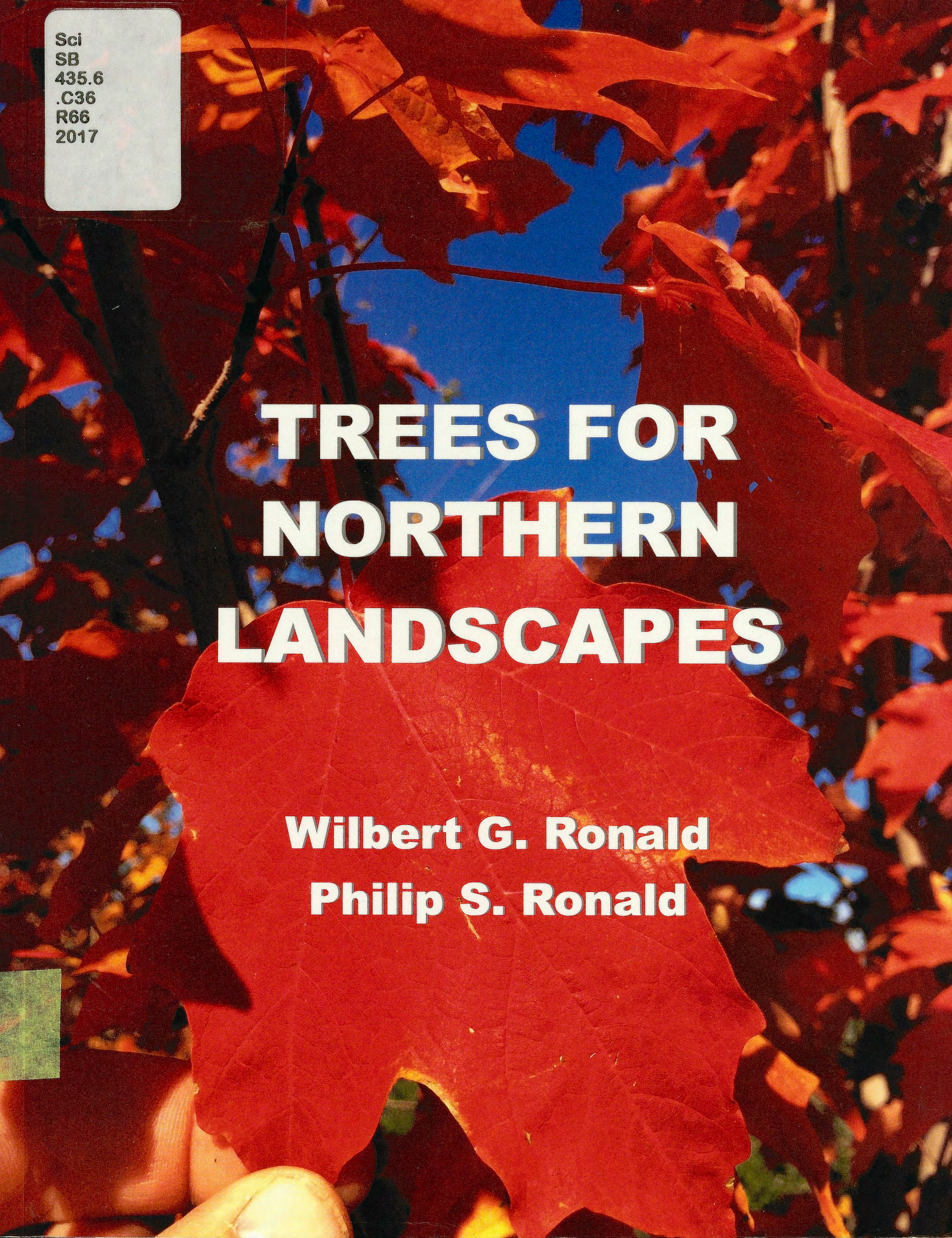


TREES FOR NORTHERN LANDSCAPES

Wilbert G. Ronald
Philip S. Ronald

TREES FOR NORTHERN LANDSCAPES

ACKNOWLEDGEMENTS

The authors wish to acknowledge Hugh Skinner and Andrew Ronald, who reviewed the manuscript of this book and provided helpful comments.

DEDICATION

This book is dedicated to prairie tree breeders as well as the Agriculture and Agri-Food Canada Morden Research Station, which celebrated its centennial year in 2015. Private and public plant breeders together with pioneer nurseries including Skinner Nursery of Roblin, Patmore Nursery of Brandon and Boughen Nursery of Valley River have been responsible for introducing many of the tree cultivars that we grow today in the northern midwest and prairie Canada. Although Morden is not actively involved in tree breeding in recent years, the legacy of tree improvement will extend into the future for many years.

It was Wilbert's privilege to be mentored by Drs. Cumming and Marshall and to mentor younger staff such as Lynn Collicutt during his years at Morden from 1968 to 1982. Both of this book's writers trained in horticulture and received their Bachelors and Master degrees at the University of Manitoba before going on to Ph. D. studies at the University of Minnesota (Wilbert) and the University of Saskatchewan (Philip). Both authors were instructed in ornamental horticulture by Professor Louis Lenz of the University of Manitoba, though separated by a generation of time and history.

To these institutions, companies and individuals we dedicate this book. We honour the early horticulturists who widened our palette of prairie trees, and the many park and municipal superintendents who planted trees in a difficult region where very few tree species are native. Hopefully this book will encourage a new generation of plants people and tree breeders who will continue to develop enduring trees for northern zones. Only by new plant development will we find replacements for the trees lost to devastating insects and diseases.

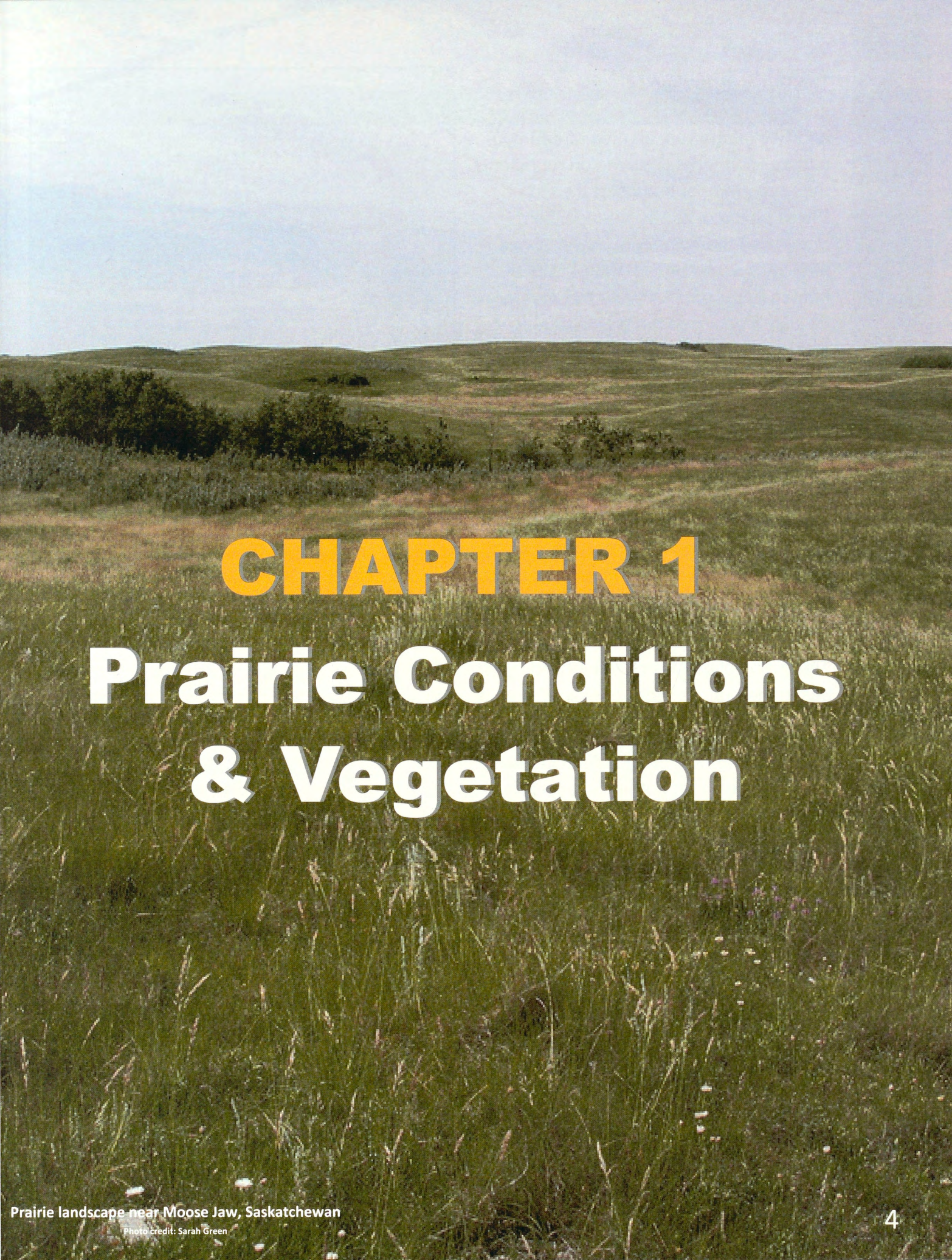
Wilbert G. Ronald, Ph.D. *Philip S. Ronald, Ph.D.*

Trees are an important part of the green cover in any landscape. Unlike herbaceous perennials and shrubs that may escape the severity of winter under the insulating safety of snow cover, trees cannot "hide" from winter's harm. We may tolerate short lifespans in herbaceous perennials and shrubs, but trees become most valuable when they can survive all the elements, whether it be cold, drought, disease or insect stress. Severe winter weather in the form of "test winters" comes in irregular cycles as does drought. So a tree may have to live through more than one cycle of these extreme weather patterns. Disease cycles and insect problems come at various times and in their severest forms, such as Dutch Elm Disease and Emerald Ash Borer, necessitate a complete change in the tree selections that we grow. With an increasing aversion to pesticide use for disease and insect control, it is essential that trees are genetically resistant or tolerant to the many problems they face.

This book addresses trees from the perspective of what grows well in colder zones. It does not deal with every tree that might grow in our area, but does cover those that can be grown well including the many superior cultivars that have been developed for hardiness zones 2, 3 and 4. While we deal mostly with northern trees from a Canadian prairie setting, we are very mindful to include native and introduced trees from northwestern Ontario as well as the northern American states, particularly North Dakota and Minnesota. Special tree stories have been included in the book which tell of new cultivar development and the people behind this exciting work.

Hopefully we have used this book to transmit the importance of tree diversity and tree improvement. If we could have looked in a crystal ball for trees 50 years ago, we would have probably foreseen the continuing spread of Dutch Elm Disease in northern zones. However, we would not have foreseen the danger to the ash genus from the introduced Emerald Ash Borer or the havoc Bronze Leaf Disease would cause among the popular columnar aspens. On a positive note, we may not have foreseen the potential to develop hardy strains of sugar maple, Freeman maple, white ash as well as superior lindens and the possible improvement to form and disease resistance in flowering crabapples. However, even with these improvements, we have only held our own with tree planting options in zones 2 and 3.

