

# Shade Tree Evaluation Studies at the Ohio Agricultural Research and Development Center

RAYMOND R. CHAPIN and PHILIP C. KOZEL



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RAYMOND R. CHAPIN and PHILIP C. KOZEL\*

## FOREWORD†

The need for a comprehensive evaluation of new introductions of shade and ornamental trees for use in the North Central United States has long been recognized by horticulturists, landscape architects, utility companies, and others interested in high quality trees and the landscape environment. Two leaders in the street tree field, Mr. M. W. Staples, retired vice-president of the Davey Tree Expert Company, and Dr. L. C. Chadwick, professor emeritus of horticulture, The Ohio State University and Ohio Agricultural Research and Development Center (OARDC), developed a proposal by the Ohio Chapter, International Shade Tree Conference (I.S.T.C.), for a 10-year comprehensive evaluation of street trees in urban and suburban areas. The OARDC, in cooperation with a committee of the Ohio Chapter, I.S.T.C., and Ohio Electric Utilities Institute, established a research program entitled: *Characteristics and Adaptability of Species and Cultivars of Shade and Ornamental Trees with Emphasis on Street and Highway Landscape Use*.

In addition to the Ohio Agricultural Research and Development Center, the agencies supporting this project include: Ohio Chapter, International Shade Tree Conference, Ohio Nurserymen's Association, Ohio Edison Co., Cleveland Electric Illuminating Co., Toledo Edison Co., Cincinnati Gas & Electric Co., Dayton Power & Light Co., Monongahela Power Co., Ohio Power Co., and Columbus & Southern Ohio Electric Co.

## INTRODUCTION†

With population growth and increasing congestion, trees are considered one of the most valuable environmental assets in the modern city and suburban area. Trees offer such aesthetic features as softening lines of buildings and screening unsightly areas, in addition to modifying the harshness of concrete and asphalt.

In many urban and suburban situations, trees are planted in an unnatural environment with such detrimental features as insufficient light and water, polluted air, high velocity wind currents, excessive salt from ice control programs, plus temperature fluctuations and heat radiation.

Because of increased emphasis on tree planting in cities and along streets and highways, many new species and cultivars are being selected and intro-

duced for use in these landscape areas. The expanding population has enlarged the need for new trees and has been responsible for the decline and necessary removal of trees from older city areas. Unfortunately, limited data on adaptability of trees to specific conditions led to the selection of types poorly suited to many sites, resulting in high maintenance and removal costs.

Many new introductions have several attributes favoring their use as street or park trees. These attributes include a size or height which will not interfere with overhead utilities, a branching habit which does not interfere with foot or vehicular traffic, a tolerance of some environmental stresses, a resistance to pest problems, and a lack of such undesirable characteristics as bark or fruit litter. Most of these new selections have been evaluated by the producer and often by arboretums and similar agencies. However, no program had been developed in the North Central United States to make an intensive and continuing comparative evaluation in one location.

As more streets and highways are built, the need for new cultivars will continue to increase. Thus, a nonbiased, scientific evaluation of morphological characteristics and environmental adaptations was believed to be essential to provide useful information to utility companies, municipalities, public agencies, landscape contractors, and homeowners. Urban renewal, expansion of park development, increased construction of recreation areas such as golf courses, and landscaping of public and commercial buildings are additional factors indicating a need for more knowledge of ornamental tree selections which can be used in these areas. It is anticipated that case histories developed in this project will be valuable in preparing recommendations of trees for specific sites.

## PROCEDURES

### Project

This project, which involves two parts, was initiated at the OARDC in 1966. The first phase of the study involves a planting of numerous tree species and cultivars located in a randomized pattern in the Shade Tree Evaluation Plot at the OARDC

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†Adapted from the first project publication: Reisch, K. W., G. Hull, and H. M. Hill. July 1971. Case Histories of Several Street Tree Species and Cultivars at Selected Sites in Five Ohio Cities. Ohio Agricultural Research and Development Center, Horticulture Dept. Series 376.

in Wooster. Plantings have been made each year since 1965. In 1974, there were 128 species and cultivars represented in the 842 trees in the plot.

When initially planted, each tree type had eight replications and each tree was planted bare root in the 6 to 8-foot size. The trees were planted randomly in the plot at 25 x 25-foot or 15 x 25-foot spacing, depending on the suggested ultimate size. Selection of tree types to be included in the test plot was made by members of the shade tree evaluation committee.

The shade tree evaluation committee, which meets twice each year, consists of representatives from the utility companies, The Ohio State University, and the OARDC, as well as representatives from the Ohio Chapter, I.S.T.C., and the nursery industry. At these semi-annual meetings, the committee rates each tree in the Shade Tree Evaluation Plot at Wooster. This observational evaluation rating is based on a 0 to 4 scale, with 0 as excellent, 1 as good, 2 as fair, 3 as poor, and 4 as dead. Some criteria used in determining these ratings are foliage density, foliage color, branch and crotch development, disease and insect susceptibility, overall growth rate, and general tree condition.

Each year since 1966, measurements of height to the nearest tenth of a foot have been taken at the highest point in the tree. Caliper measurements to the nearest hundredth of a foot are taken at 4 feet above the soil line or on smaller trees at a point directly below the first scaffold branch. The spread has been measured since 1970 to the nearest tenth of a foot at the widest point of spread, unless the tree has an exceptionally irregular habit, in which case the average spread is taken.

Maintenance of trees in the plot is minimal. The intention is to provide an environment as similar as possible to a street tree planting. The only maintenance consists of limbing-up of the trees to street tree height, the spraying of the Lindens to control Japanese beetle, and vegetation control below the tree.

The second phase of the project involves evaluation of existing plantings of 53 different species and cultivars in five Ohio cities: Toledo, Wooster, Columbus, Cincinnati, and the Greater Cleveland area. At each of the 99 separate sites, five replications of a tree type are being evaluated, except where trees have been removed for one reason or another.

The annual evaluation of each of these trees includes measurement of height, caliper, and spread. Height is measured to the nearest tenth of a foot with a Haga altimeter. Caliper measurements are taken at 4 feet above the soil level with a caliper tape calibrated to the nearest hundredth of an inch. Spread is measured to the nearest tenth of a foot at the widest point of spread unless a tree has an exceptionally ir-

regular habit, in which case an average spread is taken. In addition, such information as tree lawn width, height of utility lines, new growth in inches, disease and insect damage, and mechanical injury are recorded.

#### Publication

This publication is the first in a series concerning performance of trees planted in the shade tree evaluation plot at Wooster. A previous publication\* from this project dealt with information derived from trees planted on city streets in five Ohio cities.

The following are results from observations of and data taken primarily from trees planted in the Shade Tree Evaluation Plot at Wooster during the years 1965 through 1970. It was felt that trees planted after this date had been under observation for too short a time period to warrant a fair evaluation. A report on the trees planted after 1970 will be given in a later publication.

The information on each tree type includes botanical and common names and the expected mature height (EMH). This height is representative of the heights the various trees will reach in a landscape situation. The photograph of each individual specimen is characteristic of those trees of that type in the plot. The numerical data are an average for the replications of each tree type in this study. The height is given in feet and tenths of feet, the caliper in inches and hundredths of inches, and the spread in feet and tenths of feet.

A brief discussion of each type is also provided. These comments are based on a composite of information from all replicates in this study. In addition, comments on trees observed elsewhere in city plantings are included. Branching texture, crotch development, and overall form are also discussed. Branching texture was defined as fine, medium, coarse, and very coarse. Crotch development was roughly defined as good: more than 60°, fair: 45° to 60°, and poor: less than 45°. Branches of fastigate types which generally had narrow crotches were, in most cases, considered good and this strict definition was not applied with these trees.

The evaluation committee's observational rating for each tree type group for the two evaluations during 1973 is included. The authors felt that this recent evaluation rating is most indicative of the present status of the trees in the test plot. This rating is one of several factors considered in making the final tree recommendations. It is not intended to be a recommendation by itself.

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\*Reisch, K. W., G. Hull, and H. M. Hill. July 1971. Case Histories of Several Street Tree Species and Cultivars at Selected Sites in Five Ohio Cities. Ohio Agricultural Research and Development Center, Horticulture Dept. Series 376.

## RESULTS

### *Acer campestre*

#### Hedge Maple

EMH\*: 25 to 30 feet

Year	Height	Caliper	Spread
1966	7.7		
1967		1.11	
1968	8.1	1.13	
1969	8.5	1.36	
1970	10.9	1.78	5.5
1971	13.0	2.54	8.2
1972	13.9	3.01	9.6
1973	15.4	3.64	10.2



*Acer campestre* is a round, slow-growing species. As a young tree, it may tend to be rather irregular in habit and somewhat difficult to train single stem, but it develops a shapely, formal, rounded crown with age. This tree has a medium branch texture. In addition, it is usually pest-free and fairly tolerant of dry soil conditions. Two other attributes are its dark green summer foliage and excellent yellow fall color.

Rating: 0.833

### *Acer ginnala*

#### Amur Maple

EMH: 15 to 20 feet

Year	Height	Caliper	Spread
1966	5.6		
1967		.88	
1968	6.3	.88	
1969	6.7	1.09	
1970	7.3	1.29	4.2
1971	9.2	1.94	6.2
1972	10.1	2.30	7.8
1973	10.9	2.87	8.7



*Acer ginnala* is a small species tree. This tree is very difficult to train single stem and requires considerable maintenance to obtain a successful street tree. Under dry, city street conditions, its growth has been poor and its fall color, which is generally a bright red, has not been good. It is recommended that use of this tree as a street tree should be discouraged.

Rating: 1.695

\*Expected mature height.

*Acer platanoides*  
Norway Maple  
EMH: 50 feet

Year	Height	Caliper	Spread
1966	11.4		
1967		.93	
1968	11.4	1.01	
1969	11.4	1.17	
1970	11.4	1.40	2.7
1971	13.7	2.00	4.7
1972	15.0	2.47	7.3
1973	15.8	2.91	8.9



*Acer platanoides* Norway Maple is a coarsely branched street tree species which has been used for many years as a street tree. This tree has declined in vigor in recent years in the city plantings associated with this project. It has good crotch development, but has extensive surface roots and a foliage canopy which is so dense that it is difficult to maintain grass underneath. As a seedling tree, it is subject to great variability in size, form, and rate of growth. It is recommended that for street tree use, one of the newer cultivars mentioned later should be chosen, depending on the particular planting site.

Rating: 1.251

*Acer platanoides* 'Cleveland'  
Cleveland Norway Maple  
EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.9		
1967		.81	
1968	9.2	.87	
1969	9.4	1.10	
1970	10.7	1.46	3.5
1971	11.6	1.95	5.4
1972	14.2	2.61	7.1
1973	15.1	2.97	7.5



*Acer platanoides* 'Cleveland' is an extensively used, coarsely branched Norway Maple cultivar. It has an upright oval habit, thus causing less interference with traffic than the species. Although it has a dense, dark green foliage canopy like the species, its habit allows for growth of grass underneath. Generally it was found to have good crotch development. Planting beneath utility lines is not recommended.

