

Figure 1. Green Ash in Winter Showing Undesirable Growth Habit Growing on a Boulevard in Velva, North Dakota. Pruning for Utility Line Clearance May Possibly Have Accentuated the Problem.

TREE IMPROVEMENT IN THE NORTHERN PLAINS

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Millions of dollars are spent annually in North Dakota for ornamental plants. Interest in ornamentals and a recognition of the importance of such plants in our environment has increased markedly, nationally as well as in the northern plains area. The significance of the national beautification program, including highway beautification plantings, needs no repetition.

Emphasis on leisure and outdoor recreation potential has brought about new recreational developments in the Northern Great Plains by the Army Corps of Engineers contiguous with Missouri River basin reservoirs. Cities, towns and counties have embarked upon park programs or have expanded existing facilities with assistance of the Federal Land and Water Conservation Act (LAWCON) funds. The dire need for conserving

our natural resources, including our natural beauty, has been brought home to each of us.

The tremendous increase in construction of private homes in the post-World War II years has never subsided. Coinciding with this building surge has been an emphasis in naming "tailored" plants suitable for such properties. "Tailored" plants is a term used to describe cultivated varieties (**cultivars**) of trees, shrubs or groundcovers which have resulted from breeding programs or by natural selection (e.g., bud sports, mutations). They are characterized by a particular growth habit, size or quality that satisfies a given landscape need (see Figures 4-7).

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A number of smaller, more compact trees and shrubs have been introduced. Some are distinctly dwarf. In most cases, these new cultivars are asexually (vegetatively) propagated; that is, by rooting cuttings, or by grafting or budding. This is essential, because if they are propagated by seed each seedling is different genetically from the parents and you lose the desirable traits that you want to reproduce. When you reproduce a particular plant asexually, each plant is identical to the parent, the desirable traits are retained and all plants are uniform. Cultivars reproduced asexually from a single selected parent are termed **clones**.

Climatic conditions of our northern plains present a real challenge to growing woody ornamentals in North Dakota. Although many new cultivars and tailored plants have been introduced in the United States, a large percentage are not reliable or adaptable in North Dakota. Selection of clonal scion and rootstock varieties is of particular significance in the Northern Great Plains because only a small percentage of genotypes perform satisfactorily in many species. This may be due to various factors: lack of winter hardiness; lack of resistance to drought, low humidity and desiccating winds; such unfavorable soil conditions as high pH (alkalinity); or inherent genetic weaknesses.

Problems may be encountered even with hardy native plant material. The green ash (*Fraxinus pennsylvanica* var. *subintegerrima*) serves as an example. A high percentage of seedlings survive, but undesirable types, characterized by irregularities in growth habit, are common within a seedling population (see Figures 1 and 2). Thus, a considerable percentage of available stock produces only mediocre shade or specimen trees. Our native boxelder (*Acer negundo*) is notorious for producing a high percentage of trees with poor form. This problem could essentially be alleviated by clonal selection.

Much greater emphasis also needs to be placed on the original seed source of ornamental plants. There is a direct correlation between seed source and hardiness. Original seed source plays a major role due to the effect of latitude and elevation on plant growth and triggering the onset of dormancy.

If you would collect seed of native green ash from Oklahoma or southern Kansas sources, and attempt to grow them in North Dakota, chances are you would fail to produce a tree. Plants originating from these southern seed sources would freeze back severely year after year, as is borne out in Collins', (1) data from regional tree evaluation studies in the Great Plains states.