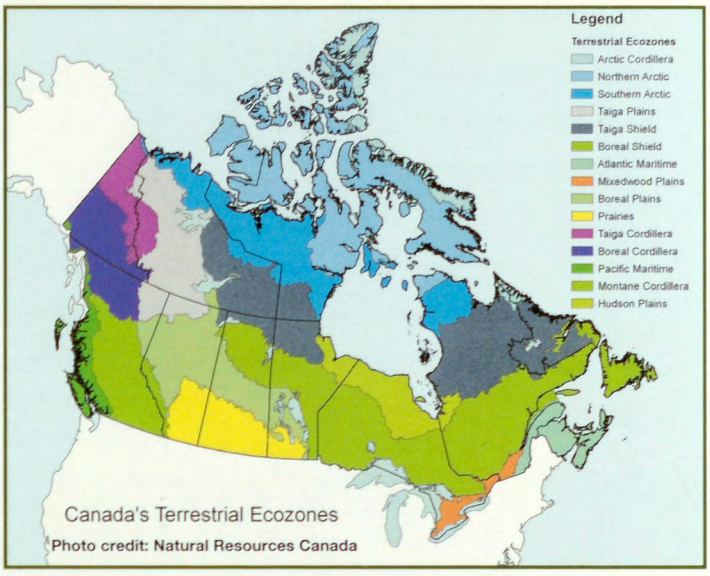
Our aim with this publication is to encourage a new generation of tree breeders and propagators who will retain the knowledge developed by earlier generations. Other parts of the book deal with best practices for growing and establishing trees. This information will prove helpful for landscapers and municipal arborists.



CHAPTER 1
Prairie Conditions & Vegetation

Prairie landscape near Moose Jaw, Saskatchewan
Photo credit: Sarah Green

The Prairie eco-zone spreads across southern portions of Alberta, Manitoba and Saskatchewan, an area of 520 000 square kilometres. This region represents the northernmost branch of the Great Plains biome of North America. Farmland dominates the eco-zone, covering nearly 94% of the land base. The majority of the human population in these three provinces also lives within the prairie eco-zone, including the five largest cities: Calgary, Edmonton, Winnipeg, Saskatoon and Regina.



Canada's Terrestrial Ecozones
Photo credit: Natural Resources Canada

PRAIRIE CLIMATE

The prairie eco-zone is a fascinating region when it comes to unique and ever-changing environmental conditions. The region shows a flat topography with few moderating influences. The Rocky Mountains on the western edge of the prairies serve as a wall to funnel cold northern air across the region. Temperature swings can be extreme due to the lack of buffering from large bodies of water. Especially challenging is the rapid transition between fall and winter, which often leaves trees unprepared for extremely cold temperatures.

The prairie climate is characterized by short, hot summers and long, cold winters. Many areas in the prairies receive minimal precipitation and experience a frost-free period between 100 and 140 days. Some interesting weather trends can be observed across the prairies:

- Mean annual precipitation increases moving from west to east across the prairies. The southeastern corner of Alberta and southwestern corner of Saskatchewan constitutes Palliser's triangle, an arid region that is extremely limiting for agriculture. Annual precipitation has a major impact on soil type and vegetation types. Snow is important across the region for water storage and soil moisture recharge in the spring.
- Mean minimum January temperature decreases moving from southwest to northeast. Manitoba tends to experience a consistently cold winter with minor temperature fluctuations across the months of December - March. The warmest portion of the prairies in the winter months is southern Alberta where chinooks often cause rapid temperature spikes and the loss of snow cover.
- Average July temperature increases from north to south within each of the prairie provinces. Southern Alberta and southern Manitoba both offer the highest heat units and longest growing seasons across the region. However, southern Manitoba features higher summer rainfall and humidity levels than southern Alberta.

HARDINESS ZONE MAP

Hardiness Zones: based on coldest minimum temperature

Zone 1:	Zone 2:	Zone 3:	Zone 4:	Zone 5:
below -46° C (below -50° F)	-46° to -40° C (-50° to -40° F)	-40° to -34° C (-40° to -30° F)	-34° to -28° C (-30° to -20° F)	-28° to -22° C (-20° to -10° F)

Hardiness zone map for the prairie eco-zone and northern great plains using data from 1961 to 1990.

Photo credit: Landscape Alberta Nursery Trades Association

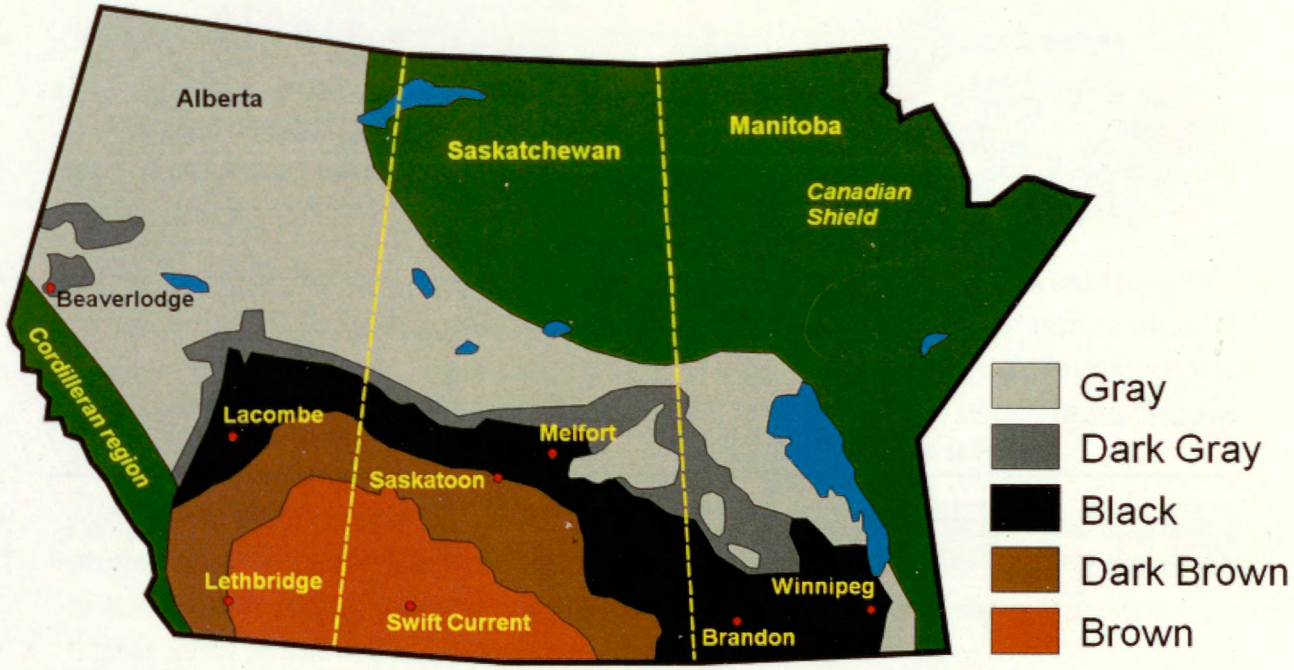
PRAIRIE SOILS

In general, the prairie eco-zone is characterized by the chernozemic order of soils, These soils offer rich topsoil and have developed over long periods of time under grassland vegetation. Within the chernozemic order, there are a number of soil zones across the prairie region including black, dark brown and brown soil types.

Gray soil zones in the region between the prairies and the northern boreal region are often acidic and heavily organic in contrast to the generally alkaline and less organic prairie soils. One of the limitations in moving trees such as large toothed aspen, balsam fir, red pine and eastern white pine from eastern to more westerly regions of Manitoba has proven to be the high soil alkalinity. This soil factor trumps the hardiness factor in utilizing many eastern and boreal tree species in prairie landscapes.

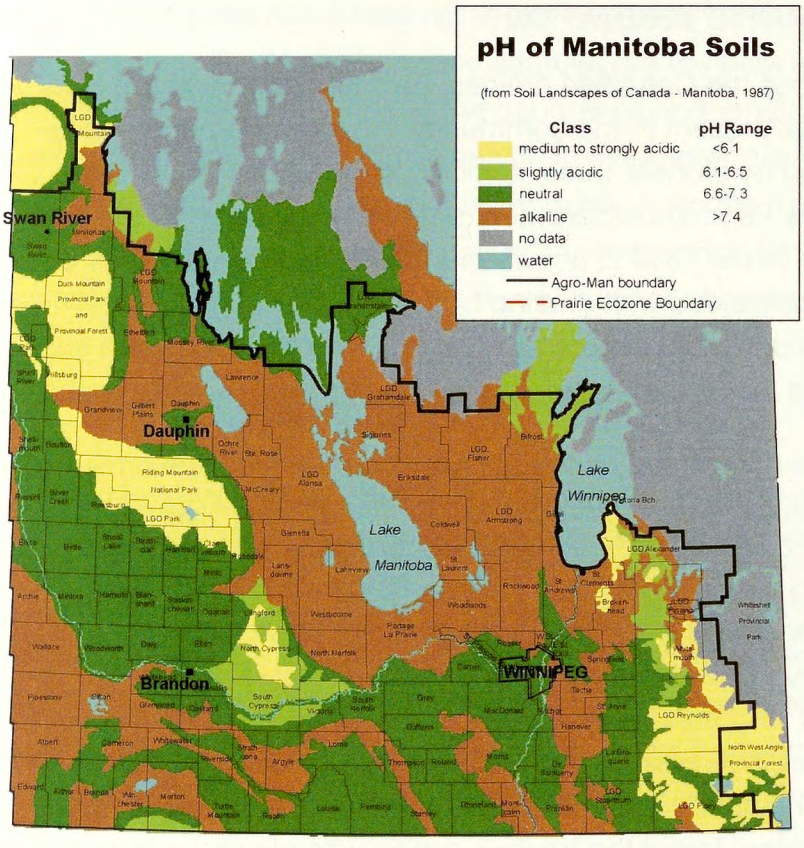
Parts of the prairie eco-zone in all three provinces are marked by soils with high pH (>7.5). Soil pH has a striking effect on nutrient availability and many micronutrients including iron, manganese and boron are restricted on high pH soils. As discussed later in this book, some temporary remediation of alkaline pH is possible through soil amendment with acidic peat moss, sulfur or the application of iron chelates. However, these modifications must be continued year-after-year to ensure survival of alkali-intolerant tree species.

Alkaline soils result in problems for a number of introduced species that are adapted to more acidic soil types. Red maple is a classic example of deciduous tree species with ample cold hardiness for zones 2 and 3, but its use is severely restricted by high soil pH. Eastern white pine is an example of an evergreen tree species which does not adapt well to alkaline soils, even though it is not lacking in cold hardiness and occurs widely in the more acidic soils of southeastern Manitoba.



Distribution of soil types across the prairie provinces.

Photo credit: http://www.fao.org/ag/agp/agpc/doc/counprof/canada/canada.html



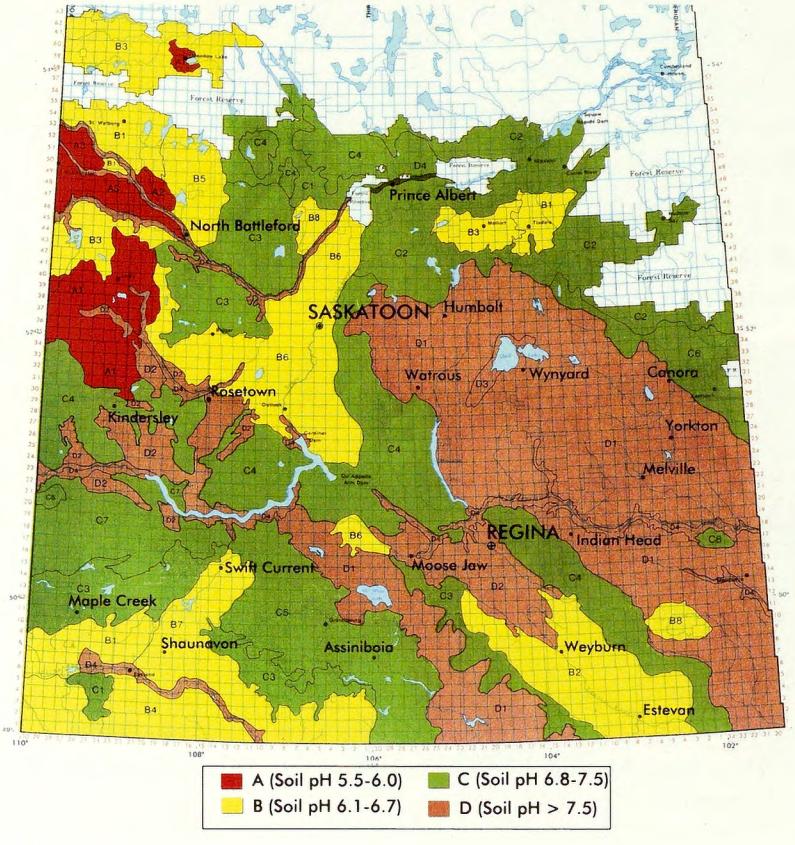
Manitoba Agriculture
Agricultural Resources Section
October, 1999

The accompanying figures provide the pH status of topsoil in Manitoba, Saskatchewan and Alberta. Soil pH is reported as a logarithmic scale so that a single unit change in pH represents a 10-fold difference in conditions.