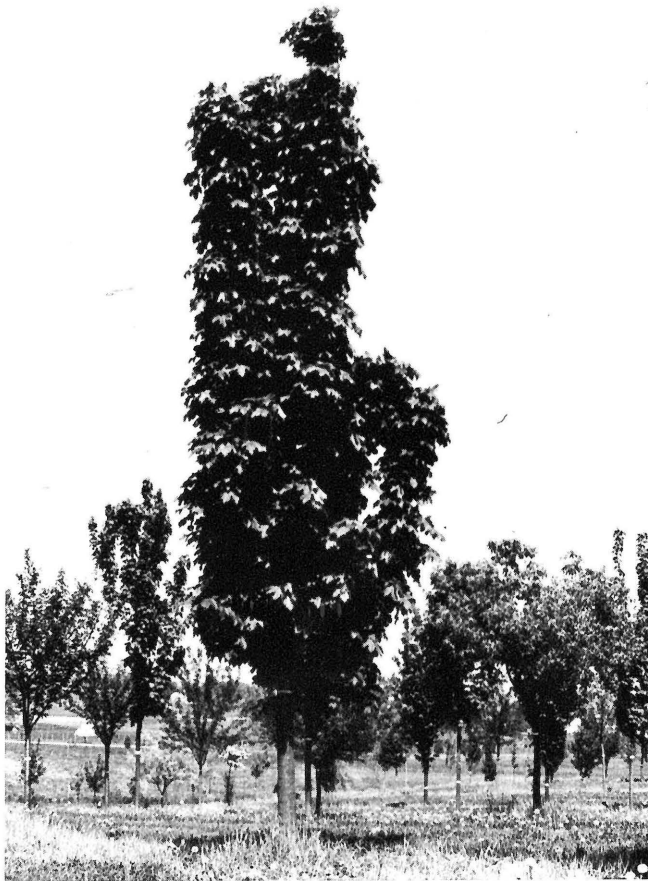
Rating: 0.993



*Acer platanoides* 'Columnare'  
Columnar Norway Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.1		
1967		.76	
1968	8.3	.84	
1969	9.5	1.15	
1970	11.1	1.55	2.6
1971	14.0	2.26	4.0
1972	16.1	2.94	5.6
1973	17.1	3.45	6.0



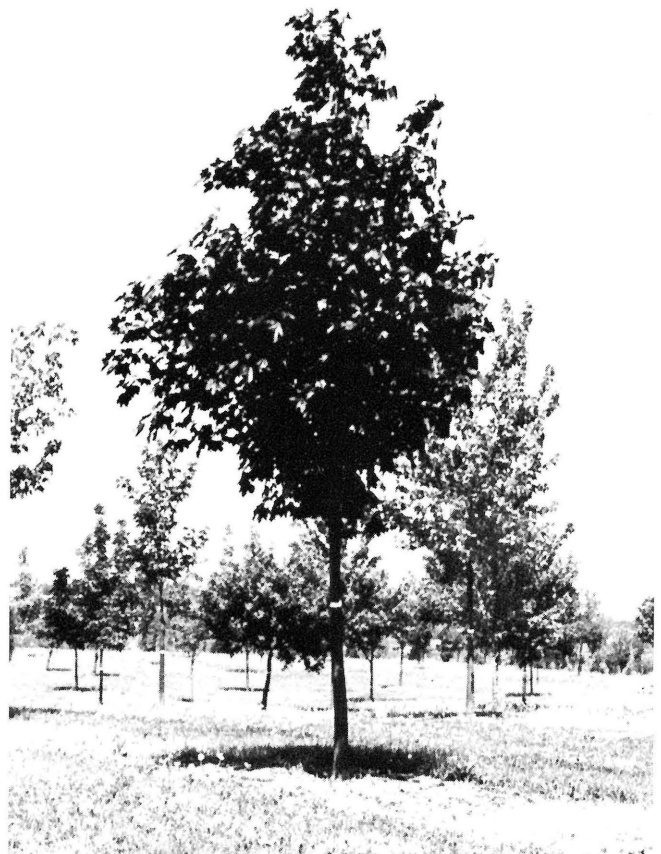
*Acer platanoides* 'Columnare' is a narrow columnar, compact Norway Maple cultivar which is well suited to planting in narrow tree lawns. As a young tree it is not densely branched, but good branching develops with age. The trunk is large in proportion to the body of the tree. The excellent dark green foliage is subject to some leaf scorch in very narrow tree lawns when root growth is limited. This coarsely branched tree, which develops good crotches, requires a minimum of maintenance. It is satisfactorily planted adjacent to utility lines where the tree lawn is suitable for this location.

Rating: 0.585

*Acer platanoides* 'Crimson King'  
Crimson King Maple

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966	7.8		
1967		.53	
1968	7.7	.60	
1969	7.8	.86	
1970	8.5	1.10	2.6
1971	11.7	1.69	3.7
1972	14.0	2.23	5.5
1973	14.4	2.45	6.3



*Acer platanoides* 'Crimson King' is a coarsely textured, purple leaf Norway Maple cultivar. The purple foliage color persists throughout the summer but fades as the leaves mature. Leaf scorch has been noted late in the season. It is very slow to develop when bare-root specimens are planted. Its use may be limited because of the foliage color contrast with that of surrounding vegetation. The habit tends to be upright and oval with a good crotch development. This cultivar is more vigorous than *Acer platanoides* 'Royal Red', another purple leafed Norway Maple cultivar.

Rating: 1.284

*Acer platanoides* 'Emerald Queen'

Emerald Queen Maple

EMH: 50 to 60 feet

Year	Height	Caliper	Spread
1966	8.6		
1967		.66	
1968	8.8	.74	
1969	10.3	1.13	
1970	11.8	1.57	2.6
1971	14.0	1.87	5.1
1972	16.7	2.74	7.3
1973	17.5	3.14	8.6



*Acer platanoides* 'Emerald Queen' is an upright oval, uniformly coarse-branched cultivar, even in smaller sizes. In addition, it has good crotch development and is fairly vigorous, as indicated in the growth data. The fall color is a bright yellow persisting for 1 week or less.

Rating: 0.728

*Acer platanoides* 'Globosum'

Globe Norway Maple

EMH: 15 feet

Year	Height	Caliper	Spread
1966			
1967		.81	
1968	9.3	.80	
1969	9.4	.89	
1970	10.2	1.10	1.7
1971	10.1	1.40	2.1
1972	10.9	1.90	4.1
1973	11.1	2.17	5.0



*Acer platanoides* 'Globosum' is a very formal globose selection which may be too formal for most street situations. It is a very slow-growing selection requiring a broad tree lawn. It has been reported that with age the spread will surpass the height. Planting in narrow tree lawns results in loss of vigor and shortening of tree life. Where the formality is acceptable, this medium branched, textured selection can be planted beneath utility lines without creating a problem.

Rating: 1.318



*Acer platanoides* 'Greenlace'

Greenlace Maple

EMH: 40 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	8.9	.92	1.9
1971	9.2	1.16	3.6
1972	9.2	1.41	4.3
1973	9.0	1.40	4.4

*Acer platanoides* 'Superform'

Superform Norway Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.0		
1967		.70	
1968	8.3	.75	
1969	8.4	.94	
1970	9.8	1.17	2.7
1971	11.9	1.81	5.8
1972	14.0	2.33	6.8
1973	15.0	2.76	7.8



*Acer platanoides* 'Greenlace' is a slow-growing cultivar. Specimens in the Shade Tree Evaluation Plot have been found to lean heavily, suggesting a less than adequate root system. This characteristic has been apparent only in this one medium textured Norway Maple cultivar. The form of young specimens was found to be very irregular. The attractive 'cut-leaf' foliage is its most favorable characteristic. Staking of the plant until it achieves a trunk diameter of 3 inches is recommended.

Rating: 1.738

*Acer platanoides* 'Superform' is coarsely branched and has a rounded to upright oval habit. The crotch development is only fair. Fall color is a good yellow, persisting for about 10 days.

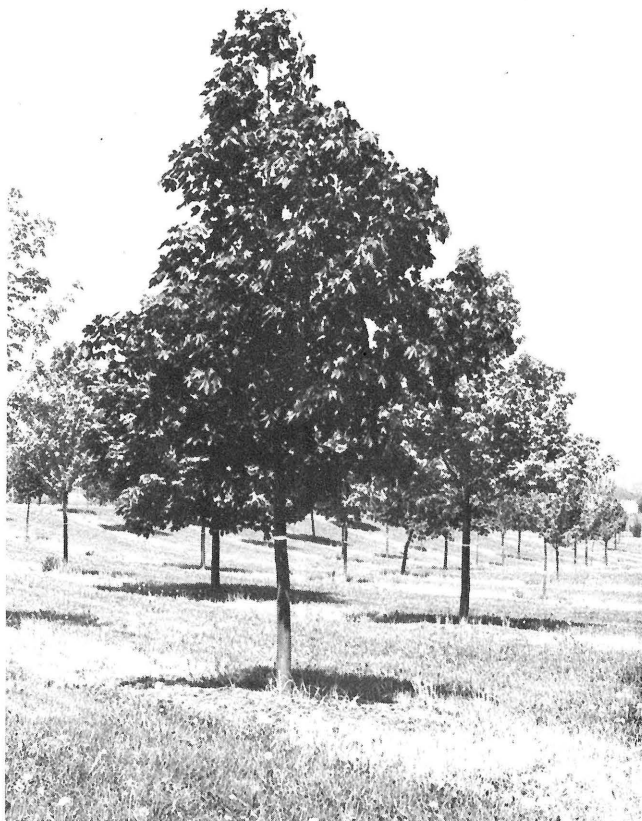
Rating: 0.900

*Acer platanoides* 'Royal Red'

Royal Red Norway Maple

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966	8.8		
1967		.70	
1968	8.6	.71	
1969	8.4	.89	
1970	9.3	1.08	2.3
1971	10.9	1.76	4.2
1972	13.0	2.29	6.1
1973	13.8	2.59	6.6



*Acer platanoides* 'Royal Red' is a purple leaf, upright oval Norway Maple cultivar. Although similar to 'Crimson King' in many respects, it is a less vigorous grower. It also has good crotch development with a coarse branch texture. The foliage in the late summer has been better than 'Crimson King', holding its dark purplish red color throughout the entire growing season.

Rating: 0.859

*Acer platanoides* 'Summershade'

Summershade Maple

EMH: 55 to 60 feet

Year	Height	Caliper	Spread
1966	11.8		
1967		.87	
1968	12.7	.95	
1969	12.9	1.25	
1970	13.2	1.65	3.6
1971	15.6	2.14	7.2
1972	16.7	2.86	9.3
1973	17.2	3.34	10.4



*Acer platanoides* 'Summershade' is a coarsely branched, large Norway Maple cultivar. It is an oval selection and is generally more vigorous and open than most of the newer Norway Maple cultivars. This character is quite evident even in young specimens. It has good crotch development and its leathery foliage has been reported as withstanding hot, dry, city conditions very well. Planting of this tree near utility lines should be discouraged due to the height and spreading nature of the tree.

Rating: 1.450

*Acer pseudoplatanus*

Planetree Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.2		
1967		1.02	
1968	9.4	1.09	
1969	9.6	1.19	
1970	9.6	1.42	2.4
1971	12.0	1.92	4.2
1972	13.2	2.56	6.0
1973	14.2	2.76	6.9



*Acer pseudoplatanus* is a tree which has done fairly well in the Shade Tree Evaluation Plot, but has performed rather poorly in some city plantings. Under compacted city soils, its performance has been less than satisfactory. In addition, severe winter injury has occurred in northern Ohio. This species seeds heavily, which can be unsightly and a maintenance problem. Its major attribute is the dark green, leathery foliage.

