* and 18 taxa of Michigan native plants: *Agastache foeniculum* (lavender hyssop), *Allium cernuum* (nodding wild onion), *Aster laevis* (smooth aster), *Coreopsis lanceolata* (lanceleaf coreopsis), *Fragaria virginiana* (wild strawberry), *Juncus effusus* (spikerush), *Koeleria macrantha* (junegrass), *Liatris aspera* (rough blazingstar), *Monarda fistulosa* (bergamot), *Monarda punctata* (horsemint), *Opuntia humifosa* (prickly pear), *Petalostemon purpureum* (purple prairie clover), *Potentilla anserina* (silver feather), *Rudbeckia hirta* (black-eyed Susan), *Schizachyrium scoparium* (little bluestem), *Solidago rigida* (stiff goldenrod), *Sporobolus heterolepis* (prairie dropseed), and *Tradescantia ohiensis* (spiderwort). The Michigan natives were planted as plugs and nine species of sedum were planted as either seed or plugs. Criteria for evaluating species included rate of establishment, capability to exclude invasive weeds, heat and cold tolerance, drought tolerance, and survival and persistence.

Results

All nine species of *Sedum* significantly outperformed the native forbs and grasses in criteria such as rate of establishment, substrate coverage, drought tolerance, and plant mortality. Without irrigation, the native plants either died or went dormant by June, resulting in a brown mass of dead-looking plants that could be a major fire hazard. The natives looked fantastic early in the year, but could not withstand the heat and drought conditions when growing in only four inches of roof substrate. After three years, all natives were dead except for a few plants of *Coreopsis lanceolata, Tradescantia ohiensis,* and *Allium cernuum*. These could be potential selections for green roofs depending on the range of conditions present. However, if any of these native plants are to be grown successfully and maintain their aesthetic value, then irrigation must be available or the substrate must be deeper, an impractical solution considering the weight limitations of a green roof installation. In contrast, all of the *Sedum* species survived and thrived under all environmental conditions.

Genetic improvement of Scotch pine for Christmas tree production in Michigan

Authors

Paul Bloese and Daniel Keathley, MSU Department of Forestry

Funding source

SAPMA, Michigan Christmas Tree Association

Industry partners

Michigan Christmas Tree Association, Michigan Seedling Growers Association

Significance to the industry

Michigan is one of the nation's leading producers of Christmas trees. Each year Michigan growers harvest more than four million trees, producing approximately $60,000,000 in gross revenue and supplying more than 20 percent of the national market. Although Scotch pine production has decreased over the last decade, it remains an important component of the Christmas tree market. To maintain or increase their share of an increasingly competitive national market, Michigan Scotch pine growers must grow high quality trees. The development of genetically improved Scotch pine planting stock would provide Michigan growers with a solid foundation for producing high quality Scotch pine Christmas trees.

Objective

The goal of this project is to develop a long-term breeding program for Scotch pine and the eventual production of commercially significant quantities of genetically improved seed.

Project background

The first step in starting a breeding program is selecting a first generation breeding population, which serves as the foundation of future genetic improvement. In June 1993, over 1,000 acres of ten commercial growers' farms were examined in a search for phenotypically superior Scotch pine Christmas trees. Fifty-seven three- to four-year-old trees exhibiting exceptional branch angle, stem form, crown form, needle length and growth were selected. All selections were free of insect and disease attack when selected. Selected trees were balled and burlapped and transplanted to a breeding arboretum at MSU's Sandhill research area in fall 1993.

To produce significant amounts of seed, the above ground portion of the selected trees had to be genetically duplicated in numbers sufficient to establish a viable seed orchard, which was done by grafting. Nearly 2,000 grafts had been established in seed orchards at Russ Forest and the Tree Research Center by 1997. Both orchards were designed using

"Seed Orchard Management and Design" (SOMAD) software developed by the USDA Forest Service. SOMAD minimizes inbreeding and maximizes outcrossing by optimizing the distances between members of the same clone. At maturity (allowing for culling 30% of the poorer clones), conservative estimates indicate the two orchards will produce over 250 pounds of genetically improved seed annually for use by the Michigan Christmas tree industry.

Continuing research

The next step to improve Scotch pine for Michigan is to progeny test the clones in the orchards. Progeny testing will evaluate the genetic quality of the clones originally selected based on their phenotype, and provide data critical to the culling of poorer clones. Although most trees in both the Russ and TRC orchards have begun flowering and producing limited amounts of seed, seed production will not accommodate a full-scale progeny test for another year or two. In the interim, seedlings produced from a bulk seedlot collected from the Russ orchard in 2002 will be field planted in fall 2003 and spring 2004. This planting will provide an initial, cursory appraisal of the orchard's genetic quality and assess the relative merits of fall versus spring planting.