There is considerable variation in soil pH across individual provinces and tree planting lists for prairie communities should be customized with this fact in mind.

The impact of soil pH on tree performance cannot be overstated. At maturity, trees access water and nutrients from a large area of soil and it is very difficult to modify soil pH on this scale.

pH of Saskatchewan Soils



pH of Alberta Soils

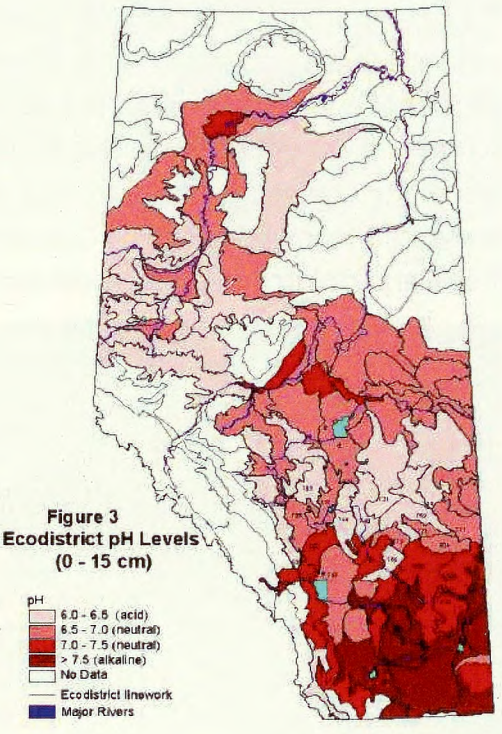


Figure 3
Ecodistrict pH Levels
(0 - 15 cm)

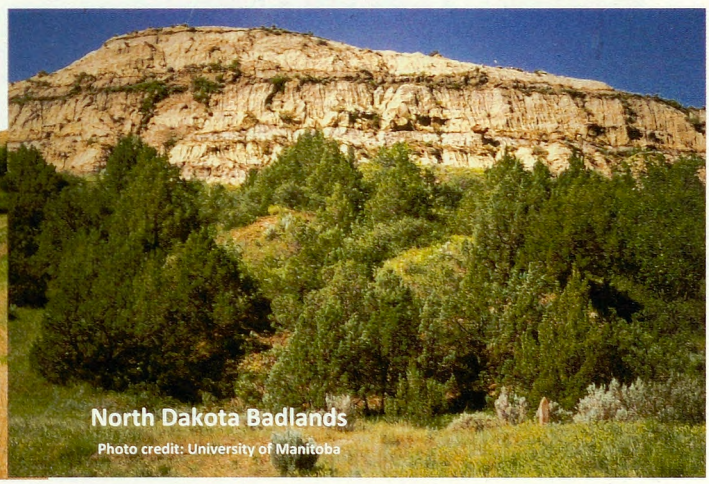
PRAIRIE VEGETATION

Natural vegetation varies greatly across the Canadian prairies. Earliest pictures of the Red River in Winnipeg show very few trees present in the community. Now the Red and Assiniboine river valleys are heavily wooded by pioneer trees including cottonwood poplar and boxelder maple. An early photo of the Pembina escarpment near Morden, taken at the time of the boundary commission surveys in the 1880's, shows much less tree cover than what currently exists. Raging prairie fires combined with grazing buffalo appear to have kept much of the great plains and prairies devoid of tree cover. The prairie grasslands were surrounded by the mixed grass/parkland forest and the more extensive, mostly evergreen, boreal forest to the north and east.

Small prairie tree refuges such as the Riding Mountain National Park, Spruce Woods Park, the Turtle Mountains, Cypress Hills Park and the Manitoba escarpment were sources of native trees, along with river valleys and deltas. The South Dakota Black Hills, North Dakota Badlands and many river systems served a similar role in the northern great plains. These areas were often typical of the nearby plains and prairies and proved to be a very good source of plant material. In Manitoba land surveys from the 1870's, some forested river lands along the Assiniboine River were surveyed as woodlots (WL) to go along with the treeless agricultural parish lots (PL) that could not give the settlers the needed wood for their cooking and heating. Homesteaders found the treeless prairie was plowed with relative ease compared to the heavy tree clearing required on forested land in the parkland areas.

Farm settlers, especially after the drought and wind erosion of the 1930's, strove to develop farmstead shelter and tree belts hence the name "shelterbelts". Settlers from Britain and Europe appreciated trees and wanted to reproduce the conditions of the countries from whence they immigrated. This led to the Prairie Farm Rehabilitation Administration nurseries at Sutherland (near Saskatoon) and Indian Head (east of Regina), as well as the Alberta Tree Nursery (near Edmonton). These nurseries distributed millions of tree seedlings and also were often involved in tree testing and improvement. Similar programs in the northern Midwest also followed with Soil Conservation Nurseries and State Forest Nurseries supplying trees and doing interesting development work in seed strains and plant materials.

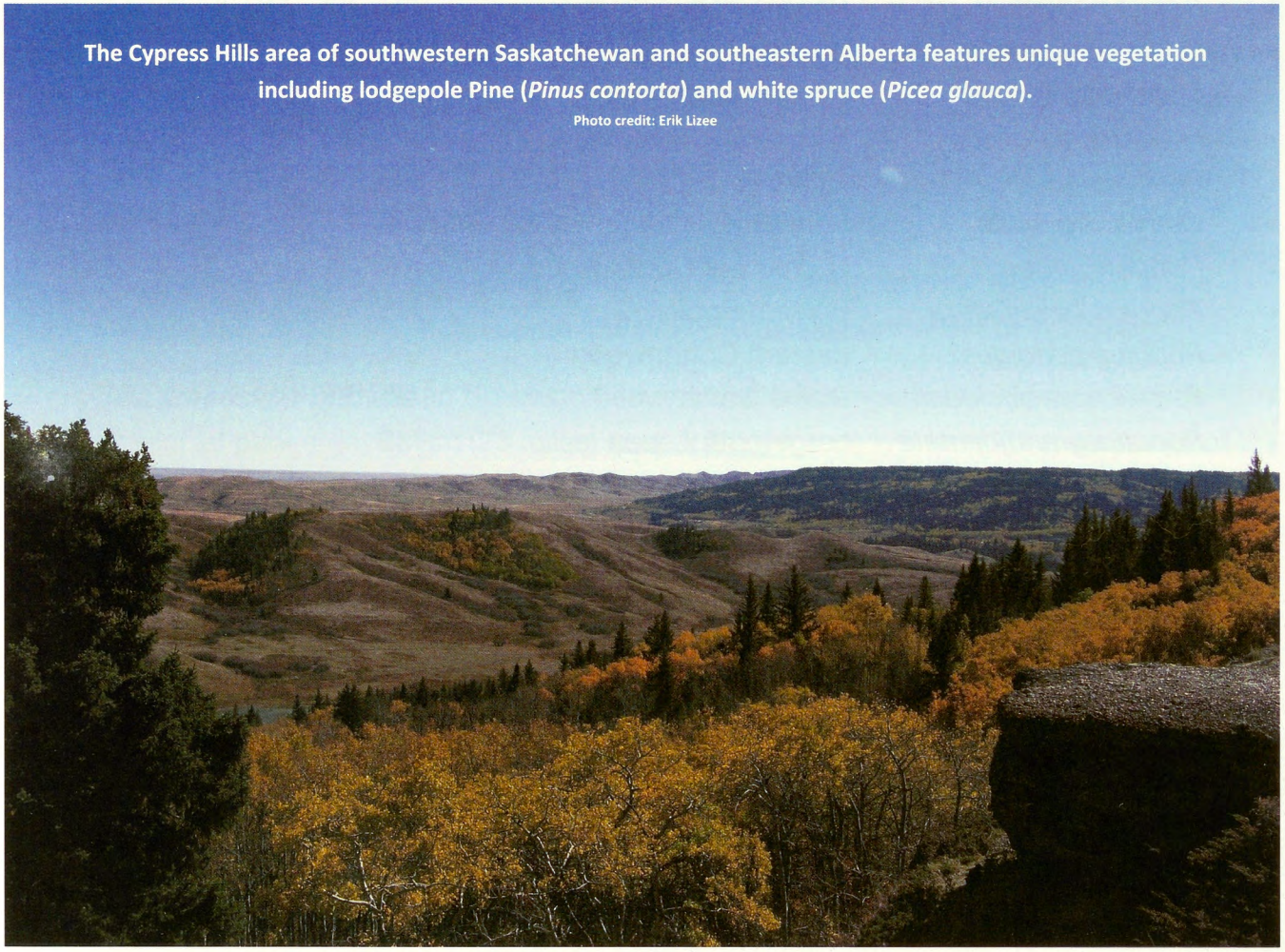
Spruce Woods Provincial Park
Photo credit: University of Manitoba



North Dakota Badlands
Photo credit: University of Manitoba

A number of trees reach their most northwesterly North American distribution range in our prairie region. These northern tree sources are the best adapted source of genetic material for the tree breeder working at the geographic extremities of a species. Northern provenances, as they are termed in tree studies, are essential for use both as rootstocks and stand-alone trees. For example, silver maple from the Kenora area of northwestern Ontario has grown well throughout the colder zones 2 and 3, but if grown from more southern and eastern seed sources it does not thrive. It is not uncommon to be able to adapt a native tree one or two zones colder than it normally occurs and to move a native tree into a zone two or three zones warmer than its native occurrence.

As one moves westerly in the prairie region, the ground elevation rises and the climate becomes increasingly drier and subject to the variable winter weather known as the "chinook effect". Moisture, in the form of precipitation and humidity, may be one of the limiting factors preventing many native trees from expanding their range westward. This may be particularly true of American basswood (*Tilia americana*) and Black ash (*Fraxinus nigra*). Some of the eastern prairie deciduous trees do extend their range into eastern and central Saskatchewan including: *Acer negundo* - boxelder maple, *Fraxinus pennsylvanica* - green ash, *Quercus macrocarpa* - bur oak and *Ulmus americana* - American elm.



The Cypress Hills area of southwestern Saskatchewan and southeastern Alberta features unique vegetation including lodgepole Pine (*Pinus contorta*) and white spruce (*Picea glauca*).

Photo credit: Erik Lizee

NATIVE TREES OF THE PRAIRIE PROVINCES

CONIFEROUS TREES

• *Abies balsamea*	Balsam Fir	AB., SK., MB.
• *Abies lasiocarpa*	Alpine Fir	AB.
• *Juniperus scopulorum*	Rocky Mountain Juniper	AB.
• *Larix laricina*	Tamarack (Eastern Larch)	AB., SK., MB.
• *Picea glauca*	White Spruce	AB., SK., MB.
• *Picea mariana*	Black Spruce	AB., SK., MB.
• *Pinus banksiana*	Jack Pine	AB., SK., MB.
• *Pinus cortorta*	Lodgepole Pine	AB., SK.
• *Pinus resinosa*	Red Pine	MB.
• *Pinus strobus*	Eastern White Pine	MB.
• *Pseudotsuga menziesii*	Douglas Fir	AB.
• *Thuja occidentalis*	Eastern White Cedar	MB.