Rating: 1.430

*Acer rubrum*

Red Maple

EMH: 50 to 60 feet

Year	Height	Caliper	Spread
1966	5.2		
1967		.71	
1968	6.2	.79	
1969	7.8	1.03	
1970	10.3	1.27	4.4
1971	12.5	1.98	6.9
1972	15.4	2.58	8.4
1973	17.0	3.17	9.2



*Acer rubrum* is a species which has grown very rapidly in these tests. As with many species grown from seed, this tree which has a medium branch texture is unpredictable in form and rate of growth. Specimens in this study have fair to good crotch development. Although noted for its ability to withstand wet soil conditions, specimens should be provided with adequate drainage when planted. This tree may develop surface roots which can create a maintenance problem. Several cultivars are a better choice when looking for a particular form, rate of growth, or fall color.

Rating: 1.378

*Acer rubrum* 'Armstrong'

Armstrong Red Maple

EMH: 35 to 40 feet

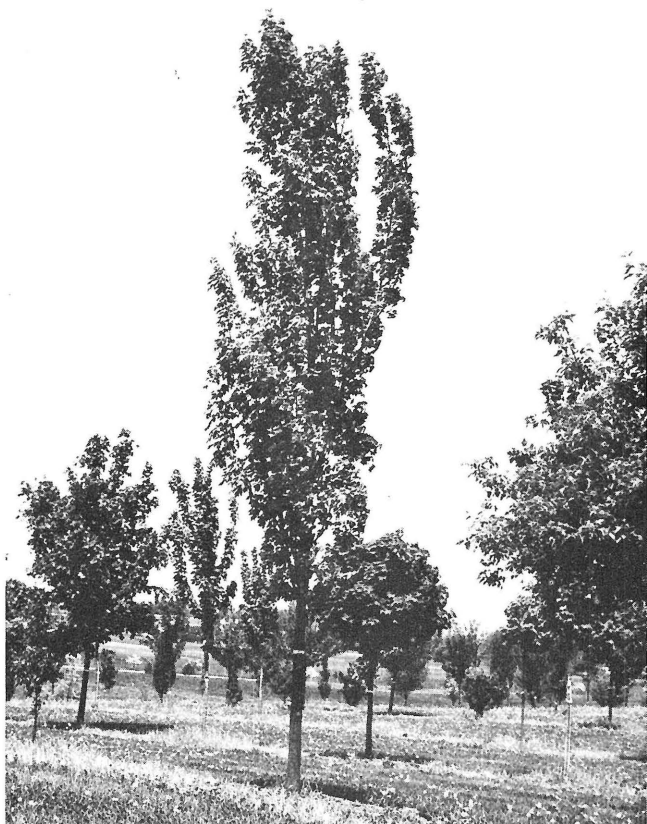
Year	Height	Caliper	Spread
1966	5.7		
1967		.71	
1968	6.0	.79	
1969	8.6	1.00	
1970	11.3	1.30	2.9
1971	15.2	2.13	4.7
1972	18.9	2.68	6.2
1973	21.3	3.28	6.9

*Acer rubrum* 'Autumn Flame'

Autumn Flame Red Maple

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966	7.0		
1967		.44	
1968	7.3	.51	
1969	7.4	.74	
1970	9.7	1.07	4.6
1971	11.5	1.75	6.5
1972	13.4	2.28	9.2
1973	14.7	2.83	9.9



*Acer rubrum* 'Armstrong' is noted as being the most fastigate of any of the columnar Red Maples. This finely branched cultivar is well suited for use in a narrow tree lawn situation and adjacent to utility lines, as well as for screen planting. Although the crotches are very narrow, they do not present a structural problem. There is little fall color on this particular cultivar. Performance in these tests has been very good, with a sizeable annual increase in height.

Rating: 0.503

*Acer rubrum* 'Autumn Flame' has a light red fall color and is the first of the Red Maple cultivars to develop this color. The form is upright and spreading. Its consistent coloring is generally completed before killing frost. The leaves are smaller than most Red Maple cultivars.

Rating: 1.019



*Acer rubrum* 'Autumn Glory'  
Autumn Glory Red Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.0		
1967		.54	
1968	8.7	.62	
1969	8.1	.77	
1970	9.7	1.03	3.3
1971	11.2	1.52	6.5
1972	13.4	1.93	8.2
1973	14.7	2.34	8.9



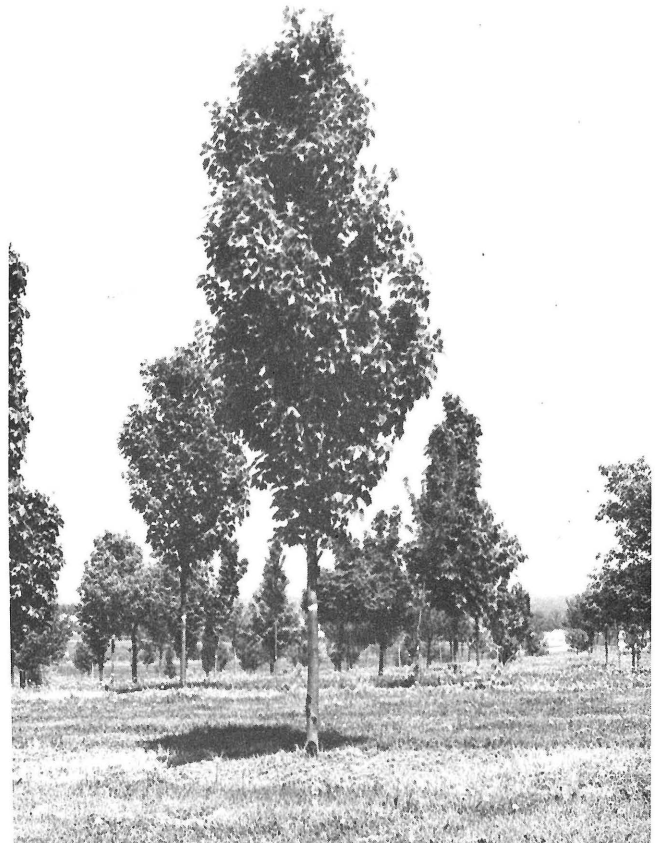
*Acer rubrum* 'Autumn Glory' is a medium textured Red Maple chosen for its exceptional red fall color. This tree has an upright spreading growth habit and its crotch development has been found to be fair to poor in this study. In overall performance and rating, this has been inferior to the other Red Maple cultivars.

Rating: 1.485

*Acer rubrum* 'Bowhall'  
Bowhall Red Maple

EMH: 40 to 50 feet

Year	Height	Caliper	Spread
1966	8.0		
1967		.72	
1968	8.3	.80	
1969	9.3	1.03	
1970	11.5	1.37	2.9
1971	14.0	2.02	5.1
1972	16.4	2.45	6.2
1973	17.7	2.93	6.9



*Acer rubrum* 'Bowhall', a narrow fastigate type, is suitable for planting in narrow tree lawns and adjacent to utility lines where space permits. The crotches are narrow but will not present a structural problem. The red fall color, foliage, and medium branch texture are similar to the species. This cultivar of Red Maple, which has rated high in this study, is generally broader than *Acer rubrum* 'Armstrong'.

Rating: 0.463

*Acer rubrum* 'Columnare'  
Columnar Red Maple

EMH: 40 to 50 feet

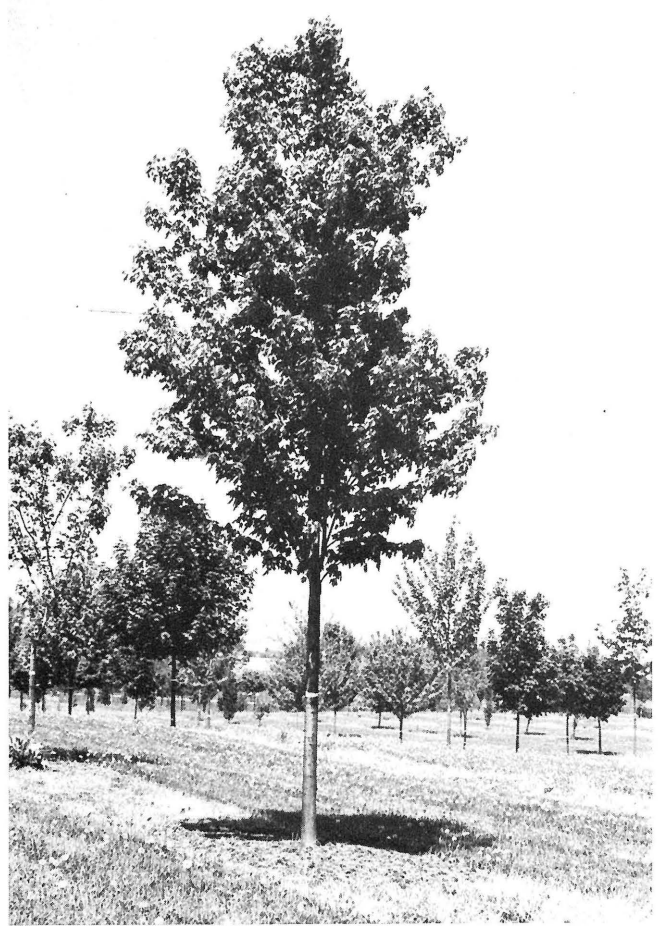
Year	Height	Caliper	Spread
1966	9.1		
1967		1.10	
1968	9.6	1.04	
1969	9.6	1.21	
1970	11.2	1.44	2.6
1971	13.7	1.94	4.2
1972	15.6	2.27	5.9
1973	16.5	2.59	6.5



*Acer rubrum* 'Gerling'  
Gerling Red Maple

EMH: 30 to 35 feet

Year	Height	Caliper	Spread
1966	9.7		
1967		1.14	
1968	9.8	1.17	
1969	11.3	1.37	
1970	13.4	1.73	5.0
1971	17.1	2.29	7.6
1972	19.7	2.96	9.3
1973	21.1	3.56	10.5



*Acer rubrum* 'Columnare', with a medium branch texture, is a fastigate type which is broader than *Acer rubrum* 'Armstrong'. Its growth rate is slower than other columnar types. The crotch development is only fair. Its dependable red fall color is better than either *Acer rubrum* 'Armstrong' or *Acer rubrum* 'Bowhall' and persists for 1 week or less. It is well suited for planting adjacent to utility lines where space permits.

Rating: 1.129

*Acer rubrum* 'Gerling' is described as an upright selection, but in this study has been observed to be broader spreading. Variation was noted in the individual specimen trees, which range from fastigate to upright oval. The crotch development is generally good. The red fall color is similar to the species. This medium branch textured cultivar has been reported to reach 30 to 35 feet, but specimens in these tests are expected to surpass this height.

Rating: 0.553



*Acer rubrum* 'October Glory'

October Glory Red Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	8.2		
1967		.76	
1968	8.4	.86	
1969	9.6	1.17	
1970	10.9	1.52	5.1
1971	13.8	2.41	9.0
1972	16.0	2.87	10.1
1973	18.1	3.56	10.5



*Acer rubrum* 'October Glory' has excellent crimson red fall color which occurs later in the fall than most Red Maple cultivars. Hence, the fall color is frequently not fully developed due to early frosts in the Wooster area. This rounded selection has good to fair crotch development. This Red Maple cultivar has very shiny leaves in addition to a medium branch texture.