Provenance testing Noble fir for Christmas tree production in Michigan

Authors

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Funding Source

Michigan Christmas Tree Association, Dept of Forestry MSU

Industry Partners

Michigan Christmas Tree Association, Michigan Seedling Growers Association

Significance to the industry

Over the past 10 to 15 years, the species produced by Michigan Christmas tree growers has become much more diverse. Although Scotch pine once dominated production, Michigan's Christmas tree crop is now much more evenly distributed across several species of pine, spruce and fir. True firs in particular have gained importance as their popularity among consumers has risen nationally. In addition to their increasing market share, high quality true firs command premium prices. Although Noble fir is the premier Christmas tree species in the Pacific Northwest, the adaptability of this species to Michigan has not been systematically examined. If high quality Noble fir Christmas trees can be efficiently produced in Michigan, growers could add a high value, high demand species to their production mix.

Objective

Establishing a Noble fir provenance test on several sites will enable the systematic evaluation of this species for Christmas tree production in Michigan.

Project background

Seed from 21 Washington and Oregon Noble fir provenances was purchased and sown in styroblock containers in MSU Department of Forestry's greenhouses. Only inland provenances were included in the test because past experience with other Pacific Northwest conifers indicates that coastal provenances are not cold hardy in Michigan. The first crop suffered widespread mortality from fungal root infections (primarily *Fusarium* and *Phytophthora)* when transplanted to the nursery. Consequently, a second crop was sown in January 2003 and a new, more varied fungicide regime has produced, to date, healthier seedlings. Portions of provenances with surplus seedlings were transplanted to the nursery in October 2003. All remaining seedlings will be overwintered in their containers and transplanted to the nursery in spring. Varying the transplant season will provide information on the viability of fall transplanting Noble fir in Michigan, and whether over-wintering Noble fir in containers contributes to root disease (Container stock root systems are assumed to be healthy prior to over-wintering based on the observed health of the fall transplant stock.).

Continuing research

Assuming the 2003 crop survives and grows well in the nursery, planting stock should be available for field planting by Spring 2005. Test plantings will be established at two or more sites in a randomized block design with four-tree linear plots. Because Noble fir seed does not store well, all remaining seed is currently being stratified and will be sown in containers in January 2004. The 2004 crop will be transplanted to the nursery in either Fall 2004 or Spring 2005. The transplant date will be chosen based on the relative vigor of seedlings transplanted October 2003 versus Spring 2004. The 2004 crop should produce field stock for a second set of test plantings in Spring 2006.

Turfgrass evaluation results (2000-03) at MSU's Northwest Michigan Horticultural Research Station

Author

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Cooperators

Tom Reed, Sr., TriTurf, Inc.; Suleiman Bughrara, Department of Crop and Soil Sciences; James Beard, International Sports Turf Institute; MSU - Northwestern Michigan College (NMC/Traverse City) Applied Plant Science Program students; and the National Turfgrass Evaluation Program (NTEP).

Industry partners

TriTurf Inc., J. R. Simplot Inc., Lebanon Seed Company, Spartan Distributors of Sparta, La Cross Landscaping of Cedar, The GreenMan's Landscape Services of Traverse City and S. White Inc., Robert B. Adams of Overby Farm Lake Leelanau, Northern Michigan Turf Managers Association and Traverse City Golf and Country Club staff.

Significance

Many new turfgrass cultivars are being developed and commercialized each year for use in lawns, athletic fields, golf courses, roadsides, and the like. Claims made about varieties, such as "drought tolerant," "disease resistant" or "lower growing" may not be substantiated by objective research. The National Turfgrass Evaluation Program (NTEP) Commercial/Consumer trials are designed, developed and coordinated for uniform evaluation of turfgrass cultivars in the United States and Canada. (**Editor's note**: For more information about the NTEP program, and for NTEP evaluation results for East Lansing, Michigan, visit the NTEP website at: http://ntep.org/states/mi1/mi1_eastlansing.htm)

The first turfgrass cultivar plots in Northwest Michigan were planted over 40 years ago. The new turfgrass plot site at the MSU Northwest Michigan Horticultural Research Station (NWMHRS) in Traverse City was developed to provide scientifically based information to the turf and landscape industries and property owners to further their management objectives, while protecting water and natural resources. Throughout the season and at subsequent research station open houses in August 2001, 2002 and 2003, bluegrass plots were shown and explained to interested donors and individuals. This report provides an update of turfgrass research trials that began in 2000.

Objectives

The current plots demonstrate the performance of some commonly used and newly developed cultivars of bluegrass and tall fescue. The parameters for evaluation of the plots at the MSU NWMHRS include density, color, texture, percentage of ground covered, pest problems and environmental stresses.