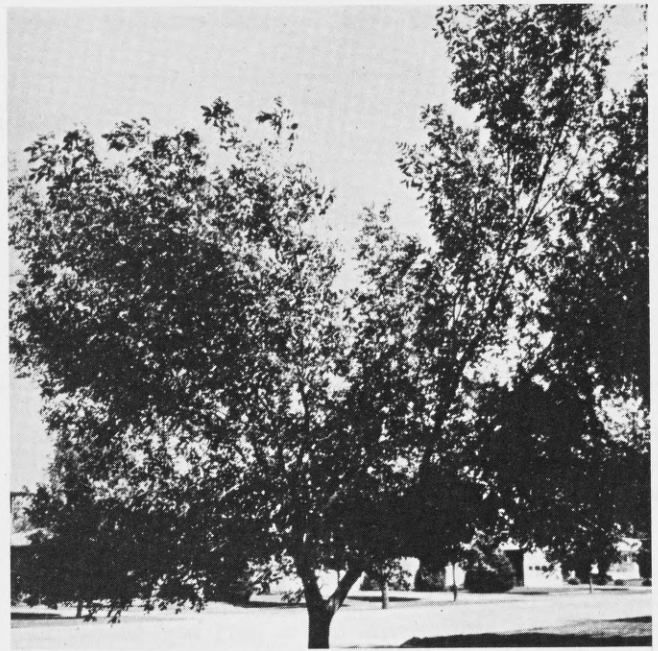


Figure 2. Green Ash in Leaf Showing a Low, Forked Trunk Resulting in a Poorly Shaped Tree Growing on a Boulevard in Fargo, North Dakota.

Paper birch (*Betula papyrifera*) is native in several areas of North Dakota. However, most paper birch sold in North Dakota originates from seed sources east of the northern plains. Consequently, many people have experienced failure or difficulty in establishing quality trees. If such seed were collected in the Turtle Mountains of North Dakota, the problem of successful establishment probably would be resolved. Similar seed source problems are encountered with many other trees. Some examples include the maple species (*Acer*), black walnut (*Juglans nigra*), common hackberry (*Celtis occidentalis*), common honeylocust (*Gleditsia triacanthos*), as well as many ornamental shrubs.

What needs to be done? Seed should be collected and/or vegetatively propagated selections should be made of trees native in the northern plains and also of trees native east and south of the northern plains, particularly in the midwest. In the latter instance, however, **collected materials should be obtained from the northern and western extremity of the native range of a given species.**

We in the northern plains should also be paying much closer attention to plant materials native immediately to the west of the Dakotas. For example, fountain birch (*Betula fontinalis*) is a western native which is proving to be well adapted in the northern plains. Another small tree native to the west is Greene's mountain-ash (*Sorbus scopulina*). It is performing very well in evaluation plantings. Some plant materials obtained from the Rocky Mountain states do not

adapt well to northern plains conditions, however. One explanation for this is the marked difference in elevation between the two locations.

Pest problems further amplify the need for greater variety of adapted plant materials. Insect and/or disease problems are limiting the planting of our popular white-barked birches (*Betula*), poplars (*Populus*), Siberian elm (*Ulmus pumila*) and such small trees as hawthorns (*Crataegus*) and certain varieties of crabapples (*Malus*). Over half of the boulevard and specimen shade trees in towns and cities throughout the Great Plains is composed of one species — American elm (*U. americana*). In some municipalities, this percentage is considerably higher. In older sections of many of our cities, this percentage may be up to 90 percent. With Dutch elm disease spreading in the northern plains, the American elm has been removed from many recommended planting lists. Dutch elm disease has been taking its toll of trees in Mandan, North Dakota, since 1969, and the first infected trees were removed in Fargo and Valley City in 1973.

Only meager work in improved tree selection has been carried out in the northern plains states, even though the challenge and need exists. One reason is that tree improvement research is not a short-term effort. In 1971, a comprehensive bulletin (2) was completed discussing the characteristics and adaptability of deciduous trees in the northern plains. During the last two years, the author initiated a tree selection program at NDSU (3).

Ash Species

Green ash is one of the most widely adapted, hardy trees in the northern plains; therefore, this species provided a natural starting point. Thirty-five selections have been made to date throughout North Dakota and were propagated largely by whip grafting. Propagation by budding proved much less effective due to the predominance of undesirable flower buds, in lieu of vegetative buds, on budwood collected from sizable green ash trees. Only male trees were selected since they are seedless. Also, only trees essentially free of ash flower gall (*Aceria fraxinivorus*) were collected (see Figure 3). Flowers on male trees are much more prone to infection and development of the dark brown, irregular, tumor-like growths than are flowers on female trees. The disease is caused by tiny mites.

The quality of the tree's growth habit was of prime importance in selection. Of particular interest were trees displaying global, oval or pyramidal crowns. Such advantageous forms are pictured in Figures 4-7. Tree forms selected vary all the way from narrow, nearly columnar types



Figure 3. Young, Male Green Ash Tree Showing High Susceptibility to Ash Flower Gall. The Dark Tumor-like Growths Persist on the Tree Over Winter.

to those with a broad spreading habit of growth. These selections are now ready for outplanting and field evaluation. Branch and foliage density, foliage quality, fall color, growth rate, pest resistance and other factors also will be considered as the trees are further evaluated.