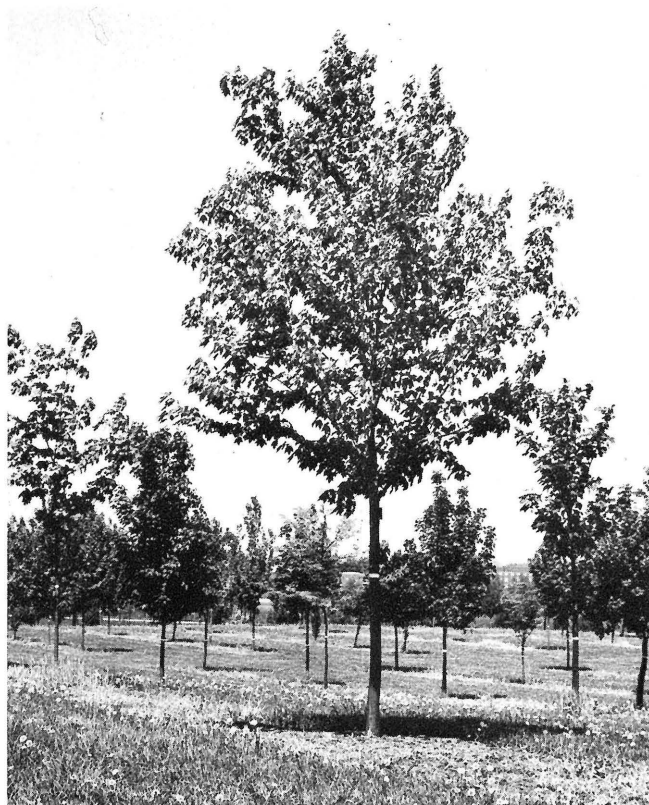
Rating: 0.124

*Acer rubrum* 'Red Sunset'

Red Sunset Red Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	10.3		
1967		1.18	
1968	10.4	1.09	
1969	10.9	1.34	
1970	12.4	1.68	5.1
1971	15.1	2.23	7.7
1972	17.5	2.90	9.8
1973	19.1	3.49	10.6



*Acer rubrum* 'Red Sunset' has a bright orange-red fall color. The fall coloring, which is generally effective for 1 to 2 weeks, usually occurs before killing frost. This tree with an upright oval habit has good crotch development and a medium branch texture.

Rating: 0.159

*Acer rubrum* 'Schlesinger'

Schlesinger Red Maple

EMH: 50 feet

Year	Height	Caliper	Spread
1966	10.8		
1967		.81	
1968	10.4	.94	
1969	9.2	1.09	
1970	10.0	1.34	2.7
1971	13.3	1.97	5.3
1972	15.4	2.53	7.1
1973	16.4	3.08	8.6



*Acer rubrum* 'Schlesinger' is a Red Maple cultivar selected for its excellent red fall color, which persists for about 10 days. Its broad-spreading habit is less uniform than some of the other Red Maple cultivars. In addition, its growth rate has been slow as shown in the data. This selection generally had good crotch development.

Rating: 1.395

*Acer rubrum* 'Tilford'

Tilford Red Maple

EMH: 45 feet

Year	Height	Caliper	Spread
1966	11.0		
1967		1.09	
1968	11.0	1.09	
1969	12.0	1.34	
1970	14.1	1.69	5.0
1971	15.9	2.14	6.7
1972	19.7	2.62	8.6
1973	20.6	3.10	9.6



*Acer rubrum* 'Tilford', an upright spreading cultivar, is a vigorous grower with fair to good crotch development. Reports on city plantings indicate that this medium textured specimen requires little maintenance.

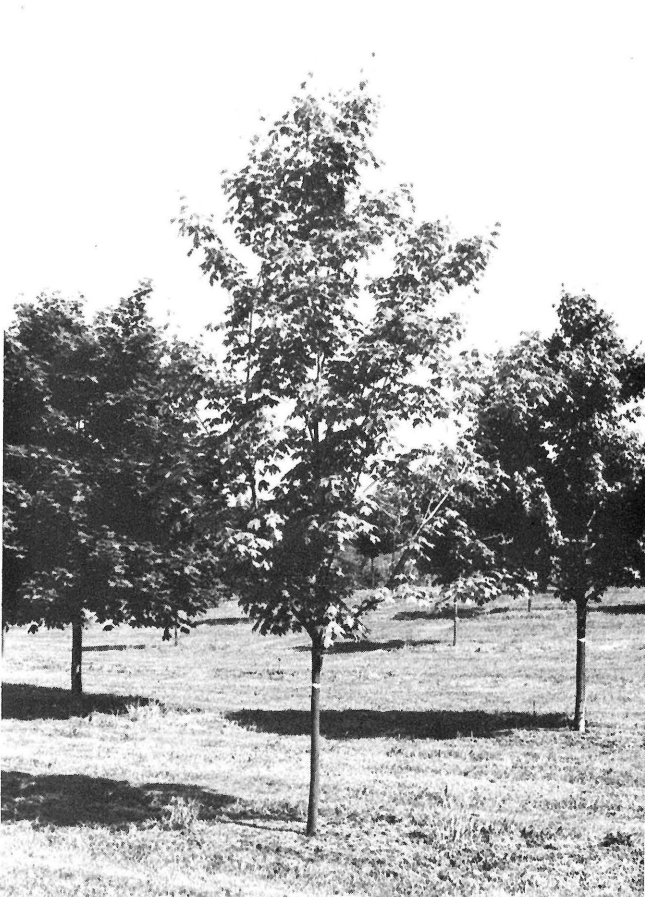
Rating: 0.929

*Acer saccharum*

Sugar Maple

EMH: 70 to 75 feet

Year	Height	Caliper	Spread
1966	5.7		
1967		.54	
1968	7.4	.68	
1969	7.9	.77	
1970	9.1	.89	2.3
1971	11.4	1.33	3.8
1972	13.3	1.66	5.5
1973	14.7	1.91	6.3



*Acer saccharum* is quite variable in form (from upright oval to upright spreading), rate of growth, and resistance to leaf scorch. The branch texture also varies from medium to fine. It generally has good crotch development. Plantings in narrow tree lawns are usually unsuccessful due to its susceptibility to leaf scorch. Good soil, adequate drainage, and ample soil moisture are required for proper development. Several cultivars of this species are more tolerant of adverse conditions and are better choices for specific planting sites.

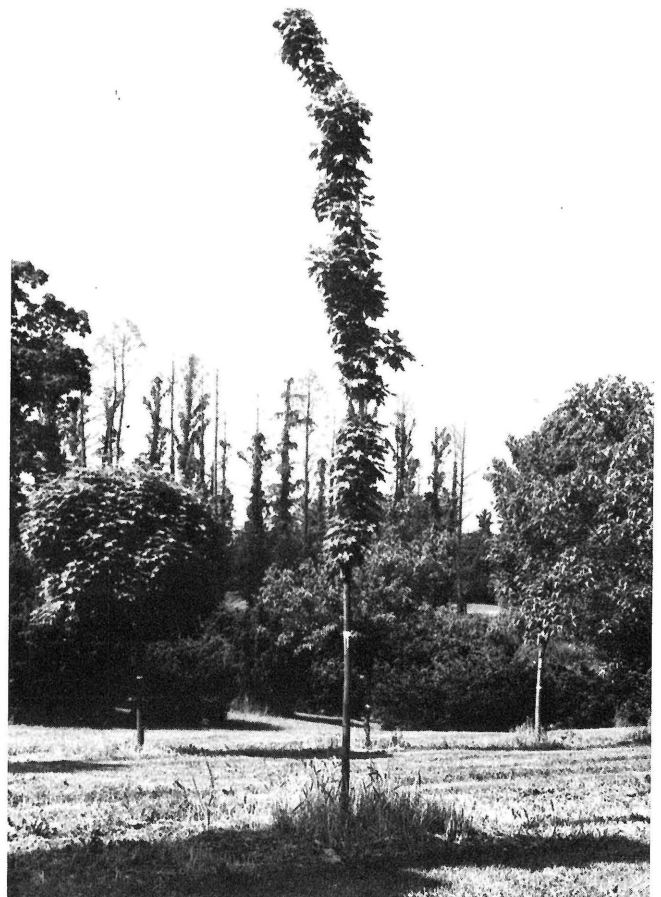
Rating: 2.109

*Acer saccharum* 'Columnare'

Columnar Sugar Maple

EMH: 50 to 55 feet

Year	Height	Caliper	Spread
1966	6.7		
1967		.50	
1968	7.0	.58	
1969	7.1	.67	
1970	8.4	.94	1.8
1971	10.2	1.27	3.1
1972	12.4	1.57	4.0
1973	13.2	1.92	4.5



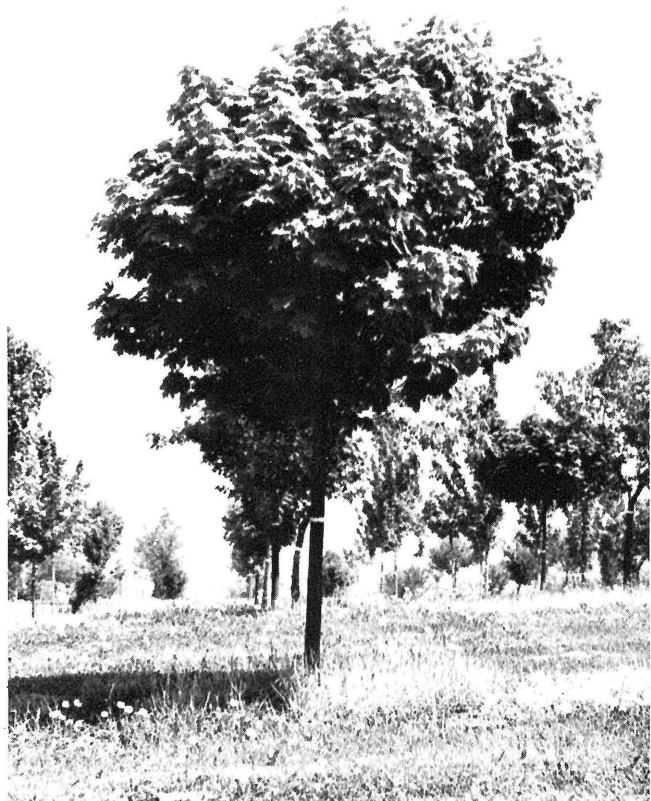
*Acer saccharum* 'Columnare', because of its narrow columnar form, is often placed in tree lawns too narrow to provide adequate moisture. Generally it is susceptible to the same leaf scorch problems as the species. The development and growth rate of this cultivar have been very satisfactory. This cultivar has a medium branch texture.

Rating: 2.080

*Acer saccharum* 'Globosum'  
Globe Sugar Maple

EMH: 15 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	8.4	1.16	
1969	8.5	1.12	
1970	8.6	1.15	2.8
1971	9.5	1.60	3.8
1972	10.4	1.92	5.2
1973	10.8	2.11	5.7



*Acer saccharum* 'Globosum', a densely branched, medium textured, formal globe cultivar, generally requires more time to develop this habit than *Acer platanoides* 'Globosum'. Leaf scorch is also a problem with this cultivar. When planted bare root, a low survival rate frequently occurs. As with many of the globe types, it is suitable for planting beneath utility lines in favorable soil conditions.