DECIDUOUS TREES

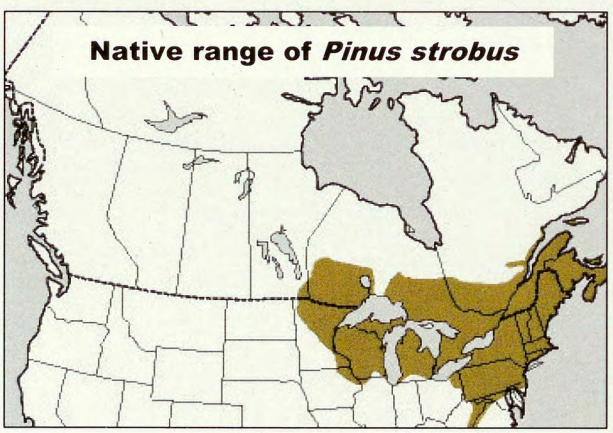
• *Acer negundo*	Boxelder Maple	AB., SK., MB.
• *Betula occidentalis*	Water Birch	AB., SK., MB.
• *Betula papyrifera*	Paper Birch	AB., SK., MB.
• *Celtis occidentalis*	Hackberry	MB.
• *Cornus alternifolia*	Pagoda Dogwood	MB.
• *Fraxinus nigra*	Black Ash	MB.
• *Fraxinus pennsylvanica*	Green Ash	AB., SK., MB.
• *Ostrya virginiana*	Ironwood	MB.
• *Populus angustifolia*	Narrowleaf Cottonwood	AB.
• *Populus balsamifera*	Balsam Poplar	AB., SK., MB.
• *Populus deltoides*	Eastern Cottonwood	SK., MB.
• *P. deltoides occidentalis*	Plains Cottonwood	AB., SK.
• *Populus grandidentata*	Largetooth Aspen	MB.
• *Populus tremuloides*	Trembling Aspen	AB., SK., MB.
• *Prunus virginiana*	Common Chokecherry	AB., SK., MB.
• *Prunus nigra*	Canada Plum	MB.
• *Prunus pensylvanica*	Pin Cherry	AB., SK., MB.
• *Quercus macrocarpa*	Bur Oak	SK., MB.
• *Salix amygdaloides*	Peachleaf Willow	AB., SK., MB.
• *Sorbus americana*	American Mountain Ash	MB.
• *Sorbus decora*	Showy Mountain Ash	MB.
• *Tilia americana*	American Linden	MB.
• *Ulmus americana*	American Elm	SK., MB.

Manitoba interfaces with the eastern and southern Great Lakes forest region. A number of predominately eastern North American tree species reach their known western or northern range limit in Manitoba. These "range limit" populations have been very important in the development of appropriate seed strains and cultivars for the prairie region.

- *Celtis occidentalis* - hackberry's northern range limit is reached at Delta, 25 km (15 miles) north of Portage la Prairie; its westerly range limit is a small stand near Killarney in south-western Manitoba
- *Fraxinus nigra* - black ash reaches its western range limit just east of Portage la Prairie; its northerly range limit reaches into the central Lake Winnipeg south basin
- *Ostrya virginiana* - ironwood reaches its western range limit in Miami, Manitoba area 65 km (40 miles) south of Portage la Prairie; its northern range limit is the Pinawa area some 80 km (50 miles) northeast of Winnipeg
- *Populus grandidentata* - large tooth aspen reaches its known northwestern range limit at Thalberg, Manitoba, 65 km (40 miles) northeast of Winnipeg
- *Pinus resinosa* - red pine reaches its northwesterly range limit on Black Island in Lake Winnipeg, 160 km (100 miles) north of Winnipeg
- *Pinus strobus* - eastern white pine reaches its westerly range limit at Falcon Lake, 130 km (80 miles) east of Winnipeg.
- *Sorbus decora* - showy mountain ash reaches its northwesterly range limit in the areas surrounding Lake Winnipegosis and Lake Winnipeg
- *Thuja occidentalis* - eastern white cedar reaches its northwesterly range limit in the Cedar Lake area of Manitoba some 450 km (250 miles) north west of Winnipeg
- *Tilia americana* - American basswood's northwesterly range limit is Spruce Woods provincial park area, 40 km (25 miles) east of Brandon or 175 km (110 miles) west of Winnipeg

Native eastern white pine near Kenora, Ontario

Photo credit: University of Manitoba



Alberta interfaces with the montane forest region at the Rocky Mountain range. A number of predominately southwestern North American tree species reach their eastern geographic range limit in Alberta including the following:

- *Abies lasiocarpa* - alpine fir ranges eastward into Alberta along the eastern slopes of the Rocky Mountains and is also reported along the Athabasca river in northeastern Alberta.
- *Pinus contorta* - lodgepole pine can be found on the eastern foothills of the Rocky Mountains as well as the Cypress Hills in Alberta and Saskatchewan
- *Pinus flexilis* - limber pine can be found at the top of the foothills in southern Alberta
- *Populus angustifolia* - narrowleaf cottonwood can be found along the banks of streams in southern Alberta.
- *Pseudotsuga menziesii* - The blue douglas-fir ranges east to the eastern slope of the Rocky Mountains in southwestern Alberta, where it reaches its northern range limits at Lake Brule, near Jasper.

There are a number of tree species associated with Canada's boreal forest in the shield region of the north-central prairie provinces including: *Abies balsamea* - balsam fir, *Betula papyrifera* - paper birch, *Larix laricina* - tamarack, *Picea glauca* - white spruce, *Picea mariana* - black spruce, *Pinus banksiana* - jack pine, *Populus balsamifera* -balsam poplar and *Populus tremuloides* - trembling aspen.

Trembling aspen stand
Photo credit: University of Manitoba

Native black spruce in boreal forest
Photo credit: University of Manitoba

CHAPTER 2
Augmenting our Native Trees

Specimen of 'Hot Wings' Tatarian maple

Photo credit: Bailey Nurseries Inc.

The prairie region features around 35 kinds of native trees including deciduous and coniferous species. These native trees are the backbone of our forests and often show excellent longevity and durability despite the vagaries of climate. Nevertheless, there has always been interest in augmenting our palette of native landscape trees with non-native species.

Within the continent of North America it is possible to find a number of tree species with sufficient adaptability to ensure their survival in the prairie region. Native stands of these trees can often be found within a day's drive of our region, in places where weather patterns and soil types can be quite similar to our own. Examples include the following:

- *Acer rubrum* Red maple
- *Acer saccharinum* Silver maple
- *Acer saccharum* Sugar maple
- *Acer x freemanii* Freeman maple
- *Aesculus glabra* Ohio buckeye
- *Betula nigra* River birch
- *Fraxinus americana* White ash
- *Gleditsia triacanthos* Honeylocust
- *Juglans nigra* Black walnut
- *Juglans cinerea* Butternut
- *Juniperus scopulorum* Rocky Mountain juniper
- *Picea pungens* Colorado spruce
- *Pinus ponderosa* Ponderosa pine
- *Quercus ellipsoidalis* Northern pin oak
- *Quercus rubra* Red oak

Black walnut
Photo credit: Bailey Nurseries

Many of these trees range close to Manitoba's borders, particularly to the east and south:

Acer saccharinum - silver maple, *A. rubrum* - red maple and their hybrids (*Acer freemanii*) range northward to near Kenora, Ontario, 200 km (120 miles) east of Winnipeg

Acer saccharum - sugar maple's northern range reaches the Maple Lake area of northwestern Minnesota, 200 km (120 miles) south of Winnipeg

Juniperus scopulorum - native populations of Rocky Mountain juniper can be found in a limited area of southwestern North Dakota

Pinus ponderosa subsp. scopulorum - native populations of ponderosa pine follow the Little Missouri river into southwestern North Dakota

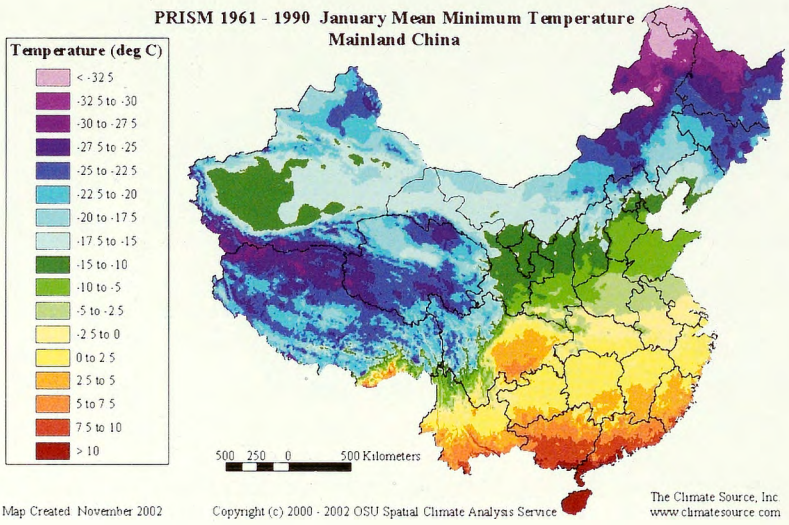
Quercus rubra - red oak and *Q. ellipsoidalis* - northern pin oak - reach their northern range limit north of Rainy River, Ontario and their western range limit nearby in western Minnesota some 250 km (150 miles) south east of Winnipeg.

Prairie landscapes would look very different today without the influence of tree species from Asia. The earliest plant explorers realized the many similarities between the harsh prairie climate and conditions in northwestern Asia. Geographical areas such as Siberia, Mongolia and northern China were sampled for useful germplasm that could have relevance in North America. Many accessions arose through seed exchanges with northeast Asia plantsmen including those done by Dr. Frank Skinner and U.S. institutions such as the Arnold Arboretum of Harvard University. The results are outstanding, with many of our current best-selling trees derived from these introduced species. Examples include:

- *Acer ginnala* Amur maple
- *Alnus hirsuta* Manchurian alder
- *Betula platyphylla* Asian white birch
- *Elaeagnus angustifolia* Russian olive
- *Fraxinus mandshurica* Manchurian ash
- *Juglans mandshurica* Manchurian walnut
- *Larix siberica* Siberian larch
- *Maackia amurensis* Amur maackia
- *Malus baccata* Siberian crabapple
- *Phellodendron amurense* Amur cork tree
- *Prunus maackii* Amur chokecherry
- *Pyrus ussuriensis* Ussurian pear
- *Syringa reticulata* Japanese tree lilac
- *Syringa pekinensis* Peking tree lilac
- *Quercus mongolica* Mongolian oak
- *Tilia mandshurica* Manchurian linden
- *Tilia mongolica* Mongolian linden
- *Ulmus davidiana japonica* Japanese elm

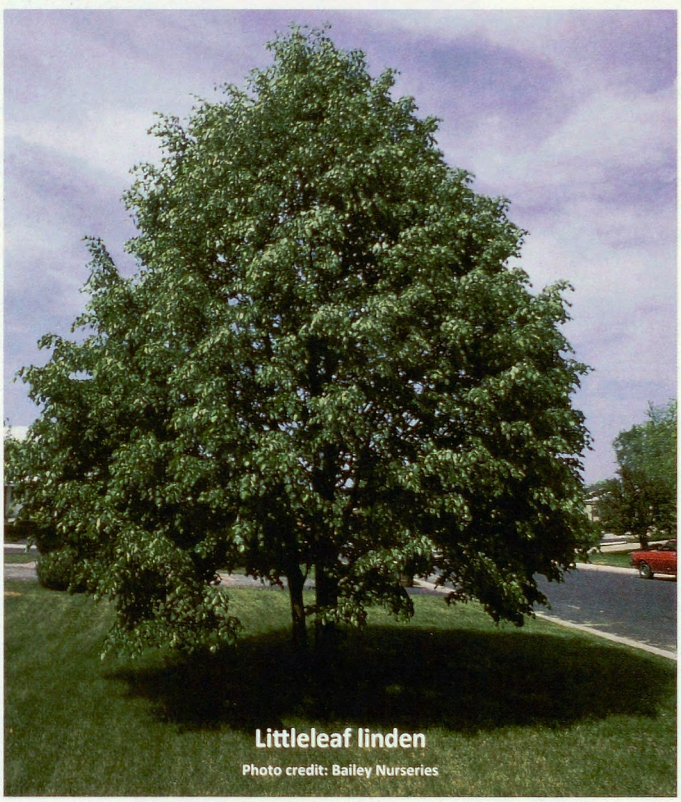

Japanese tree lilac
Photo credit: Bailey Nurseries

Minimum winter temperatures in northeastern China are very similar to those experienced in parts of the Canadian prairies and northern great plains.