One of the most attractive green ash boulevard plantings located to date in the Dakotas is in Rugby, North Dakota. The boulevard trees illustrated in Figure 8 apparently were transplanted from a local farmstead shelterbelt. The trees originated as seedlings, but certainly represent a superior seed source. Two selections were made from this planting.

Green ash selections also must be comparatively evaluated with previously named introductions. Several clones of green ash have been named in other states. Two are popular in the commercial nursery trade, and reference should be made to them here.

'Marshall's Seedless' is a staminate (male) green ash clone with attractive, glossy green foliage. Although widely planted, recommendations for the northern plains must be qualified in light of the following observations. Marshall's Seedless grows rather late into the fall and its leaves tend to freeze off. Good yellow autumn color, typical of the species, usually fails to develop. It tends to lack a central leader and often the terminal bud on branches fails to develop in the spring. Thus, considerable pruning and maintenance is needed to produce a quality tree. All of these observa-

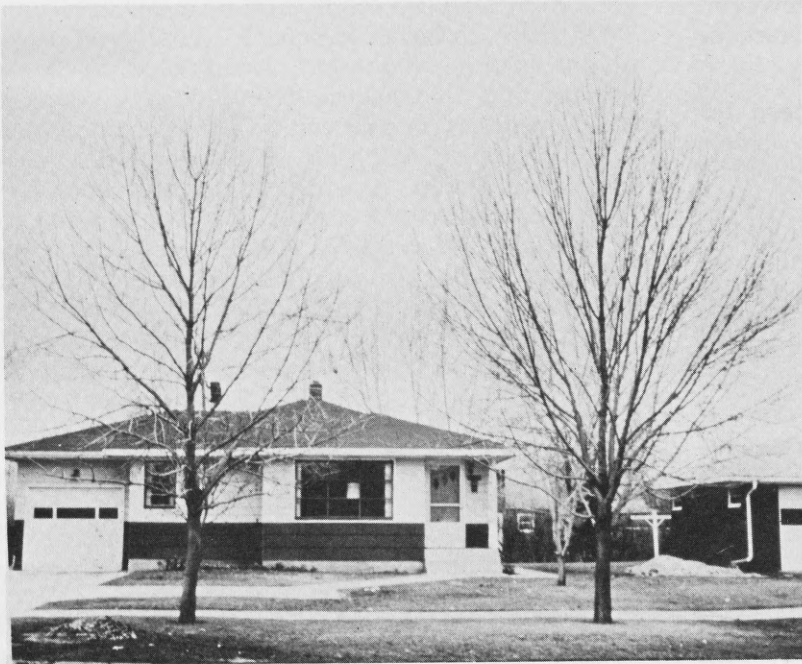


Figure 4. Two Green Ash in Dormant Condition Growing Side by Side on a Wahpeton, North Dakota Boulevard. Both Trees Display a Superior Broad Oval Form, but Vary in Branch Density. These Trees were the First Trees Selected and Propagated in the Tree Improvement Program.

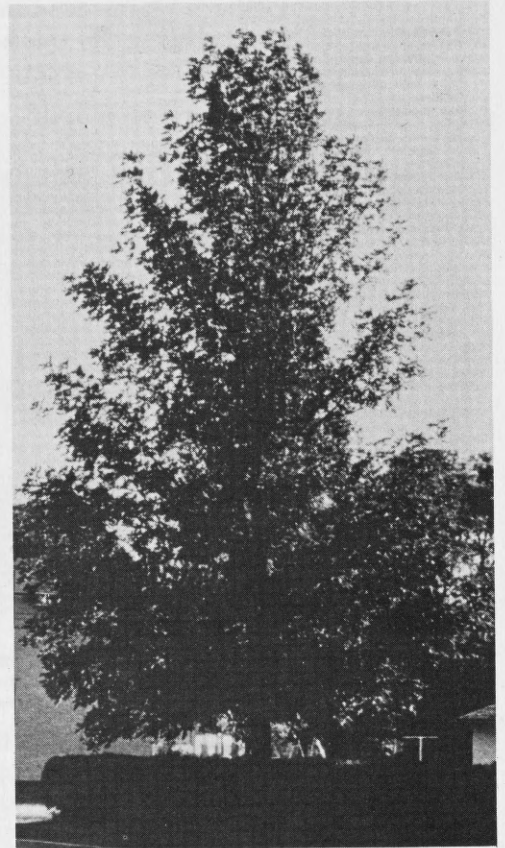


Figure 5. Green Ash Selected for Its Striking Pyramidal Growth Habit. Rugby, North Dakota is the Home of This Attractive Tree.