Rating: 1.835

*Acer saccharum* 'Green Mountain'  
Green Mountain Sugar Maple

EMH: 60 to 70 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	8.5	1.00	
1969	8.4	.96	
1970	10.2	1.20	2.7
1971	13.0	1.77	6.2
1972	15.3	2.3	8.3
1973	17.7	2.9	9.0



*Acer saccharum* 'Green Mountain' is reported to be more resistant to leaf scorch than the species. Several specimens of this oval-headed selection died during the wet spring experienced in 1973. The fall color is yellow to orange-red which is quite similar to the species and persists for 1 week. The crotch development is generally good.

Rating: 2.541



*Acer saccharum* 'Sweet Shadow'  
Sweet Shadow Sugar Maple

EMH: 60 feet

Year	Height	Caliper	Spread
1966	10.4		
1967		.85	
1968	10.2	.88	
1969	10.3	1.03	
1970	11.4	1.22	3.8
1971	14.8	1.69	4.9
1972	16.9	2.07	7.0
1973	18.1	2.29	7.3



*Acer saccharum* 'Sweet Shadow' has a very attractive, cut-leaf foliage pattern. With age, this distinctiveness is less apparent. Growth of this upright oval cultivar has been slightly more vigorous than the species, with crotch development only fair. Although not documented, its susceptibility to leaf scorch will probably be similar to the species. Excessive loss was experienced during the very wet spring of 1973.

Rating: 2.161

*Amelanchier grandiflora*  
Apple Serviceberry

EMH: 25 to 30 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	7.2	1.13	2.2
1972	8.2	1.35	4.8
1973	9.7	1.71	6.9



*Amelanchier grandiflora* is often grown in bush form, but can be trained single stem into an upright spreading tree. It is a rapid growing, small tree. Unless proper pruning is provided early, it is difficult to develop this species as a single stem tree, and thus its use as a street tree is limited.

Rating: 1.381

*Crataegus intricata*

Thicket Hawthorn

EMH: 20 to 22 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	5.8	.58	
1969	6.4	.75	
1970	7.5	1.08	3.0
1971	9.3	1.61	5.8
1972	10.2	1.88	7.4
1973	10.8	2.15	7.8



*Crataegus intricata* has been found to be an upright spreading species. In addition, it fruits heavily and is noted for its excessive thorns. The crotch development is good and it has a medium branch texture.

Rating: 1.565

*Crataegus lavallei*

Lavalle Hawthorn

EMH: 20 feet

Year	Height	Caliper	Spread
1966			
1967		.74	
1968	8.3	.78	
1969	9.0	.98	
1970	10.0	1.28	3.0
1971	10.9	1.89	5.0
1972	11.1	2.20	6.0
1973	11.7	2.50	6.7



*Crataegus lavallei* is a very tightly branched, columnar species, with a medium to fine branch texture. The head on mature trees eventually becomes as wide as it is tall. It has glossy green foliage and persisting, showy, orange-red fruit following its creamy white flowers. Generally there are few thorns. It does well in difficult urban environments where at least a 3-foot tree lawn is provided. The development of the crotches is good. It is a small, slow-growing species, making it well suited for planting beneath utility lines.

Rating: 1.314



*Crataegus mollis*

Downy Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	7.5	.76	
1969	7.6	.85	
1970	8.6	1.06	2.4
1971	10.9	1.73	5.6
1972	11.7	2.11	7.3
1973	12.6	2.54	9.0



*Crataegus mollis* has abundant large red fruits which may pose an objectionable feature when planted as a street tree. The branching is medium textured. The oval habit may limit its use to wide tree lawns. However, the open growth habit makes this a beautiful specimen. Crotch development has been generally found to be good. The presence of thorns may be objectionable in some locations.

Rating: 0.588

*Crataegus monogyna* 'Stricta'

Upright Single Seed Hawthorn

EMH: 20 feet

Year	Height	Caliper	Spread
1966			
1967	6.6	.57	
1968	6.8	.62	
1969	9.3	.92	
1970	10.4	1.22	2.0
1971	13.0	1.88	3.5
1972	14.3	2.46	4.7
1973	15.8	2.92	5.5



*Crataegus monogyna* 'Stricta' is very narrow upright in growth habit. It has been reported that specimens broaden with age. The habit makes it suitable for confined locations. This cultivar has been found to be lightly to severely susceptible to fireblight, and somewhat subject to insect infestations. Specimens have been found to be medium-finely textured, with a few thorns. Although the crotches are narrow, they are acceptable on such a fastigate tree.

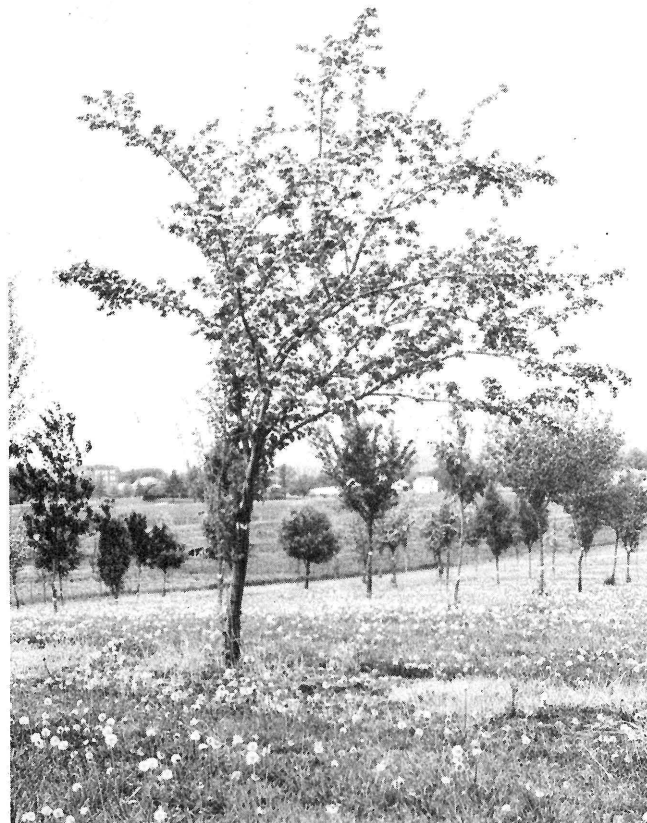
Rating: 1.298

*Crataegus mordensis* 'Toba'

Toba Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967		.65	
1968	6.1	.63	
1969	7.4	.92	
1970	9.4	1.48	4.0
1971	11.7	2.32	7.0
1972	12.0	2.89	9.2
1973	12.4	3.12	9.7



*Crataegus mordensis* 'Toba' is a pink, double flowering, Canadian cultivar which has proven to be a very erratic grower in this study. It frequently leans heavily and suffers from many of the insects and diseases common to the Hawthorns. The bark is ridged and twisted.

Rating: 1.440

*Crataegus nitida*

Glossy Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	7.2	.83	
1969	6.2	.83	
1970	6.1	1.05	1.8
1971	8.7	1.63	4.2
1972	9.7	1.92	6.1
1973	10.4	2.43	6.7



*Crataegus nitida* is a dense, round-headed species with a medium branch texture. It develops persistent red fruit. This beautiful compact tree has an interesting zig-zag branching pattern. Height increase is very slow, as indicated in the growth data. The thorns are very large and may be objectionable in some locations.

Rating: 0.870

*Crataegus oxyacantha* 'Autumn Glory'

Autumn Glory Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967		.57	
1968	6.2	.63	
1969	8.9	.92	
1970	9.9	1.51	5.5
1971	11.0	1.95	7.5
1972	11.3	2.35	8.2
1973	11.6	2.59	8.7



*Crataegus oxyacantha* 'Autumn Glory' is a rapid growing, thorny cultivar chosen for its white flowers and persistent, large, red fruit. Fireblight has been found to be a severe problem with this selection.

Rating: 1.744

*Crataegus oxyacantha* 'Pauli'

Paul's Scarlet Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967		.72	
1968	8.0	.80	
1969	8.7	1.07	
1970	11.8	1.59	4.5
1971	13.9	2.17	7.3
1972	14.4	2.88	8.6
1973	15.9	3.31	9.1



*Crataegus oxyacantha* 'Pauli' has attractive scarlet flowers and shiny foliage, but is not recommended because of its susceptibility to many insect and disease problems. When the tree is planted in difficult environmental situations, these problems are more evident.

Rating: 1.786

*Crataegus phaenopyrum* 'Tree Form'

Tree Form Washington Hawthorn

EMH: 20 to 25 feet

Year	Height	Caliper	Spread
1966			
1967		.71	
1968	6.9	.77	
1969	8.2	1.08	
1970	10.6	1.46	4.2
1971	13.5	2.16	8.0
1972	13.8	2.54	9.3
1973	14.9	2.91	10.0



*Crataegus prunifolia*

Plum Leaf Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	6.7	.68	
1969	6.2	.72	
1970	7.4	.89	1.9
1971	9.0	1.71	5.5
1972	9.7	2.25	7.1
1973	10.9	2.83	7.8



*Crataegus phaenopyrum* 'Tree Form' has done exceptionally well in the OARDC plots, as well as in the city plantings. It has survived even in the smallest of planting sites. This selection has beautiful flowers, foliage, and fruit. It is a small, thorny, upright oval selection and must be trained single stem for street tree use. This tree has very few of the problems associated with many of the Hawthorns and is adaptable to difficult urban environments.

Rating: 0.927

*Crataegus prunifolia* is a densely growing, round-headed, thorny species at early ages. The fruits drop early. This species, like several Hawthorns, frequently leans heavily. The crotch development is good.

Rating: 0.704



*Crataegus punctata*  
Dotted Hawthorn

EMH: 18 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	7.8	.62	
1969	7.5	.83	
1970	8.1	1.12	3.3
1971	10.0	1.88	6.2
1972	10.8	2.20	7.1
1973	10.8	2.66	7.7



*Crataegus punctata* is documented as broad-spreading at maturity, thus limiting its use to wide tree lawn areas. The foliage is less glossy than most Hawthorns. In addition to its attractive bark, it has large flower clusters and colorful red fruits which drop early. Generally there are only a few thorns. Some fruit rust problems have been reported. This species has good crotch development and medium branch texture.  
Rating: 1.076

*Crataegus viridis* 'Winter King'  
Winter King Hawthorn

EMH: 25 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	9.3	1.20	4.0
1972	10.3	1.51	6.3
1973	11.7	1.90	7.6



*Crataegus viridis* 'Winter King' has performed well in this study. It is less thorny than most of the Hawthorn species and the white flowers, red fruit, and silver gray bark are outstanding. Generally it is not as broad spreading as the other Hawthorns.  
Rating: 1.274

*Fraxinus americana* 'Autumn Purple'  
Improved White Ash

EMH: 65 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	10.1	1.00	3.4
1971	11.0	1.54	4.1
1972	11.2	1.50	4.6
1973	11.5	1.54	4.2



*Fraxinus americana* 'Autumn Purple' has excellent, reddish-purple, dependable fall color. The upright spreading habit is similar to the species. The large size may limit its use as a street tree. The branch texture is medium to coarse and crotch development is good.

Rating: 1.998

*Fraxinus excelsior* 'Hessei'  
Hesse European Ash

EMH: 50 to 60 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	8.5	1.25	2.2
1972	10.5	1.72	4.1
1973	13.1	2.29	5.8



*Fraxinus excelsior* 'Hessei' in this study has been a very vigorous growing, upright oval, seedless cultivar. Pests common to the ashes have not been observed on this selection to date. The branch texture is medium to coarse and crotch development is good. Specimens observed elsewhere have been found to be attractive at all ages. The simple leaf foliage is glossy, green, and heavy-textured, and is retained late in the fall, thus having little showy fall color. Its considerable size limits its use to large areas.