Numerous deciduous and evergreen tree species have also been imported from European countries. In many cases, these trees are not quite as cold hardy as their North American or Asian counterparts. Nevertheless, many show promise in zones 3 and 4.

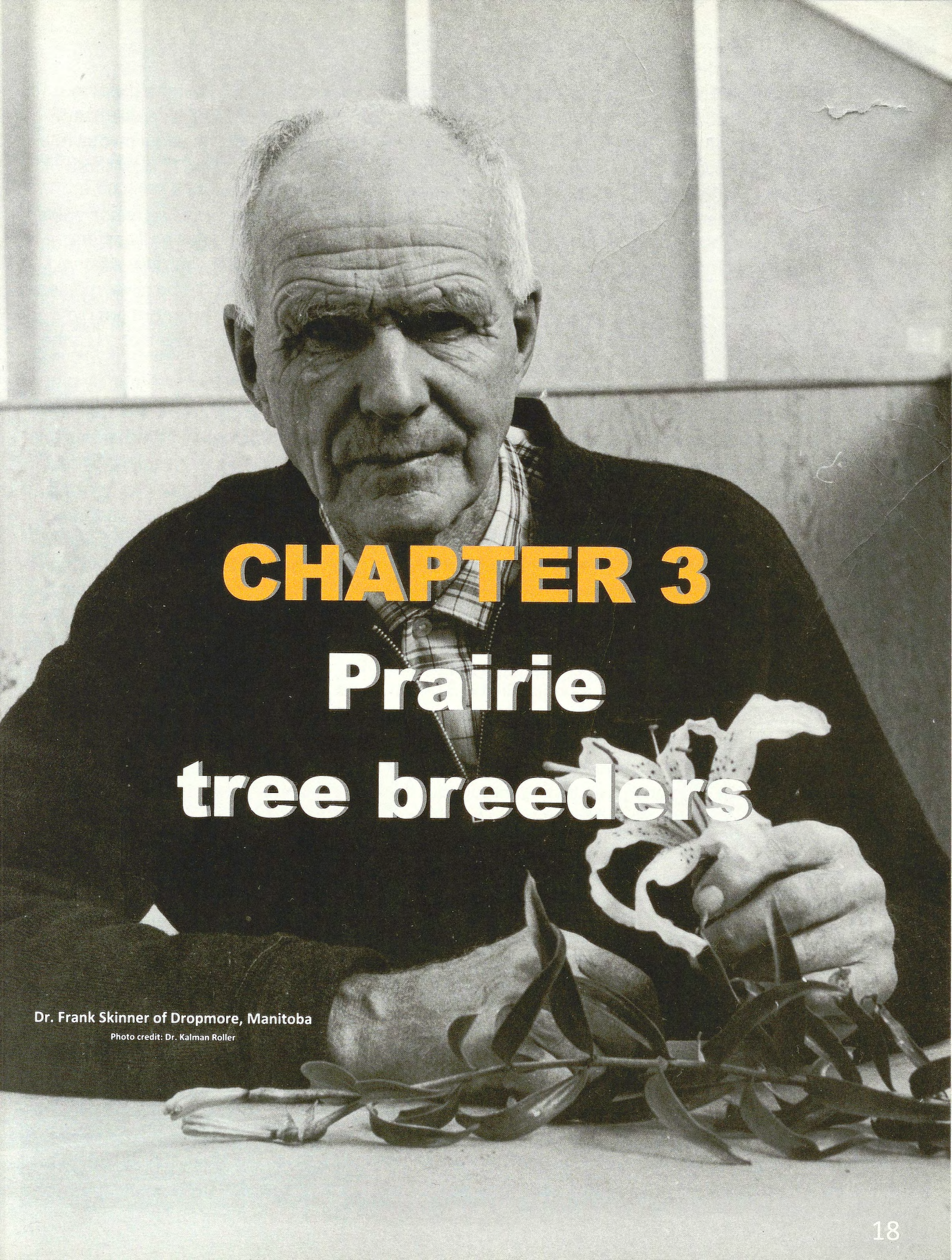
- *Acer platanoides* Norway maple
- *Acer tataricum* Tatarian maple
- *Betula pendula* European birch
- *Picea abies* Norway spruce
- *Pinus cembra* Swiss stone pine
- *Pinus sylvestris* Scots pine
- *Populus nigra* Black poplar
- *Populus tremula erecta* Swedish aspen
- *Salix alba* White willow
- *Salix pentandra* Laurel willow
- *Sorbus aucuparia* European mountain ash
- *Tilia cordata* Little leaf linden



Littleleaf linden
Photo credit: Bailey Nurseries

Swiss stone pine
Photo credit: Bailey Nurseries

One concern with augmenting our native trees with exotic species is the risk of invasiveness. Invasiveness refers to the displacement of endemic species by aggressive exotic species. Invasiveness has been less of an issue in the prairies than in warmer zones of North America, where species such as Norway maple, common buckthorn and tree-of-heaven have escaped the landscape and invaded natural areas, displacing native species.



CHAPTER 3
Prairie tree breeders

Dr. Frank Skinner of Dropmore, Manitoba

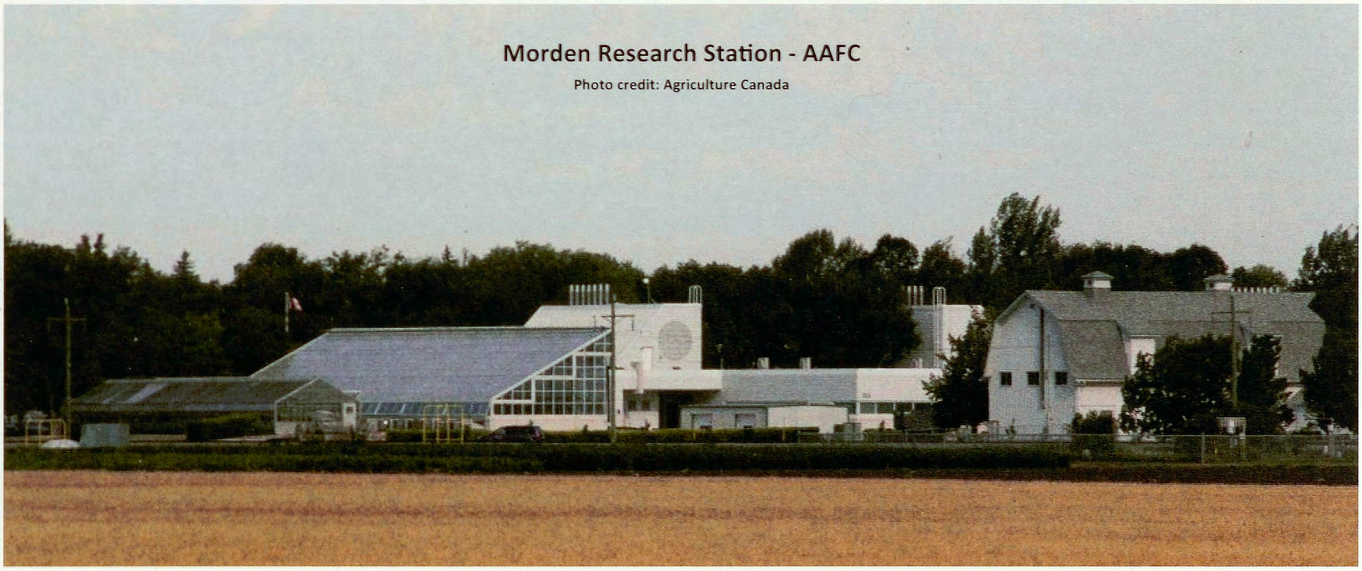
Photo credit: Dr. Kalman Roller

Formed in 1870 and later expanded to its current size, the province of Manitoba has been settled for just over 125 years, except for the small 200 year old "Lord Selkirk settlement" associated with the Red River basin. During this time, Manitobans have played a pivotal role in plant improvement especially tree breeding for northern cold zone areas. At least three reasons can be given for these outstanding contributions.

Firstly, Manitoba's special geographic location between the western prairies and eastern Great Lakes forest vegetation zones opened up opportunities for the very hardiest eastern tree provenances to be adapted to western regions. Prime examples would be silver maple, sugar maple, red maple, hackberry, Ohio buckeye, black ash, white ash and northern pin oak. The greatest limitation to these eastern tree species is not cold hardiness alone but the drier, alkaline soils found throughout much of the prairie grassland.

The second stimulus to Manitoba tree development was the diverse origin of Manitoba settlers, particularly from the British Isles. These individuals wanted to create, in this harsh climate, some of the beauty they recalled in their original homelands. This interest led to the founding of several tree nurseries and the resulting arrival of many tree accessions from foreign lands, adjoining states and eastern Canada. Some notable private nurseries who contributed to Manitoba tree introductions will be recorded in this book. Skinner Nursery was one of these nurseries that developed a noted tree collection and left a legacy that is without peer among nurseries in the region.

Without question, the third stimulus was the role of the Federal Experimental Farm/ Research Station/Research Centre in Morden, Manitoba. This facility conducted landscape plant improvement from its founding in 1915 until the year 2000. Morden became an important center for tree hybridization as well as the accessioning of exotic tree species and testing of native tree adaptation. The notable "Morden Arboretum" plant collection brought visitors from afar and served as a training centre for nurseries and university students. In addition to coordinating tree testing throughout the prairie region, Morden staff conducted propagation research to enable trees to be efficiently propagated as clones or seed strains.



Morden Research Station - AAFC

Photo credit: Agriculture Canada

Three Manitoba nurseries stand out as having made an impact on the trees which are grown in the prairie region today.

Patmore Nurseries was founded in Brandon in 1883 by H.L. Patmore. Patmore was originally from England and brought nursery experience with him in opening up one of the earliest prairie nurseries in the western Manitoba city of Brandon. Patmore Nurseries became known as a very important supplier of trees to cities and farms in the prairies. They incorporated some equipment including a tree under-cutter blade, pulled by 10 horses, for harvesting larger bare-root tree liners. They grew a wide range of trees, two of which have become very well known. The 'Brandon' American elm remains the predominant elm planted in DED -free western areas of the prairies, including all of Alberta. The 'Patmore' ash is a seedless and gall mite-resistant green ash that Richard Patmore discovered in Alberta and began to evaluate. Staff from Morden were instrumental in helping Patmore's new owners protect and commercialize the ash tree in the U.S. where it became the dominant green ash cultivar from 1980 until 2005. Only the advent of a new pest, Emerald ash borer, and some new ash cultivars have reduced the demand for 'Patmore' green ash.