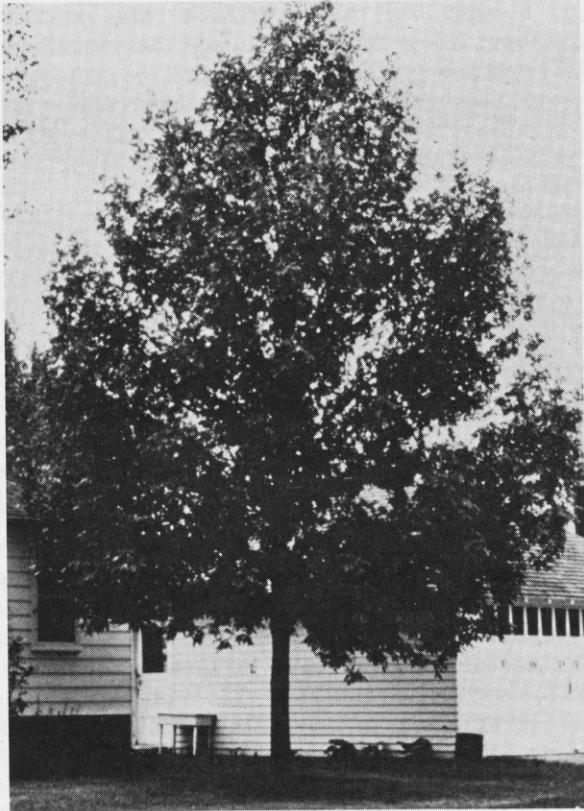


Figure 6. Green Ash Selection with a Broad Ovate Form Growing in New Rockford, North Dakota. This Tree is also Characterized by a Desirable Scaffold Branch Arrangement and Excellent Golden-Yellow Fall Color.

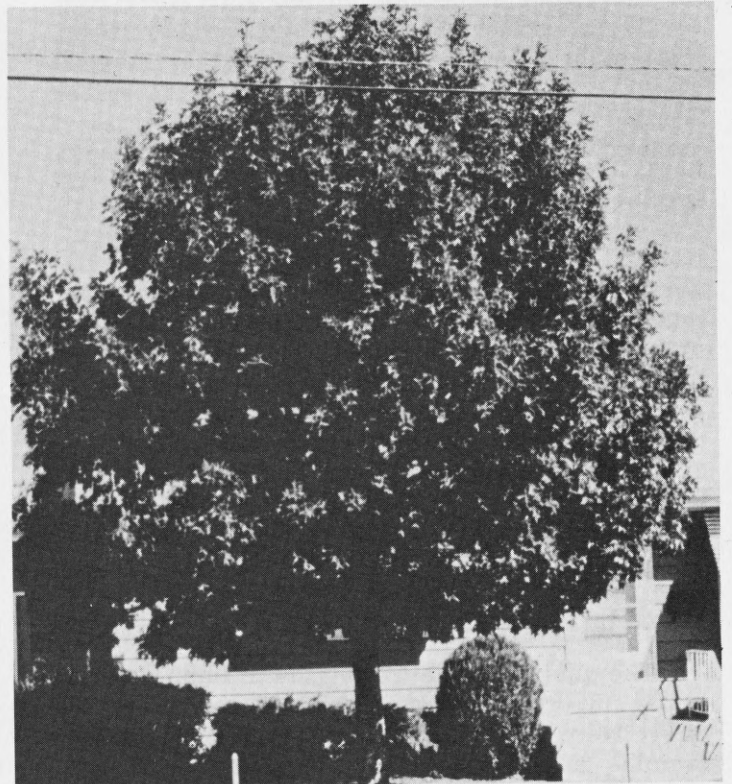


Figure 7. A Distinctly Globe-Shaped Green Ash Selection Located in a Yard in Minot, North Dakota. Note the Foliage Density.



Figure 8. A Street Planting of Green Ash in Rugby, North Dakota which is Far Superior to an Average Population Grown from Seed.

tions indicate that Marshall's Seedless ash is not totally winter-hardy in the northern plains. This is to be expected since the original source is reported to be in Utah.