Rating: 1.533



*Fraxinus pennsylvanica lanceolata*

'Marshall Seedless'

Marshall Green Ash

EMH: 55 to 60 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	7.2	.67	
1970	9.8	1.10	2.6
1971	12.2	1.97	4.8
1972	14.0	2.52	6.5
1973	17.4	3.22	7.5

*Gleditsia triacanthos inermis*

'Imperial'

Low-Gro Honeylocust

EMH: 45 to 50 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	11.3	.91	
1970	11.6	1.04	3.0
1971	13.1	1.63	7.2
1972	13.7	1.95	9.7
1973	14.6	2.28	10.4



*Fraxinus pennsylvanica lanceolata* 'Marshall Seedless' is a very vigorous, upright oval, seedless cultivar which transplants easily. Growth has been very uniform and is expected to reach 55 to 60 feet at maturity. The fall color is bright yellow. Some borer problems have been reported.

Rating: 0.379

*Gleditsia triacanthos inermis* 'Imperial' is a uniform, moderate growing, oval cultivar.

Rating: 0.961

*Gleditsia triacanthos inermis* 'Shademaster'  
Shademaster Honeylocust

EMH: 45 to 50 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	6.0	.68	
1971	9.5	1.22	6.0
1972	12.3	1.72	10.4
1973	14.9	2.39	12.3



*Gleditsia triacanthos inermis* 'Shademaster' is a rapid growing, upright selection, growing generally with a straight trunk. However, observations indicate that it does not develop a strong central leader.

Rating: 1.400

*Gleditsia triacanthos inermis* 'Skyline'  
Pyramidal Honeylocust

EMH: 45 to 50 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	7.2	.81	1.6
1971	11.9	1.34	5.0
1972	15.1	1.97	8.8
1973	17.3	2.45	9.2



*Gleditsia triacanthos inermis* 'Skyline' is a widely adaptable, rapid growing cultivar. It has been the fastest growing Honeylocust selection in this study. This tree has an upright spreading habit of growth with a strong central leader.

Rating: 0.925

*Halesia carolina*

Carolina Silverbell

EMH: 15 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	5.7	.81	1.2
1972	7.1	.98	3.2
1973	8.1	1.20	4.2

*Liquidambar styraciflua* 'Moraine'

Moraine Sweetgum

EMH: 60 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	7.0		
1971	7.5	1.2	2.5
1972	8.9	1.6	4.0
1973	12.1	2.0	6.1



*Halesia carolina* needs excellent nursery culture to produce a satisfactory single-stemmed tree. It is a small tree which flowers abundantly in May. The crotch development is good and the branch texture is medium. The persistent fruit pods make an attractive winter feature. Thus far no pest problems have been found. *Halesia monticola* is another Silverbell which is generally found as a tree form in growth habit.

Rating: 1.473

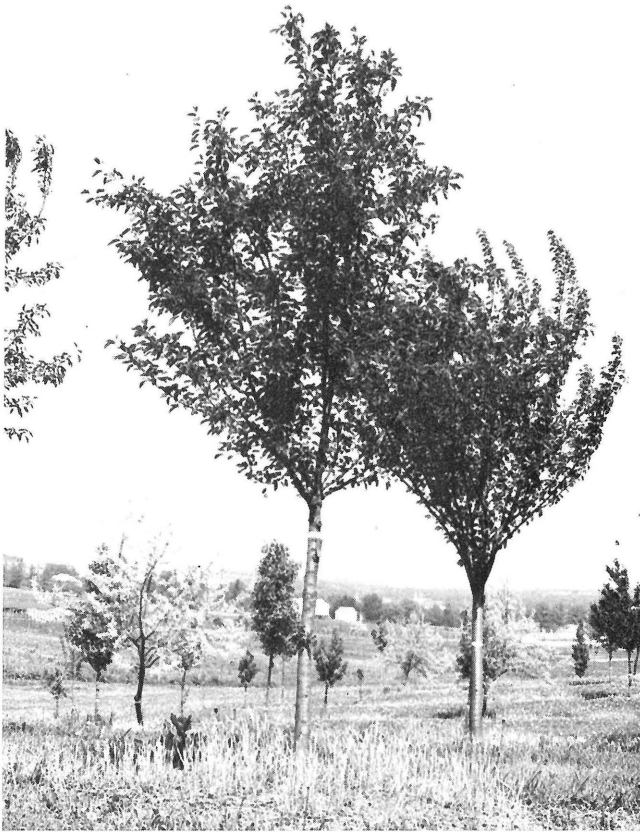
*Liquidambar styraciflua* 'Moraine' is more uniform and faster growing than the species. It has an upright oval habit with a medium branch texture. The fall color is excellent. Crotch development has been found to be good.

Rating: 0.556

*Malus* 'Radiant'  
Radiant Crabapple

EMH: 20 to 25 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	7.8	.89	
1970	9.4	1.26	3.0
1971	11.0	1.88	6.5
1972	12.1	2.16	7.2
1973	12.9	2.49	7.6



*Malus* 'Radiant', a small, round-headed Crabapple, is suitable for planting in wide lawns, but apple scab infestations have become a severe problem with this species recently. It has very attractive pink flowers and small red fruit, in addition to a medium branch texture.

Rating: 1.693

*Malus* 'Snowdrift'  
Snowdrift Crabapple

EMH: 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	7.7	.94	
1970	9.3	1.42	3.5
1971	11.6	2.41	7.9
1972	12.8	3.03	9.1
1973	13.3	3.61	9.6



*Malus* 'Snowdrift' is a round-headed, broad, oval cultivar. The foliage is heavily textured and highly scab-resistant. Some fireblight may occur in favorable seasons. Its straight trunk is easily limbed-up to street tree heights, and the crotch development is good. In the spring it produces abundant white flowers. The small fruits drop readily after a heavy frost. This is a highly desirable Crabapple for street tree use.

Rating: 0.507



***Malus* 'Tschonoski'**  
**Tschonoski Crabapple**

EMH: 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	6.4	.79	1.4
1971	8.1	1.46	3.1
1972	9.2	1.95	3.5
1973	11.1	2.37	4.1



*Malus* 'Tschonoski' is a narrow, upright, fastigate cultivar. Although the crotches are narrow, they will not present a structural problem. No insect or disease problems have been detected. It has a distinctive gray-green foliage, turning to a medium green in mid-summer, and the fall color is an orange-red. This tree has been found to be flowerless and fruitless.

Rating: 0.806

***Malus* 'Van Eseltine'**  
**Van Eseltine Crabapple**

EMH: 15 to 20 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	4.9	.76	1.3
1971	7.5	1.36	2.8
1972	9.6	1.56	3.9
1973	10.6	1.84	4.5



*Malus* 'Van Eseltine' is an upright, vase-shaped cultivar which is quite irregular. Its large, double, pink flowers rival those of the flowering cherries. It is reported to become more broad spreading at maturity. The narrow crotches will not be a structural problem. Fireblight can be a problem, which downgrades this cultivar as a street tree.

Rating: 1.531

*Ostrya virginiana*

Hophornbeam

EMH: 25 to 30 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	7.2	.81	1.50
1972	8.8	1.14	3.36
1973	10.0	1.41	4.13



*Ostrya virginiana* is a shapely, upright, spreading tree when young. It has a fine branch texture and elm-like foliage. It does well in the city plantings in very narrow tree lawns. Initial establishment has been difficult after transplanting with this slow-growing selection.

Rating: 1.278

*Platanus acerifolia*

London Planetree

EMH: 60 to 70 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	9.8	.99	
1970	12.0	1.32	4.7
1971	14.0	2.19	7.4
1972	16.1	2.87	10.2
1973	18.6	3.57	11.0



*Platanus acerifolia* is a rapid growing, pyramidal species widely adaptable to adverse downtown situations. It tolerates soil compaction, heat, and drought, as well as severe pruning. The trunk and coarse-textured branches have attractive exfoliating bark. The crotch development is good. The leaves are very large and may create a problem. It is susceptible to anthracnose, but much less so than the native *Platanus occidentalis* in which anthracnose causes defoliation in some humid seasons. *Platanus acerifolia* 'Bloodgood', a cultivar of this species, has greater resistance to anthracnose than the species.

Rating: 0.324

*Prunus sargentii*

Sargent Cherry

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	5.3	.69	
1970	6.9	.85	2.0
1971	10.9	1.78	4.7
1972	11.4	2.32	5.9
1973	12.8	2.71	6.3

*Prunus sargentii* 'Columnaris'

Columnar Sargent Cherry

EMH: 20 to 25 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	7.1	.89	
1970	9.6	1.31	2.1
1971	13.8	2.09	4.1
1972	15.3	2.75	5.9
1973	16.3	3.36	6.6



*Prunus sargentii* is the hardiest of the flowering cherries. It has attractive, single, pink flowers. Its upright spreading growth habit is well-suited for street tree use. In the fall, the foliage on this medium branch textured species turns an excellent red to orange-red.

Rating: 1.229

*Prunus sargentii* 'Columnaris' is a narrow columnar cultivar which has been found to be hardy like the species. It is generally pest-free and has single pink flowers, like the species. This selection has good crotch development and medium branch texture. The fall color is a good red.

Rating: 0.971

*Prunus serrulata* 'Kwanzan'

Kwanzan Oriental Cherry

EMH: 20 to 25 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	9.7	1.16	
1970	11.4	1.48	3.8
1971	15.0	2.69	7.4
1972	15.4	3.33	9.0
1973	16.7	3.99	9.4



*Prunus serrulata* 'Kwanzan' is a beautiful flowering cherry with masses of carnation-like flowers in the spring. It has a formal, vase-shaped habit with a medium to coarse branch texture. Use as a street tree has been unsuccessful in many instances. In northern Ohio, it suffers severely from frost cracks, is quite susceptible to salt damage, and some borer problems have been reported. Planting in narrow tree lawns results in loss of vigor. When top grafted onto 6-foot standards, specimens reach 20 to 25 feet at maturity. Crotch development is only fair to good.