Boughen Nurseries came into operation in north central Manitoba, near Dauphin, about 1900 and have been long term tree growers. The nursery founder, William Boughen, was a pioneer plant explorer and mostly known for his work with fruit trees. However, his efforts combined with that of the second (Russell) and third generation (Ron) family members have given the outstanding 'Skybound' cultivar of pyramidal eastern white cedar. This cedar cultivar has proven to be more winter hardy than existing pyramidal cedars such as the 'Brandon' cultivar.


'Skybound' pyramidal cedar
Photo credit: Jeffries Nurseries

Skinners Nursery was founded by Frank Skinner who immigrated from Scotland as a young child in 1895. By the early 1900's he had started his own farm near Roblin, Manitoba and was active in plant introduction from 1910 until 1967. In 1925, Skinner started selling plants under the name of Dropmore Hardy Plant Nursery to support his plant development work. Skinner's plant interest was broad including perennials, shrubs and trees and his own self-taught home study made him and his plant collections a world wide phenomenon in cold hardy plant material. Skinner's collection of native plants and his exchanges with American and European arboretea and, most importantly, with plant collectors in northeast China and Manchuria have greatly benefited landscapes in our cold prairie region.

The name of Dropmore is seen in several important plants including 'Dropmore' catmint, 'Dropmore Scarlet Trumpet' honeysuckle, 'Dropmore' elm and 'Dropmore' linden. The latter tree, a hybrid of our native American linden and the introduced European little leaf linden, has consistently been the best selling linden cultivar in prairie Canada. Skinner's work with Japanese tree lilac, DED-resistant Asiatic elm (*U. davidiana*), Manchurian ash, Manchurian linden and many other tree species will carry on into the future. Skinner is credited with importing the hardy 'Dropmore' strain of Siberian elm, hardy strains of Amur Maple and northern strains of Scots Pine. His columnar Swedish aspen accession obtained in 1948 from Sweden has been the most important columnar tree for the Canadian prairies and western U.S. over the past 35 years. Only the arrival of the fungal Bronze leaf disease has dimmed the prospects for this striking, columnar, zone 2 tree which had been the top selling tree at many nurseries.

Frank Skinner received many honours including the M.B.E (Member Order British Empire-1943), Honorary LL.D. from the University of Manitoba (1947), Stevenson Medal (first award in 1932), as well as many Honorary memberships and Hall of Fame awards. The development of the Shellmouth reservoir, for flood control on the Assiniboine River, meant the end to the hamlet of Dropmore but the Skinner name has been carried on as Skinner Nurseries by family members. Skinner's life work with plants is recorded in his book "Horticultural Horizons: Plant Breeding and Introduction at Dropmore, Manitoba" an invaluable reference to aspiring plant breeders. Frank Skinner's long life, his singular dedication to horticulture and his genius in collecting and hybridizing plant materials make him a Manitoba icon and treasure trove to tree breeders.

'Dropmore' hybrid linden
Photo credit: Honeywood Heritage Nursery

The role of the **Prairie Farm Rehabilitation Administration** (PFRA) nurseries has been crucial in the breeding of flowering crabapples and poplars. The work of Dr. Les Kerr at Sutherland's PFRA station produced the 'Royalty' and 'Pink Spires' rosyblooms which continue to be grown and appear in the breeding parentage of new cultivars. The work of the Indian Head PFRA station in the development of 'Walker', 'Okanese' and the recently-introduced 'Sundancer' poplar will be carried on into the future.

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The role of Morden Research Centre staff has been vital in the development of the trees we grow today in northern zones. As a former staff member, I (Wilbert) can write with the experience of over 50 years since first coming to work at Morden as an undergraduate student. At the same time, my departure from Morden close to 35 years ago has hopefully removed all bias from my views! I have known all the station directors over the past 50 years and I did have a passing relationship with the long-serving W.R. Leslie. I have been familiar with all the research staff in what was known as the "Ornamentals and Tree Fruit" section over the same time frame .

W.R. Leslie, station director at Morden from 1921 to 1956, while doubtless occupied with administrative work, was never far from his real passions: assembling the tree collection and observing tree performance. A native of Saskatchewan, Leslie graduated from the University of Manitoba in Arts and Agriculture so he could appreciate in a special way the value of landscaping and art in the prairie region. Leslie built up the plant collection at Morden and hired a number of excellent horticulturists including Les Kerr and William Cumming as well as technical staff including Henry Marshall, Alfred Vitins and Bert Harp.

The abiding heritage seen from Leslie's tenure would include the 'Toba' and 'Snowbird' hawthorns which are respective F1 and F2 generation plants from the cross of the red flowered *C. laevigata (oxycantha)* 'Paul's Scarlet' from Europe with the native Manitoba fleshy hawthorn, *C. succulenta*. Leslie's greater contribution to tree breeding rests in the diverse tree collection he developed at Morden. Some of these trees were introduced following Leslie's retirement including 'Mancana' Manchurian ash, now recognized as EAB-resistant. Other germplasm has been used by breeders to produce new trees such as the Morton Arboretum's 'Triumph' elm, developed from Morden stock of *Ulmus davidiana*. Leslie was a proponent of using northern U.S. strains of sugar maple as a landscape tree. Leslie received an Honorary L.L.D. and the Stevenson Medal for horticulture as well as many other rewards over his long career.

Flowers of 'Toba' hawthorn

Photo credit: Jeffries Nurseries

William Leslie (Les) Kerr of Ontario, graduated from the Ontario Agricultural College and moved on to complete his Masters degree at the University of Maryland in 1928. After graduating, he worked at the Maryland Fruit and Vegetable Inspection Service for four years. Les then briefly moved to the AAFC Rosthern Station in Saskatchewan before his ten years at Morden in fruit breeding from 1932-1942. Following his tenure at Morden, Les carried on his plant breeding work at the PFRA nursery in Sutherland, SK until his retirement in 1970.

Kerr's interest were broad and we still grow his 'Kerr' applecrab ('Dolgo' x 'Haralson') and many sour cherries from the University of Saskatchewan which trace to his Mongolian cherry (*P. fruticosa*) x sour cherry (*P. cerasus*) hybrids. Kerr's interest in trees led him to work on flowering crabapples and his 'Sutherland', 'Pink Spires' and 'Royalty' cultivars are still grown today. The 'Royalty' rosybloom remains unsurpassed for shiny purple foliage and good tree form, but it is susceptible to bacterial fire blight which has limited its usefulness in northern areas. 'Royalty' has appeared again as a breeding parent of the increasingly popular, purple-foliaged 'Gladiator' introduction.

Kerr also had a special interest in the *Prunus* genus and developed the well known *Prunus virginiana* 'Shubert' x *P. padus* hybrids. 'Canada Red' and 'Midnight', two cultivars developed from this cross, were popular until the developing fungal black knot problem. His work with caragana for shelterbelts led to the introduction of the columnar 'Sutherland' caragana which is still grown today. Kerr also left us valuable shrubs such as 'Sutherland' Golden elder and the dwarf 'Goldenlocks' elder. Kerr received numerous honours including the Stevenson Medal from the Manitoba Horticultural Association and an Honorary LL.D from the University of Saskatchewan.

'Pink Spires' rosybloom crabapple - fruit

Photo credits: Bailey Nurseries Inc.

William A. Cumming, a native Manitoban, graduated in horticulture from the University of Manitoba in 1932 at the height of the economic crisis known as the "Great Depression". Cumming was employed as a Federal Plant Inspector for 10 years before his plant interest led him to work at Skinners Nursery from 1945-1955. His experience at Skinner's Nursery equipped him for the move to the Morden Research Station where he organized and developed the Arboretum and began plant breeding work on flowering crabapples, lilacs and shade trees. The 'Kelsey' and 'Selkirk' rosybloom crabapples trace to this time frame, as do the widely grown 'Miss Canada' and 'Minuet' lilacs. However, Cumming's most important role may have been his mentoring of younger staff and his development of a wide network of horticultural associates in the northern U.S. and Canada. Cumming received an Honourary D.Sc from his alma matter and the Stevenson Medal for his research contributions in addition to many other honours.

'Kelsey' rosybloom crabapple
Photo credit: Jeffries Nurseries

'Selkirk' rosybloom crabapple
Photo credit: Jeffries Nurseries

Henry H. Marshall, was born and raised only 30 miles from Morden along the scenic Manitoba escarpment. Marshall was a self-taught botanist, geneticist and plantsman and worked at the Morden Research Station from 1938 until joining the Canadian Army as an artillery officer in 1942. After his war service, Marshall started work in general horticulture at the federal research station in Brandon, Manitoba. Marshall's creative plant hybridization in roses, bee balm (*Monarda*) and coral bells (*Heuchera*) attracted the interest of his superiors. He transferred to the Morden Reseach Station in 1970 to work full time on plant breeding and used the last 11 years of his career to do what he loved best, namely breeding landscape plants. While best known for his work with roses, monarda and coral bells, Marshall was also interested in northern trees. He mentored Lynn Collicutt who took over his work and carried it on very successfully. Marshall received an Honorary D. Sc from Brandon University, the Stevenson Medal and many other recognition awards over his long career.

Wilbert Ronald, one of this book's authors, started work at the Morden Research Station in 1965 as a summer student after completing his second year in general agriculture. The summer's work in agronomic crops was interesting, but he was impressed with the collection of trees in the Morden Arboretum and decided to specialize in horticulture. Following completion of his undergraduate coursework, an assistantship enabled his graduate studies on the taxonomic relationship of Manitoba's native poplar hybrids.

A most fortunate job offer to join the Morden research staff in October of 1968, enabled Wilbert's thesis to be completed and some of the first tree crossing to start in 1969. A list of needed trees for the industry was developed and the tree breeding program was expanded based on the extensive tree collection at Morden. Goals included the development of a northern zone weeping willow, pyramidal trees of poplar and aspen, DED-resistant elms, seedless ash and superior maples. Ten tree introductions were made leading up to his departure from Morden in 1982; six of these are still grown in the industry. Several trees were introduced later from his work including 'Northern Treasure' ash and 'Prairie Sky' poplar.

Wilbert's work with trees continued in the private sector at Jeffries Nurseries where collaborative research with Rick Durand led to many introductions including: 'Unity' and 'Inferno' sugar maple, 'Prairie Rouge' red maple, 'Regal Celebration' Freeman maple; 'Emerald Spire' and 'Starlite' crabapple; 'Klondike' Amur cherry; 'Harvest Gold' and 'Golden Cascade' linden. The propagation technology of grafting or budding Columnar Swedish aspen followed by the implementation of root cuttings and suckering procedures made this plant a multi-million dollar nursery item in the prairie and western Midwest regions. Wilbert has received the Manitoba Horticultural Association's Stevenson medal, the Wodartz award from the North Dakota State Horticultural Society and the Coleman award from the American Nursery and Landscape Association.

Rick Durand, a native of Dauphin, Manitoba graduated with an honours degree in Forestry from Lakehead University and has pursued a career working with nursery trees for 35 years in Manitoba and more recently in British Columbia. His Prairie Shade Nursery has released 16 tree cultivars including 'Shooting Star' northern pin oak, 'Discovery' Japanese elm, 'Silver Cloud' silver maple, 'True North' American linden, 'Sabre' large tooth aspen as well as 'Gladiator', 'Courageous' and 'Ambassador' rosyblooms. In particular, the purple-leafed 'Gladiator' rosybloom has become a best seller across North America. Additionally, Rick helped to develop a number of trees while working for Jeffries Nurseries in Portage la Prairie, Manitoba including: 'Unity' and 'Inferno' sugar maple, 'Skyfest' cottonwood, as well as 'Emerald Spire', 'Starlite' and 'Royal Mist' crabapples. Rick's work with tree cultivar testing through the Western Nursery Growers Group has led to a renewed focus on tree evaluation and development for the prairie region. More details on this study can be found at www.prairietrees.com

'True North' American linden
Photo credit: Prairie Shade Nursery

Philip Ronald, one of the authors of this book, graduated from the University of Manitoba in horticulture and plant breeding and moved to complete his Ph.D. in the native fruit program at the University of Saskatchewan. While in graduate school, he discovered a dwarf spur-type Amur cherry which was introduced as 'Goldspur' (see page 107) and a unique oak hybrid which has been named 'Admiration' (see page 110). Philip's studies on native tree distribution over the past 15 years have led to the discovery of hardier White ash sources in Wisconsin and out of many seedlings the 'Nobility' male clone was named (see page 89). It is considered the most reliable white ash for northern zones and has outstanding purple fall foliage. New sources of northern Sugar maple with improved fall colour and earlier maturity have also been discovered. Philip's ongoing work with oak hybridization (see page 111) may lead to a new columnar oak cultivar for zones 2 and 3.