Another named male (seedless) green ash clone is 'Summit.' This tree was selected by a Stillwater, Minnesota, nursery and is characterized by a symmetrical, upright form and central leader. Twigs and foliage tend to be finer-textured than the average green ash. The Summit ash is an attractive tree and some excellent specimens have been observed in Wahpeton, North Dakota. Unfortunately, this tree is not devoid of all problems. Newly-planted trees may suffer a sunscald-like injury on the southwest side of the trunk. Consequently, trunks should be wrapped for at least 2-3 years after planting.

Two new green ash introductions are 'Tornado,' a female (seed producing) tree, and 'Emerald' (PP #3088), another male (seedless) tree. These clones were introduced by an Iowa and Nebraska nursery, respectively, and merit early evaluation.

Another ash species is native in the Pembina Hills of North Dakota. This is black ash (*Fraxinus nigra*). This species is scarcely known to the public and rarely offered in the nursery trade. Recently, horticulturists at the Morden, Manitoba Research Station began making superior selections of black

ash. In 1972 Ronald (4) reported that this species was found to be native as far west as the Portage la Prairie, Manitoba, area. Since this is a grasslands region, this indicated that black ash can adapt to drier sites than previously accepted. The Portage la Prairie area, as well as the Pembina Hills, would be highly desirable locations to make improved selections because these areas are at the extreme western edge of the native range for this species. One selection of black ash has been propagated to date from a very attractive oval-rounded specimen growing in a yard in Fargo.

Buckeye

Tree improvement work is not being limited to ash species. Ohio buckeye (*Aesculus glabra*) is a medium-sized tree generally of excellent form. Scattered, stately specimens are found throughout the northern plains, but it certainly merits more common planting. A large and particularly outstanding specimen of this tree is growing in Brookings, South Dakota. It is characterized by a nearly perfect rounded crown and showy orange to reddish fall color (see Figure 9). This tree, plus a selection from Jamestown, North Dakota, have both been propagated by grafting. The Jamestown tree is distinctive due to its narrow, densely branched growth habit, being approximately 25 feet tall but only nine feet wide. This is a divergence from the typical form of this species. Ohio buckeye is not native north of central Iowa, so



Figure 9. Large Ohio Buckeye Selected at Brookings, South Dakota Characterized by an Excellent Rounded Crown and Orange to Red Autumn Coloration.

selections must be made from old, established trees which have proved their adaptability in the northern plains. The true horse-chestnut, a closely related species, is very rarely found in the northern plains. It is not as winter-hardy as Ohio buckeye. The identity of these two species is often confused.

Maple Species

The Northern Great Plains have few trees that display outstanding orange or reddish fall colors. Few trees display more brilliant fall coloration than the sugar maple (*Acer saccharum*). The sugar maple is native just 30 miles east of the North Dakota-Minnesota border in the Detroit Lakes area and near the South Dakota border west of Sisseton. Once again, selections and/or seed sources from such native stands at the northwest extremity of the natural range should be better adapted than sources originating from more eastern areas. Sugar maples are characterized by their dense scaffold branching habit and oval to rounded crowns. Several dozen sugar maples are noted to be performing very well in Fargo and acceptable trees have been found in other areas of eastern North Dakota. It appears that this outstanding tree has been largely neglected for potential landscape use in eastern North Dakota. Strict attention should be paid to seed source, however, and trees should be planted in sites with favored moisture conditions. Since cooler soils

also are preferred, north or east slopes and north sides of buildings are recommended. In 1971, seed was collected from several particularly attractive trees in the Sisseton, South Dakota, area. In 1973, the resultant seedling trees were outplanted in east-central North Dakota under exposed conditions to study the adaptability of this seed source in the eastern part of the state.

Several named clones of sugar maple merit evaluation for adaptability in the eastern portions of the northern plains. The clone 'Columnare' (Columnar sugar maple) has a very distinctive narrow, upright growth habit, as its name implies. This tree has performed well in early evaluations at Brookings, South Dakota. Another clone of interest is 'Green Mountain,' a hybrid maple reported to have thicker waxy leaves more resistant to scorch in dry, windy summer weather.

The silver maple (*Acer saccharinum*) is a large, rapid growing tree which has been more widely planted in North Dakota than sugar maple. It has several faults, including a weak structure and a considerable percentage of trees that are subject to iron chlorosis, particularly in heavy, alkaline soils. It is not difficult to find trees, however, which appear to be tolerant of alkaline soils and in turn do not develop yellow or chlorotic leaves. Opportunity exists to make improved selections, coupling chlorosis resistance with a stronger branch structure.