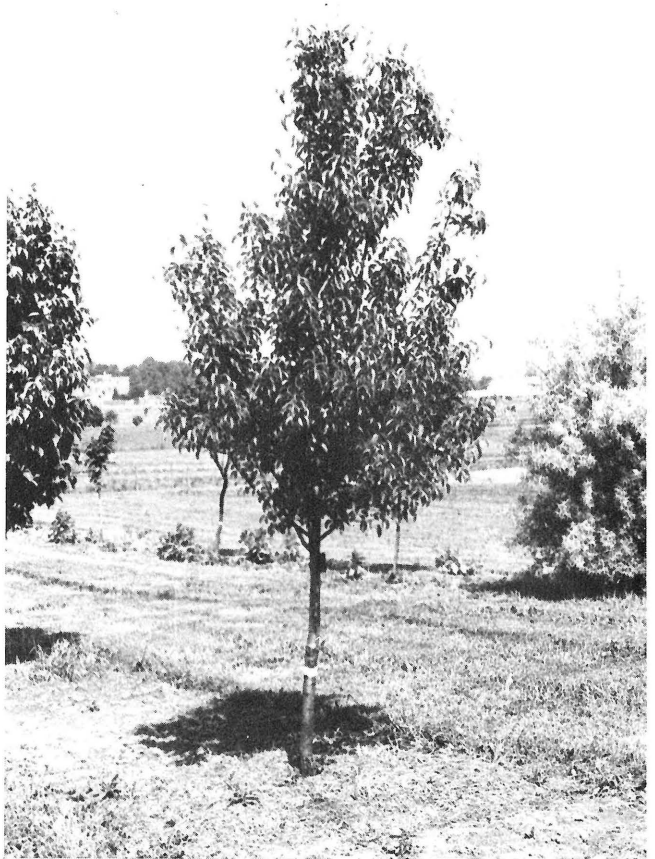
Rating: 1.196

*Pyrus calleryana* 'Bradford'

Bradford Callery Pear

EMH: 40 to 45 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	5.3	.85	1.8
1972	6.8	1.19	2.5
1973	8.9	1.65	2.9



*Pyrus calleryana* 'Bradford' is a broad, fastigate, well-branched cultivar with good crotch development. It has attractive white flowers and one-half inch small brown fruit. The foliage is glossy green in the summer and turns yellow, purple, and red in the fall. This selection has a medium branch texture.

Rating: 1.221



*Quercus robur* 'Fastigiata'  
Pyramidal English Oak

EMH: 40 to 50 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	6.6	.55	.9
1971	8.3	1.16	1.7
1972	10.7	1.53	3.2
1973	12.2	1.95	4.0

*Quercus shumardi*  
Shumard Oak

EMH: 50 to 60 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	8.4	.88	2.2
1971	9.0	1.16	2.0
1972	9.5	1.38	3.5
1973	11.3	1.70	4.4



*Quercus robur* 'Fastigiata', like the species, is tolerant of adverse soil conditions. The fastigate form permits planting in confined areas. Powdery mildew is common on this selection but apparently does not reduce the vigor. Generally these trees have been reported as having great longevity and freedom from serious pest problems.

Rating: 0.955

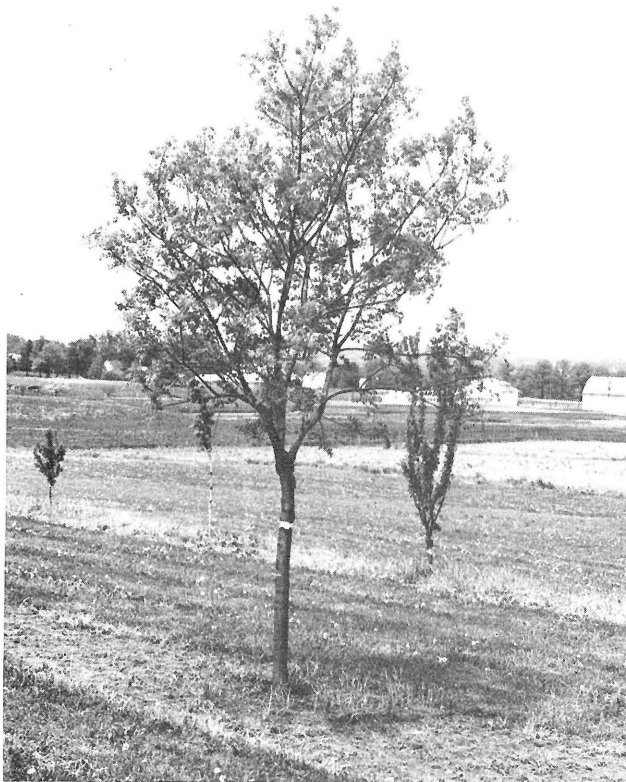
*Quercus shumardi* tends to be pyramidal as a young tree but develops a broad oval canopy with age. In addition, it transplants readily. The fall color, which is bright red, is better than that of most Red Oaks.

Rating: 1.830

*Sophora japonica* 'Regent'  
Regent Japanese Pagoda Tree

EMH: 40 to 45 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970	7.3	1.21	2.4
1971	9.0	1.58	4.2
1972	10.4	1.98	6.6
1973	11.6	2.40	6.7



*Sophora japonica* 'Regent' generally has a better branching habit and a straighter trunk than the species. It has an upright spreading form and bears large creamy clusters of flowers in mid-summer. Like the species, it is not impressive as a young tree, but develops into an attractive street tree with age. This tree has been found to be quite tolerant of narrow planting sites and adverse city conditions. The crotch development is only fair.

Rating: 0.982

*Tilia cordata*  
Littleleaf Linden

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966			
1967		.68	
1968	6.0	.75	
1969	5.8	.80	
1970	6.9	.98	2.0
1971	9.6	1.77	4.5
1972	10.8	2.23	5.9
1973	12.4	2.55	6.8



*Tilia cordata* is extensively used as a street tree and is adaptable to variable soil and climatic conditions. As a seedling tree which is frequently rounded, it is often variable in size and habit. This tree, which has good crotch development, has done very well as a street tree in difficult areas. However, it is generally recommended that one of the newer selections of this species be chosen for specific planting sites.

Rating: 0.962

*Tilia cordata* 'Chancellor'  
Chancellor Littleleaf Linden

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	6.9	.92	
1969	7.3	1.02	
1970	8.7	1.29	2.2
1971	10.9	1.99	4.4
1972	12.0	2.49	5.4
1973	13.1	3.05	6.4

*Tilia cordata* 'Greenspire'  
Greenspire Linden

EMH: 40 feet

Year	Height	Caliper	Spread
1966			
1967		.80	
1968	7.4	.83	
1969	7.3	.85	
1970	7.7	1.13	1.7
1971	10.3	1.92	4.5
1972	12.1	2.41	5.6
1973	12.9	3.01	6.2



*Tilia cordata* 'Chancellor' is a fastigate cultivar which is reported to become pyramidal with age. This symmetrical, fast-growing cultivar has good crotch development and a medium to coarse branch texture.

Rating: 0.502



*Tilia cordata* 'Greenspire' as a young tree has an upright oval form with small, dense, dark green foliage. In city plantings, it has been found to do very well under difficult conditions. Crotch development is good in this medium textured tree.

Rating: 0.751

*Tilia cordata* 'Rancho'

Rancho Linden

EMH: 35 feet

Year	Height	Caliper	Spread
1966			
1967		.66	
1968	7.7	.69	
1969	7.7	.84	
1970	8.8	1.13	2.0
1971	11.2	1.81	4.1
1972	12.6	2.27	5.5
1973	13.4	2.72	6.3

*Tilia cordata* 'XP110'

XP110 Littleleaf Linden

EMH: Unknown

Year	Height	Caliper	Spread
1966			
1967		.60	
1968	7.7	.68	
1969	8.0	.87	
1970	9.5	1.18	2.7
1971	11.6	1.92	5.4
1972	12.2	2.30	6.2
1973	13.3	2.87	7.1



*Tilia cordata* 'Rancho' is another new upright oval cultivar. Crotch development is good and as a street tree it requires very little maintenance. In addition to a medium-fine branch texture, it has attractive, small, glossy green foliage.

Rating: 0.471



*Tilia cordata* 'XP110' is an upright oval cultivar with attractive small foliage. Crotch development is good. Further comment is being withheld pending further observation.

Rating: 0.653



*Tilia euchlora*  
Crimean Linden

EMH: 50 to 55 feet

Year	Height	Caliper	Spread
1966			
1967		.62	
1968	6.6	.59	
1969	6.2	.70	
1970	7.1	.85	1.6
1971	8.8	1.26	2.8
1972	9.9	1.87	3.9
1973	10.4	1.85	4.9

*Tilia euchlora* 'Redmond'  
Redmond Linden

EMH: 50 to 55 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969	5.4	.85	
1970	7.0	.78	1.3
1971	7.1	1.32	1.5
1972	7.6	1.44	2.8
1973	9.2	1.74	3.3



*Tilia euchlora*, unlike many species of trees, is very uniform. In this study it has been found to be a slow-growing selection.

Rating: 1.330

*Tilia euchlora* 'Redmond' has been found to be a slow-growing, pyramidal cultivar in this study. It has been reported elsewhere as a rapid growing cultivar.

Rating: 1.675

*Tilia europaea* 'Pallida'

Pallida Common Linden

EMH: Unknown

Year	Height	Caliper	Spread
1966			
1967			
1968	6.9	.60	
1969	6.9	.65	
1970	7.7	.81	2.0
1971	10.5	1.60	4.1
1972	12.9	2.20	5.8
1973	14.8	2.80	6.9



*Tilia europaea* 'Pallida' has been observed for only a short time. Thus far it appears to be a vigorous pyramidal cultivar. The crotch development is good. It has been found to have a medium-fine branch texture. Further comment is being withheld pending future observation.

Rating: 0.545

*Tilia mongolica*

Mongolian Linden

EMH: 30 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	6.8	.63	
1969	6.4	.63	
1970	7.5	.87	2.9
1971	9.2	1.52	3.9
1972	9.9	1.89	5.1
1973	11.0	2.24	6.6



*Tilia mongolica* is a small species tree. It has fine branch texture and glossy green leaves with serrated edges. In the smaller sizes used in this study, it has a broadly columnar habit with good crotch development.

Rating: 1.399

*Tilia platyphyllos* 'Fastigiata'  
Upright Bigleaf Linden

EMH: 35 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	7.4	.90	
1969	6.3	.91	
1970	7.1	.82	1.1
1971	7.9	1.08	1.8
1972	7.9	1.23	2.2
1973	8.8	1.45	2.8

*Tilia platyphyllos* 'Orebro'  
Orebro Bigleaf Linden

EMH: 35 to 40 feet

Year	Height	Caliper	Spread
1966			
1967		.61	
1968	5.8	.62	
1969	6.5	.95	
1970	7.8	1.06	2.0
1971	9.0	1.63	3.5
1972	9.5	1.98	4.0
1973	10.6	2.32	4.4



*Tilia platyphyllos* 'Fastigiata' is an upright oval cultivar. The leaves are smaller than *Tilia americana* 'Fastigiata'. As a young tree, it has a fine branch texture and its symmetrical character requires very little pruning. The crotch development is good.

Rating: 1.444



*Tilia platyphyllos* 'Orebro' is a slow-growing, fastigate, medium to coarse textured cultivar. The habit of growth generally has not been as uniform as some of the *Tilia cordata* cultivars.

Rating: 1.266

*Tilia tomentosa*

Silver Linden

EMH: 50 to 60 feet

Year	Height	Caliper	Spread
1966			
1967			
1968	7.1	1.00	
1969	7.2	1.10	
1970	8.7	1.50	3.8
1971	9.8	2.00	6.1
1972	11.3	2.90	7.8
1973	13.2	3.70	8.4



*Tilia tomentosa* is a large, rounded species. Only the widest tree lawns can accommodate such a tree. As with most species, it varies in uniformity and growth rate. The whitish foliage underside and excellent yellow fall color are very attractive.

Rating: 0.631

*Zelkova serrata* 'Village Green'

Village Green Zelkova

EMH: 45 to 50 feet

Year	Height	Caliper	Spread
1966			
1967			
1968			
1969			
1970			
1971	8.7	1.17	3.4
1972	11.4	1.61	7.0
1973	12.0	1.90	6.7



*Zelkova serrata* 'Village Green' has been found to be irregular as a young tree, like the species. It is a finely textured and adaptable tree which, with age, develops a canopy similar to the American Elm.