Philip Ronald with original tree of 'Goldspur'
Photo credit: Jeffries Nurseries

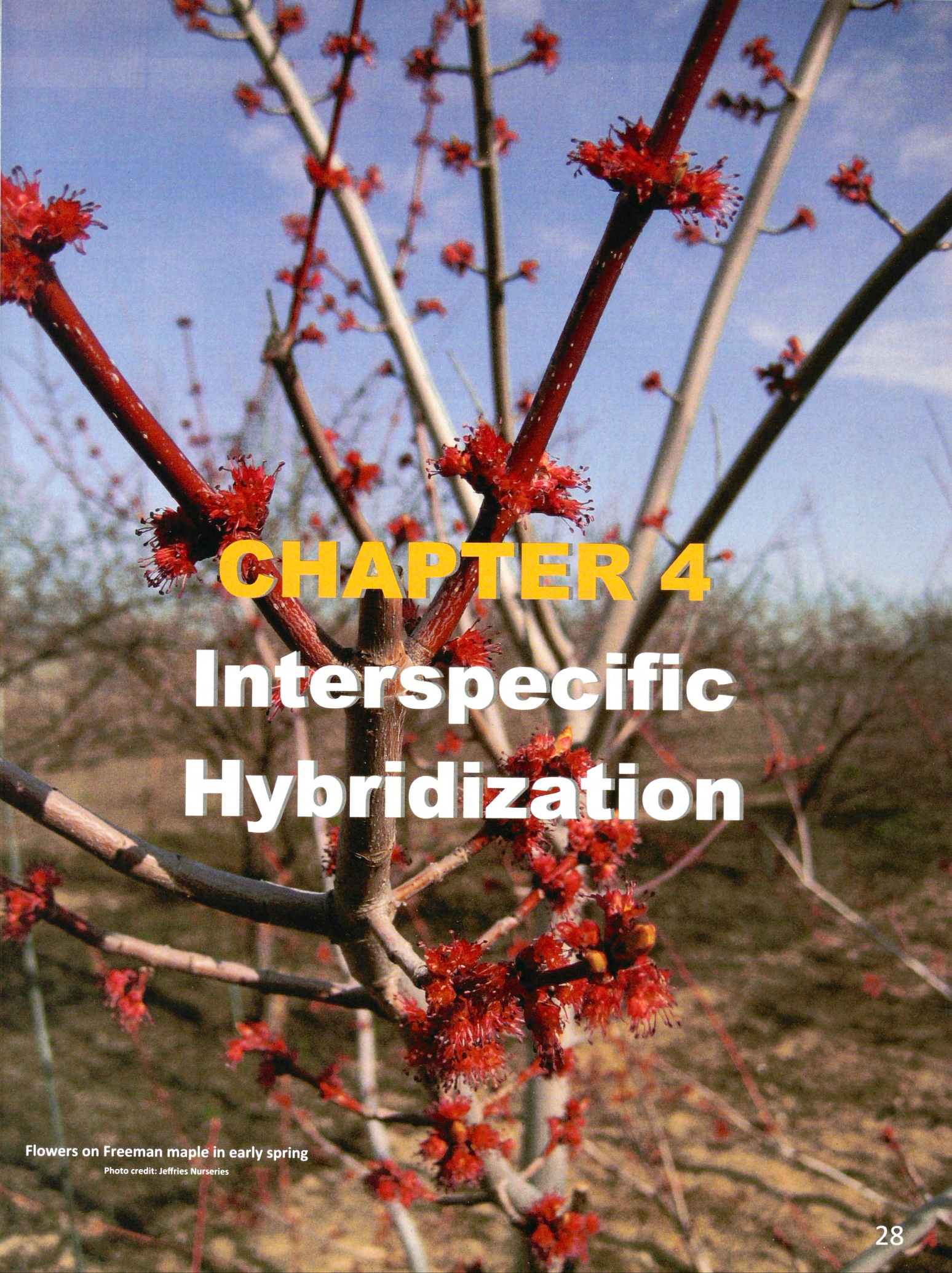
Dale Herman a now retired Professor of Horticulture at the Fargo, North Dakota State University was a native North Dakotan who understood northern climate and conditions. Herman made a number of deciduous tree introductions for northern zones including: 'Prairie Dream' and 'Dakota Pinnacle' birch, 'Prairie Horizon' Manchurian alder, 'Prairie Spire' green ash and the DED-resistant 'Prairie Expedition' American elm. Several other tree introductions are either not completely tested or perform better in Zone 4 conditions. Among coniferous tree species, Herman introduced cultivars of Swiss Stone pine, Norway spruce (see photo below) and Rocky Mountain douglas fir.

Herman assembled an extensive tree collection at the NDSU arboretum in Absaraka, N.D. that remains one of the best in the great plains. He received many honors and awards during his career. Notably among these was the Manitoba Horticultural Association Stevenson Commemorative Award for "Conspicuous Achievement in Horticulture". He has also written numerous publications, and served as an author for "The North Dakota Tree Handbook" and the book "Trees and Shrubs for Northern Great Plains Landscapes" published in 2006 by the NDSU extension service

'Royal Splendor' Norway spruce
Photo credit: North Dakota State University

'September Flare' sugar maple
Photo credit: North Dakota State Unviersity

Many other individuals have made contributions to prairie tree development including Bert Porter, Bill Schroeder, Hugh Skinner and Greg Morgensen. These individuals are mentioned throughout this book in the development of specific cultivars. The future of northern tree breeding will depend on private, university and nursery staff who have knowledge to move tree improvement forward.



CHAPTER 4
Interspecific Hybridization

Flowers on Freeman maple in early spring

Photo credit: Jeffries Nurseries

Combining the genetic characteristics of two or more species has played a role in tree improvement for many years and there are both natural and artificially-developed interspecific hybrids. Interspecific hybridization in trees is quite different than the concept in agronomic crops such as corn and canola where hybrid seeds are produced by crossing two inbred breeding lines from a single species. Tree breeding has often used a local, native, cold-tolerant species in crosses with a less hardy, native or introduced species possessing some unique trait such as flowers, fruit, foliage or form.

A knowledge of a tree's flowering system is absolutely critical to developing a hybridization program. The flowering systems in trees can be dioecious with male and female flowers on separate plants e.g. poplars, many ash, some maples and willows. Other trees show monoecious flowering with separate male and female flowers on one plant (e.g. oak). Other plants have both male and female parts in a single flower or they have the two sexes in separate flowers on the same plant. In some of the normally dioecious species it is possible to have "off type" combinations of the flowering pattern. We have seen individual trees of poplar, willow, ash and maples with male and female flowers on the same plant and with male and female flowers in the same catkin and flower cluster. These off-type flowers can enable some unusual hybridization with species that are normally dioecious.

The important 'Mancana' individual in the Manchurian ash population introduced to Canada was a male tree so it could be used only as the male parent in any interspecific crossing. This directional cross with a female black ash parent was successful, resulting in the hybrids: 'Northern Treasure' and 'Northern Gem'. These hybrids are predominantly male, but in the case of 'Northern Gem' there is on occasion some male and female flowers. This opens up opportunities for breeding that would not normally be an option in ash.

Male flowers of 'Mancana' Manchurian ash

Photo credit: Jeffries Nurseries

'Northern Treasure' hybrid ash

Photo credit: Jeffries Nurseries

Pollination can take place by wind, as in willows and poplars, or by insects as in many plants such as lindens and crabapples. Occasionally a combination of wind and insect pollination is used in some of the maple species. There are strong pressures encouraging interspecific hybridization especially where a single isolated tree of one species is grown near other species of the same genus. This has been the source of many northern hybrid species. The colder zones are often represented by only one native species: elm (*U. americana*), linden (*T. americana*), hackberry (*C. occidentalis*), tree-form maple (*A. negundo*) and oak (*Q. macrocarpa*). This limited species selection has been a motivation to widen plant diversity and intercross with compatible non-native species to make quality improvements.

The mechanics of tree hybridization offers some special challenges quite apart from the flower structure and breeding behavior of a particular tree. Trees are slow to reach sexual maturity and may take 5 to 10 years to reach flowering. This makes for slow progress in generational breeding and limits the breeding work as compared to annual crops which can have as many as two generations in a single year. Furthermore, flower structures may be hard to access in the high canopy of a tree that has reached sexual maturity. In making controlled crosses flowers must be carefully protected from extraneous wind and insect pollination otherwise the tree breeder's goal of carefully crafted hybridization is meaningless. As breeders, we have used paper or plastic bags over ash twigs to prevent extraneous pollination while inserting copious amounts of the desired pollen. In the case of poplar and willow species, cut branches with flower buds from both male and female trees have been forced in water in the greenhouse 2 to 4 weeks ahead of normal outdoor flowering. This enables early pollen collection and subsequent crossing indoors prior to the natural occurrence of pollen shedding. Seed can be ripened using the cut branch technique with both poplar and willow species.

Trees grown in containers are very useful to supplement and extend the normal means for hybridization. Trees in containers can be brought into flower at a young age and flowering dates in containers can be managed by controlling temperatures or growth activation so that species can be crossed using fresh pollen. We have found that the danger of extraneous pollen transfer can be largely eliminated by early greenhouse or growth chamber crossing where plants can be protected from wind-borne or insect-borne pollen. The earlier initiation of flowering, promoted by container growing, can be a boon in shortening the generation time of tree species.

Hybridizing two 'Regal Prince' oak with bur oak

Photo credit: Jeffries Nurseries

Many tree species appear to use interspecific hybridization at the northern limit of a species range to facilitate the genetic exchange of cold hardiness and other adaptive traits. For example, there is common hybridization of the southern native cottonwood (*P. deltoides*) with the northern boreal balsam poplar (*P. balsamifera*) in Manitoba and this sharing of genetic material may be helping the cottonwood colonize more northern locales. We have found a similar situation in northwestern Ontario where the native red maple (*Acer rubrum*) and silver maple (*Acer saccharinum*) are in a constant state of hybridization. In nearby areas to these maples, the native red oak (*Quercus rubra*) and northern pin oak (*Quercus ellipsoidalis*) also appear to be showing some hybrid mixtures.

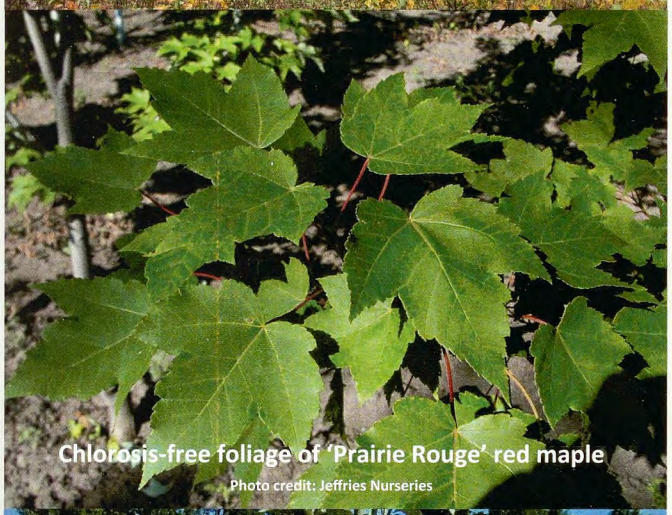
While there are the above-mentioned examples of natural hybridization, there are many situations where native tree species grow side-by-side for centuries with no obvious signs of admixture. Examples would include the native ash species of which the green ash (*F. pennsylvanica*) and black ash (*F. nigra*) have grown together for many generations in Manitoba with no evidence of interspecific hybridization.