At least a half-dozen selections of silver maple have been named in other states. These include 'Beebe,' 'Blair,' 'Pyramidale,' 'Silver Queen' and 'Weiri' (also listed as 'Laciniatum'). 'Beebe' and 'Weiri' are referred to as cutleaf maples because they both have fine textured, deeply-cut leaves. Most of these clones are available in the nursery trade, but since several are new introductions, only a few have been adequately evaluated in the northern plains.

The Norway maple (*Acer platanoides*), a European native, often is planted in the northern plains. In fact, such purplish-red leaved clones as 'Crimson King,' 'Royal Red' and 'Schwedler' are very popular in the nursery trade. Unfortunately, a large percentage of these trees fail because of a definite lack of winter hardiness. In 1972, a stately species Norway maple was located in Hatton, North Dakota. It is a large, broad rounded tree which certainly commands attention, having proven itself hardy and adaptable over the years. Plans call for propagating this tree in 1974 for further evaluation. Several recently named clones, e.g., 'Cleveland,' 'Columnare,' 'Emerald Queen,' 'Greenlace' (PP #2759), and 'Summer-shade' (PP #1748) will be obtained for comparative evaluation.

Linden Species

American linden or basswood (*Tilia americana*) is native in eastern North Dakota. This large tree has never been used very extensively in the northern plains, but it definitely deserves increased planting. Little work has been carried out in the United States to select superior clones of this tree. One reason is that seedling trees usually develop into very acceptable specimens. Although hardy, this tree is not well adapted to droughty, windswept sites particularly in the western Dakotas. Only a few cultivars of American linden have been introduced, and these are scarcely known. The clone 'Fastigiata' (Pyramidal American linden) is characterized by a more pyramidal ascending form than the species. Further evaluation is needed, but this may well be a valuable tree.

A European species, littleleaf linden (*T. cordata*), has increased in popularity in the nursery trade in recent years. Several relatively new, improved cultivars have been named in the eastern United States but appear to be borderline in adaptability in North Dakota. Examples are 'Greenspire' (PP #2086) and 'Chancellor' (PP #2712). A new introduction named 'Morden' from the Morden Research Station undoubtedly will prove adaptable when it becomes available.

In 1972, a large littleleaf linden was found growing in Steele, North Dakota. This tree appears to be well adapted, has an excellent spreading to oval form and is the largest and oldest littleleaf linden tree that has been located in the Dakotas to date. This tree was propagated by budding in 1973 for closer evaluation (see Figure 10).

Before leaving the lindens, two other trees should be mentioned. First, the Dropmore linden is a new hybrid introduction produced at the Morden Research Station by crossing the American linden with the littleleaf linden. This tree was budded in 1972 and placed in evaluation trials. Second, the Mongolian linden (*T. mongolica*) is a small, graceful Asian tree that has been evaluated and proved hardy in the northern plains. It has coarsely serrate leaves, reddish-brown twigs and buds and an attractive pyramidal growth form. Both of these trees will be of value as they become more readily available.

Hackberry

Common hackberry (*Celtis occidentalis*) is native as far west as central North Dakota. This tree is closely related to American elm and probably more closely approaches an elm in growth habit than any other northern tree. Common hackberry is plagued by several problems. It appears to be universally susceptible to nipple gall, caused by a small jumping louse or psyllid. This mars the



Figure 10. Littleleaf Linden Selection of Considerable Size Growing in Steele, North Dakota.

attractiveness of the foliage. Many hackberry trees also are disfigured by witches' broom, which results in a proliferation of twiggy, rosette-like growths in the branches. This problem is believed to be caused by a mite-powdery mildew association. This tree also is susceptible to late spring frosts. Nevertheless, hardy northern plains selections need to be made. Two large trees with an outstanding round, spreading form have been located, one on the NDSU campus and the other in Mayville, North Dakota. Both of these trees are free of witches' broom. These trees will be propagated and more closely evaluated.

Poplar

Due to their weak structure and high moisture requirements, planting poplars usually is not recommended except for shelter-type purposes. In some areas of the northern plains, particularly parts of the western Dakotas, the number of tree species which can be recommended for general planting is extremely limited. In such droughty and exposed sites, a number of the trees already discussed may fail to perform satisfactorily.