Rating: 1.513



## TREES RECOMMENDED FOR STREET TREE PLANTING

The following is a listing of trees considered outstanding in this study. This list is limited to only those trees mentioned previously in this publication and will be expanded when further observations are completed. These recommendations are based on observations, data collection, and evaluation ratings of trees in the Shade Tree Evaluation Plot. Observational information derived from city plantings elsewhere also was used in formulating these recommendations. The trees are listed alphabetically and are recommended for use as street trees in the situations described.

**Small trees** which will be less than 30 feet in height at maturity and are suitable for planting directly beneath utility lines:

*Acer campestre*, Hedge Maple

*Crataegus intricata*, Thicket Hawthorn

*Crataegus lavalleyi*, Lavalley Hawthorn

*Crataegus phaenopyrum* 'Tree Form', Tree Form Washington Hawthorn

*Crataegus viridis* 'Winter King', Winter King Hawthorn

*Malus* 'Snowdrift', Snowdrift Crabapple

*Malus* 'Tschonoski', Tschonoski Crabapple

*Malus* 'Van Eseltine', Van Eseltine Crabapple

*Ostrya virginiana*, Hophornbeam

**Medium trees** which will be 30 to 45 feet in height at maturity and are suitable for planting 20 feet or more from utility lines:

*Acer platanoides* 'Crimson King', Crimson King Maple

*Acer rubrum* 'Autumn Flame', Autumn Flame Red Maple

*Gleditsia triacanthos inermis* 'Shademaster', Shademaster Honeylocust

*Prunus sargentii*, Sargent Cherry

*Pyrus calleryana* 'Bradford', Bradford Callery Pear

*Sophora japonica* 'Regent', Regent Japanese Pagoda Tree

*Tilia mongolica*, Mongolian Linden

*Tilia cordata* 'Chancellor', Chancellor Littleleaf Linden

*Tilia cordata* 'Greenspire', Greenspire Linden

*Tilia cordata* 'Rancho', Rancho Linden

*Tilia cordata* 'XP110', XP110 Littleleaf Linden

*Tilia europaea* 'Pallida', Pallida Common Linden

*Tilia tomentosa*, Silver Linden

**Large trees** which will be more than 45 feet in height at maturity and are suitable for planting 30 feet or more from utility lines:

*Acer platanoides* 'Cleveland', Cleveland Norway Maple

*Acer platanoides* 'Emerald Queen', Emerald Queen Maple

*Acer platanoides* 'Summershade', Summershade Maple

*Acer rubrum* 'October Glory', October Glory Red Maple

*Acer rubrum* 'Red Sunset', Red Sunset Red Maple

*Acer rubrum* 'Tilford', Tilford Red Maple

*Fraxinus americana* 'Autumn Purple', Improved White Ash

*Fraxinus excelsior* 'Hessei', Hesse European Ash

*Fraxinus pennsylvanica lanceolata* 'Marshall Seedless', Marshall Green Ash

*Gleditsia triacanthos inermis* 'Imperial', Low-Gro Honeylocust

*Gleditsia triacanthos inermis* 'Shademaster', Shademaster Honeylocust

*Gleditsia triacanthos inermis* 'Skyline', Pyramidal Honeylocust

*Liquidambar styraciflua* 'Moraine', Moraine Sweetgum

*Platanus acerifolia*, London Planetree

**Upright or fastigate trees** suitable for planting 15 feet or more from utility lines:

*Acer platanoides* 'Columnare', Columnar Norway Maple

*Acer rubrum* 'Armstrong', Armstrong Red Maple

*Acer rubrum* 'Bowhall', Bowhall Red Maple

*Prunus sargentii* 'Columnaris', Columnar Sargent Cherry

*Quercus robur* 'Fastigiata', Upright English Oak

*Tilia platyphyllos* 'Fastigiata', Upright Bigleaf Linden

## TREES NOT RECOMMENDED FOR STREET TREE PLANTING

Through the years certain trees have been found to be undesirable for use as street trees. The following is a listing of trees which are generally not recommended for use as street trees because of structural problems, insect infestation, and/or disease susceptibility.

*Acer negundo*, Box Elder: This is very weak wooded and subject to many serious insect problems.

*Acer saccharinum*, Silver Maple: The weak wood and poor branch structure can result in severe breakage during wind and ice storms. Improved selections, if developed, may be acceptable for street tree use.

*Aesculus glabra*, Ohio Buckeye: The messy fruit, weak wood, early leaf drop, and leaf scorch problems limit its use.

*Aesculus hippocastanum*, Horsechestnut: Weak wooded, messy fruit, and intolerance of dry soils results in leaf scorch, limiting its use.

*Ailanthus altissima*, Tree-of-Heaven: Generally this is weak wooded, resulting in breakage during ice and wind storms. In addition, it is attacked by several pests. Usage should be limited to areas of severe environmental stress. Improved selections, if developed, may be acceptable for street tree use.

*Betula papyrifera*, *populifolia*, *alba*, Paper Birch, Grey, European: Bronze birch borer and birch leaf miner injuries generally cause these trees to be short-lived. Improved selections, if developed, could be very acceptable for street tree use. In addition, they are adaptable only to good soils and cool habitats.

*Catalpa speciosa*, Catalpa: The objectionable fruit and weak wood limit its use.

*Crataegus oxyacantha* 'Pauli', Paul's Scarlet Hawthorn: Serious leaf spot disease causes defoliation early in the growing season. This tree is also attacked by several insects.

*Juglans nigra*, Black Walnut: The fruits create a serious maintenance problem in street tree plantings.

*Malus* sp., Crabapples: Many crabapples are susceptible to fireblight and apple scab. Only crabapples resistant to these diseases should be planted.

*Morus* sp., Mulberry: Generally the fruits are very messy. New fruitless male types have been selected which may make excellent street trees.

*Populus* sp., Cottonwood: The various species are very subject to wind and ice damage, as well as excessive twig and leaf drop. Many insect and disease problems limit its use. In addition, roots from this genus frequently infest sewers.

*Robinia pseudoacacia*, Black Locust: Serious infestations by the locust borer and locust leaf miner result in a short life span, limiting its use.

*Salix* sp., Willow: Extensive twig drop, shallow root systems which cause problems in drains, and susceptibility to wind damage limit its use.

*Ulmus americana*, American Elm: Dutch Elm and/or phloem necrosis diseases restrict or limit its use. Improved selections, if developed, may be acceptable for street tree use.

*Ulmus pumila*, Siberian Elm: Excessive limb and twig breakage occur during wind and ice storms.

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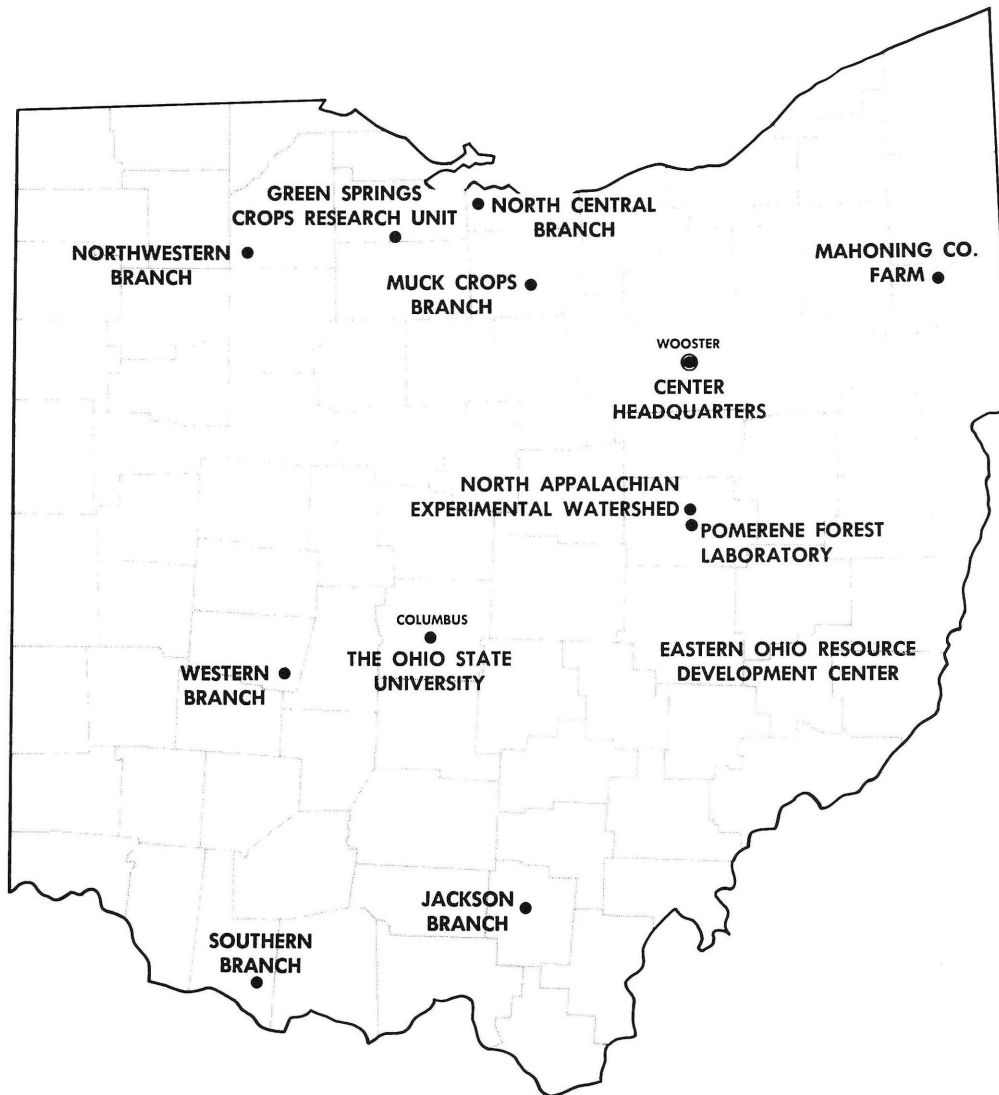
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Research at OARDC deals with the improvement of all agricultural production and marketing practices. It is concerned with the development of an agricultural product from germination of a seed or development of an embryo through to the consumer's dinner table. It is directed at improved human nutrition, family and child development, home management, and all other aspects of family life. It is geared to enhancing and preserving the quality of our environment.

Individuals and groups are welcome to visit the OARDC, to enjoy the attractive buildings, grounds, and arboretum, and to observe first hand research aimed at the goal of Better Living for All Ohioans!

# *The State Is the Campus for Agricultural Research and Development*



Ohio's major soil types and climatic conditions are represented at the Research Center's 13 locations.

Research is conducted by 15 departments on more than 7200 acres at Center headquarters in Wooster, eight branches, Green Springs Crops Research Unit, Pomerene Forest Laboratory, North Appalachian Experimental Watershed, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1953 acres

Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres

Green Springs Crops Research Unit, Green Springs, Sandusky County: 26 acres

Jackson Branch, Jackson, Jackson County: 344 acres

Mahoning County Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Appalachian Experimental Watershed, Coshocton, Coshocton County: 1047 acres (Cooperative with Agricultural Research Service, U. S. Dept. of Agriculture)

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Pomerene Forest Laboratory, Coshocton County: 227 acres

Southern Branch, Ripley, Brown County: 275 acres

Western Branch, South Charleston, Clark County: 428 acres