Methods

The Northwest Michigan trials were developed using NTEP evaluation standards. Each trial area consists of two plot areas with three replications in each plot. Thirty bluegrass cultivars and thirty-two tall fescue cultivars under evaluation were both replicated a total of six times. The NTEP Kentucky bluegrass consumer trial at the NWMHRS was planted during late September and early October of 2000. The tall fescue consumer trial was planted in late September and early October of 2001. This trial consists of a group of commercially available tall fescue cultivars plus several new cultivars that will soon be released to the trade. The two plot areas were fertilized with 10-18-18 starter fertilizer at a pound of phosphorus and potassium per 1000 square feet, covered with a white blanket made of a spun poly material and stapled to the ground for the winter. In the spring, weed control and fertilization programs were developed for the season, to manage the weeds that were present in the plots and to increase density. We started with applying 19-2-9 and Confront, alternating it with 10-18-18 starter fertilizer. Both Kentucky bluegrass plots were irrigated. One tall fescue plot was irrigated; the other was a non-irrigated plot. The bluegrass plots and the (irrigated) tall fescue plot were watered daily for 20 to 25 minutes. Bluegrass plots were mowed at one and three inches, while tall fescue plots were mowed only at three inches.

Observations/discussion

The plots were evaluated on a scale of one to nine (1-9), one being low and nine being high. The bluegrass rankings given here are the averages for both mowing heights of the six replications of each cultivar.

The first evaluation of the bluegrass plots occurred on October 22, 2001. Top ranking cultivars at that time: Serene 7.3: Northstar 7.2; Baronie 7: Boutique 6.9; Unique 6.9; Bartitia 6.7; Brooklawn and Total Eclipse 6.7. There was one cultivar (Cabernet) with significant leaf rust observed in the fall season of

2001. This cultivar did not show any significant leaf rust in fall of 2002 or 2003. From May to October 2001 rainfall was 16.47 inches, while the evapotranspiration was 29.03 inches, giving a moisture deficit of 12.56 inches.

The top-ranked cultivars of the second evaluation on April 8, 2002 were: Baronie 7.75; Serene and Champagne 7.25; Total Eclipse 6.92; Blackstone 6.88; Brooklawn 6.78; and Kenblue 6.75. On August 7, 2002, the top-ranked cultivars were: Northstar 8.67; Alpine 8.33; Total Eclipse 8.25; Serene and Blackstone 8.17; Unique 8.08; Quantum Leap and Boutique 8.0. The top rankings at the September 26, 2002 evaluation (fourth rating) were: Northstar 8.25; Midnight 8.08; Total Eclipse 8.0; Absolute, Blackstone and Odyssey 7.92. The May to October 2002 rainfall was 15.55 inches, while the evapotranspiration was 30.76 inches giving a moisture deficit of 15.21 inches.

The first rating in 2003 was on April 30. The top-rated cultivars were: Champagne and Rita at 6.58; Cabernet 6.42; Brooklawn 6.0; Kenblue 5.83; Baronie 5.75; and Odyssey 5.58.

On July 31st, top-rated cultivars were: Northstar at 8.75; Absolute 8.17; Alpine, Blackstone, Rugby II and Serene all at 8.08. Top rankings on October 2nd were: Alpine and Serene 7.92; Blackstone; Midnight and Moonlight 7.83; and Bartitia 7.75. From May to October 2003 rainfall was 13.85 inches, while the evapotranspiration was 28.46 inches giving a moisture deficit of 14.61 inches.

There has been very little general, visual difference in the irrigated tall fescue cultivars with the exception of the standard Kentucky 31, which was not as dark, dense or attractive as the remaining cultivars in the trial. The top-ranking cultivars on June 13, 2003 were: Pure Gold and JT-8 at 7.0; Tar Heel 6.83; Bonsai and K01-WAF 6.67; and Matador, Olympic Gold, KO1-8015 and KO1-8007 at 6.5. Observations suggest that KO1-8007 was the finest textured cultivar. The non-irrigated plot experienced two growing seasons of drought and has not filled in to date.

The brief summary of information presented here is only an introduction and not the entire story. The majority of the data have yet to be consolidated and analyzed. There appeared to be bluegrass cultivars that performed better, for example, in the early spring as compared to the summer months. The above ratings are a combination of the data at both the mowing heights (1" and 3") for the bluegrass plots. However, some of the bluegrass cultivars tended to rank higher when mowed at one cutting height (1" or 3"). Both tall fescue plots were mowed at a three-inch height.

Thanks to Dr. Suleiman Bughrara, for assistance with developing the trials, and to Tom Reed, Sr. and MSU -NMC Applied Plant Science students, who helped in grading and seeding the plots both years and additionally with the installation of the irrigation in 2000. J. R. Simplot Inc. and Lebanon Seed donated some of their new cultivars and the balance was supplied by NTEP (USDA- Beltsville, MD).