The white poplar (*Populus alba*), a European species, has considerable drought tolerance, however. It grows rapidly and has attractive, variably lobed leaves — dark green and semi-glossy on the upper surface contrasting markedly with a white,

densely felt-like under-surface. This tree should be more widely planted in shelter plantings, recreation areas and as a large shade tree in parks. Three selections of white poplar have been propagated and are under evaluation. One originated near Rapid City, South Dakota, and two were selected in east central North Dakota. Trees were selected on the basis of their superior growth form, including a dense, scaffold-branching habit.

The white poplar has not been recommended as a boulevard or home landscape tree. One reason is that it commonly sends up suckering shoots at considerable distances from the tree. A grafting study was carried out to evaluate other poplar species as potential non-suckering rootstocks for the white poplar. Scions of white poplar were grafted unto the following rootstocks: **Populus deltoides** 'Siouxland' (Siouxland cottonwood), **P. X robusta** (False lombardy poplar), **P. X 'Northwest'** (Northwest poplar), **P. nigra** 'Italica' (Lombardy poplar), **P. soongorica** (Manchurian poplar), **P. tristis** (Browntwig poplar) and **P. simonii** (Simon poplar). Results of this study indicate that none of these species would serve as acceptable rootstocks due to incompatibility problems. Graft rejection varied from almost immediate incompatibility with certain species to a definite delayed incompatibility with others.* Several species, including **P. tremuloides** (quaking aspen) and **P. balsamifera** (balsam poplar) were not considered as rootstocks since they are also suckering species.

In the future, plans call for experimental grafting of the three selections onto **P. alba** 'Pyramidalis,' the well-known Bolleana poplar. This narrow, upright tree rarely suckers in an objectionable manner and should prove entirely compatible as a rootstock.

Planting Considerations

The American elm is appreciated for its stately vase or umbrella form. With Dutch elm disease now spreading in the northern plains, the question is often asked, "What is the best tree to replace American elm?" First, do not think in terms of replacing elms with one "best" tree. This is dangerous, because the same thing would then be done as with American elm; that is, develop a tree population that approaches a monoculture. This is like putting all your eggs in one basket. If a serious disease or insect problem arises, the result may be the catastrophe that Dutch elm disease has caused. It is recommended, therefore, that a variety of trees be planted in home landscapes, in parks and on boulevards. Different species, or at least different cultivars of species, should be planted from block to block as our towns and cities continue to grow.

*The author wishes to acknowledge Mr. Norman Evers, assistant horticulturist at South Dakota State University, who completed this grafting study after the author accepted a new position at NDSU.

To enlarge upon this point, we might mention the Shubert chokecherry, which unfortunately is referred to incorrectly in some nursery channels as Canada red cherry. The Shubert chokecherry (**Prunus virginiana** 'Shubert'), introduced by the Oscar H. Will Company of Bismarck, North Dakota, has gained widespread acceptance as a small, colorful tree throughout the Midwest and in Canada. This tree is a selection from our native chokecherry, but differs in that its foliage changes to a purple color as leaves reach full development in July. Due to extreme hardiness and adaptability to a wide range of soils and environment it will continue to gain popularity. A word of caution, however. Our native chokecherry is commonly infected with virus diseases and also black knot, (**Dibotryon morbosum**), a fungus disease detected by blackish, tumor-like growths on small branches and twigs. Future overplanting of Shubert chokecherry may be a gamble, due to the ever-present possibility of such diseases taking their toll eventually in this clone. To repeat, we should not get caught in the trap of planting one tree to the virtual exclusion of all others.

The writer hopes that this article clearly establishes the basis and need for tree improvement research in the northern plains. The intent is also to show that a larger selection of well adapted trees are needed for North Dakota planting. The list of adapted or recommended trees will always be somewhat restricted in North Dakota. Currently, this list is particularly critical because of serious insect and disease problems. Furthermore, the herbicide 2,4-D, particularly high volatile ester formulations, must be recognized as a major "blight" to successful tree growth in the northern plains.

Our goal is to be able to recommend superior tree cultivars with predictable growth forms and adaptability for lining streets and boulevards, for shading parks and recreation areas, and for use as landscape specimens and other aesthetic purposes. We have all heard the oft-quoted, "North Dakota is just a treeless plain." I, for one, seek to remedy the implications of this statement. Planting trees demonstrates faith in the future.

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