The introduction of new species from other continents has opened the door for natural and spontaneous hybrids between native and non-native species which had previously been isolated by geography (spatial separation). Many of these intercontinental hybrids have contributed significantly to the tree selection we currently grow in northern zones.

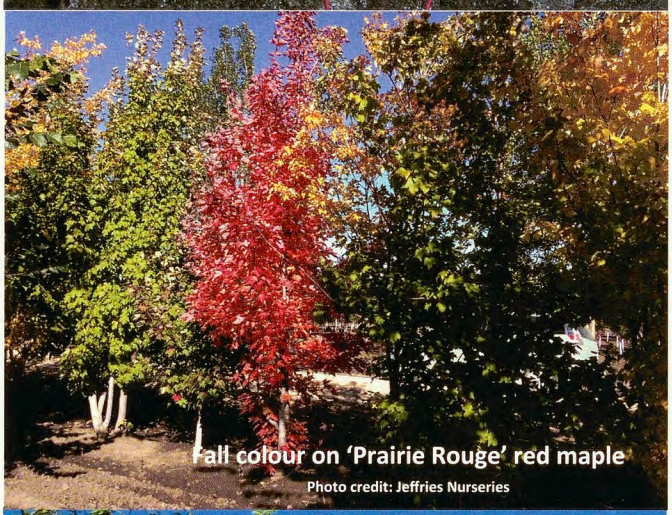
- 'Dropmore', our most reliable linden cultivar, is a natural hybrid between the European *Tilia cordata* and the native *Tilia americana*.
- 'Toba' hawthorn is a hybrid of the native *Crataegus succulenta* and 'Paul's Scarlet', a double, red-flowered, tender cultivar. A seedling of 'Toba', 'Snowbird' hawthorn is even more cold hardy and useful and would rank among the most important hawthorn cultivars for zones 2, 3, 4 and 5 in the U.S. and Canada.
- The hybridization of black ash (*Fraxinus nigra*) with the introduced Manchurian ash (*F. mandshurica*), achieved at Morden in 1969, resulted in the widely used cultivars: 'Northern Treasure' and 'Northern Gem'. These hybrids are being intensively studied to gain an understanding of the basis of genetic resistance to Emerald Ash Borer.
- Numerous poplar hybrids have been developed for northern zones based upon interspecific crosses which are common in this genus. Examples include 'Northwest' and 'Prairie Sky'.
- The hybridization of native silverberry (*Elaeagnus commutata*) with the introduced Russian olive (*E. angustifolia*) results in desirable F1 sterility. The resulting interspecific hybrid ('Silverado') cannot become a weed tree, a charge often levelled at the Russian olive parent. Similarly, the sterile F1 hybrid of Siberian peashrub (*Caragana arborescens*) with another caragana species (possibly *Caragana frutex*) has resulted in a potentially very useful sterile cultivar known as 'Green Spires'. This sterility removes any concern about the naturalization of an introduced landscape plant. These two intriguing hybrids were discovered by Greg Morgenson while he was managing Lincoln Oakes Nursery in Bismarck, N.D.

Hybrid swarm of red & silver maple in NW Ontario
Photo credit: Jeffries Nurseries

Leaves from hybrid swarm of red & silver maple
Photo credit: Jeffries Nurseries



Chlorosis-free foliage of 'Prairie Rouge' red maple
Photo credit: Jeffries Nurseries



Fall colour on 'Prairie Rouge' red maple
Photo credit: Jeffries Nurseries

'Silverado' hybrid olive
Photo credit: Jeffries Nurseries

'Green Spires' common caragana
Photo credit: Jeffries Nurseries

There are some instances where two introduced species have been hybridized over many generations to develop important landscape plants. The rosybloom flowering crabapple (*Malus x adstringens*) would probably be the most important example in northern zones. These trees have been developed with a range of foliage and flower colours, crown form, fruit retention and non-fruiting genotypes which has culminated in more than 50 introductions across North America; at least 10 of which are important in zones 2 and 3.

One example of interspecific hybridization with dubious value has been the natural hybridization of the European mayday (*Prunus padus*) with the native chokecherry (*P. virginiana*). These hybrids (e.g. 'Canada Red' and 'Midnight') have some good growth characteristics but are very susceptible to black knot fungus when grown in the eastern prairies. Similarly, some poplar hybrids involving Asiatic species are very susceptible to poplar canker making them unsuitable for production.

The indisputable evidence of hybridization is seen in intermediate morphological characteristics (e.g. leaf size and shape). Hybrid growth rates often exceed that of either parent species. Sterility in the hybrid is a sure confirmation of a complex genetic background. The measure of sterility is often related to the difficulty of the cross and the diversity between the hybridizing species.

Some key northern interspecific hybrids and their parent tree species:

- *Acer rubrum* x *Acer saccharinum* = 'Autumn Blaze', 'Regal Celebration'
- *Caragana arborescens* x *C. frutex* = 'Green Spires'
- *Crataegus laevigata* 'Paul's Scarlet' x *C. succulenta* = 'Toba', 'Snowbird'
- *Fraxinus nigra* x *F. mandshurica* = 'Northern Treasure', 'Northern Gem'
- *Malus x adstringens* hybrids = prairie rosybloom cultivars
- *Populus balsamifera* x *P. deltoides* = 'Northwest'
- *Populus deltoides* x *P. nigra* 'Italica' = 'Prairie Sky'
- *Pyrus ussuriensis* x *P. communis* hybrid = 'Early Gold'
- *Quercus alba* x *Q. bicolor* = 'Admiration'
- *Quercus macrocarpa* x (*Q. robur* x *Q. bicolor*) = JNL upright selection
- *Salix pentandra* x *S. babylonica* = 'Prairie Cascade'
- *Tilia cordata* x *T. americana* = 'Dropmore'
- *Tilia mongolica* x *T. cordata* = 'Harvest Gold'
- *Ulmus* x ['Vanguard' x 'Accolade'] = 'Triumph'

CHAPTER 5
Tree Features

Spring flowers of 'Gladiator' rosybloom crabapple

Photo credit: Jeffries Nurseries

In addition to environmental benefits such as shade and rain interception, deciduous trees offer a number of ornamental features that add aesthetic value to any landscape.

FORM, TWIGS, BARK

We will begin with form, which refers to the overall shape of the tree in silhouette. Trees are dominant features in the landscape and their form can have a marked influence in defining the spaces around them. For example, the vase-shaped form of American elm defines a comfortable space for people beneath its spreading canopy. 'Prairie Cascade' and 'Lace' willow as well as cutleaf weeping birch offer a cascading habit creating the illusion of a waterfall. 'Purple Spire' rosybloom crabapple and 'Parkland Pillar' birch offer a columnar, pillar-like habit that is striking whether planted as a specimen or in a line as a privacy screen.

Like form, twigs and bark are also year-round features of deciduous trees in the prairie landscape. Amur chokecherry and paper birch are well recognized for their exfoliating bark in orange-brown and white, respectively. 'Delta' hackberry has unique stucco-like bark, while 'Harvest Gold' linden produces bark that exfoliates in stamp-sized scales. For twigs, 'Prairie Cascade' and Golden willow offer uniquely golden colour on newer growth. Bur oak features thick corky ridges on its middle-aged branches that create a course texture and cause trees to stand out from their surroundings. The fine branching of cutleaf weeping birch is especially attractive when covered with hoar frost in spring or fall.

Vase-like canopy of American elm

Photo credit: Jeffries Nurseries

Exfoliating bark of 'Chickadee' paper birch

Photo credit: Jeffries Nurseries

FLOWERS

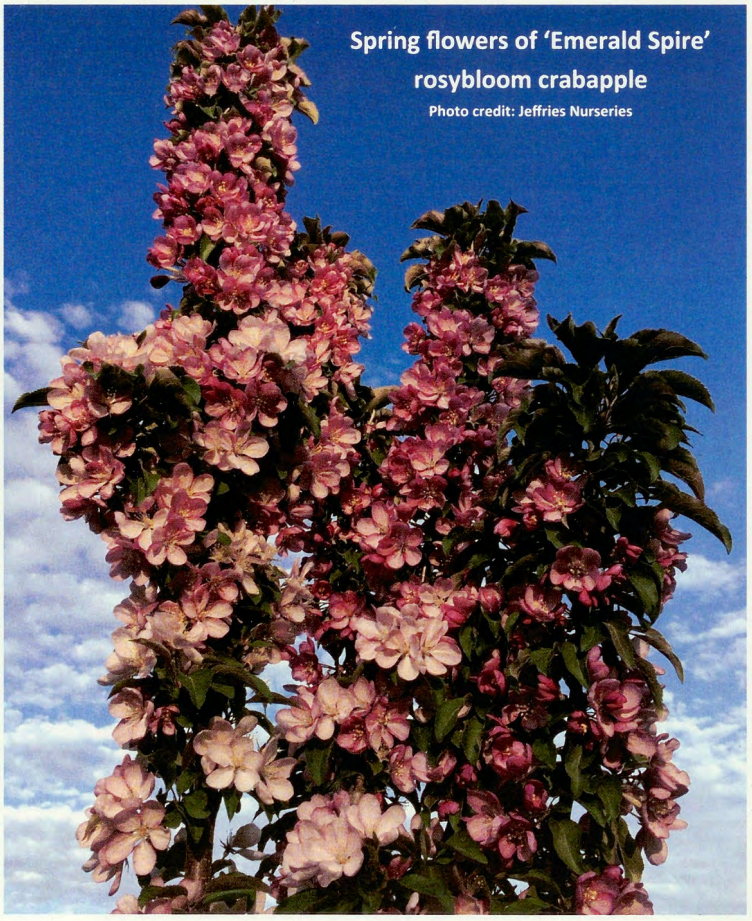
Deciduous tree flowers are ephemeral at best, with most species showing a short season of bloom. Furthermore, many of the large shade trees have wind-pollinated flowers that are not particularly showy. An exception to this rule would be the lindens which produce colourful, eye-catching, golden flower clusters in late summer. Buckeye is a medium-sized tree with delightful, creamy panicles of flowers in spring.

The most attractive floral displays are generally found among small-statured trees. Certain small to medium-sized trees produce an abundance of solitary flowers, e.g.: rosybloom crabapple (pink); Ussurian pear and Siberian crabapple (white). Other trees produce flowers in larger groupings known as inflorescences. Flower inflorescences in deciduous trees can be classed as:

racemes, e.g. Amur cherry (white), common chokecherry (white)
panicles, e.g. Amur maple (cream), buckeye (cream), tree lilac (white),
corymbs, e.g. hawthorn (white) and mountain ash (white),
catkins, e.g. paper birch (yellow), Manchurian alder (purple), poplars & willows

Several deciduous tree species offer outstanding fragrance when blooming including Russian olive, Japanese tree lilac and basswood (American linden). Moderately fragrant flowers can also be found on Ussurian pear and some flowering crabapples.


Flower panicles of 'Ivory Pillar' Japanese tree lilac
Photo credit: Jeffries Nurseries


Spring flowers of 'Emerald Spire' rosybloom crabapple
Photo credit: Jeffries Nurseries

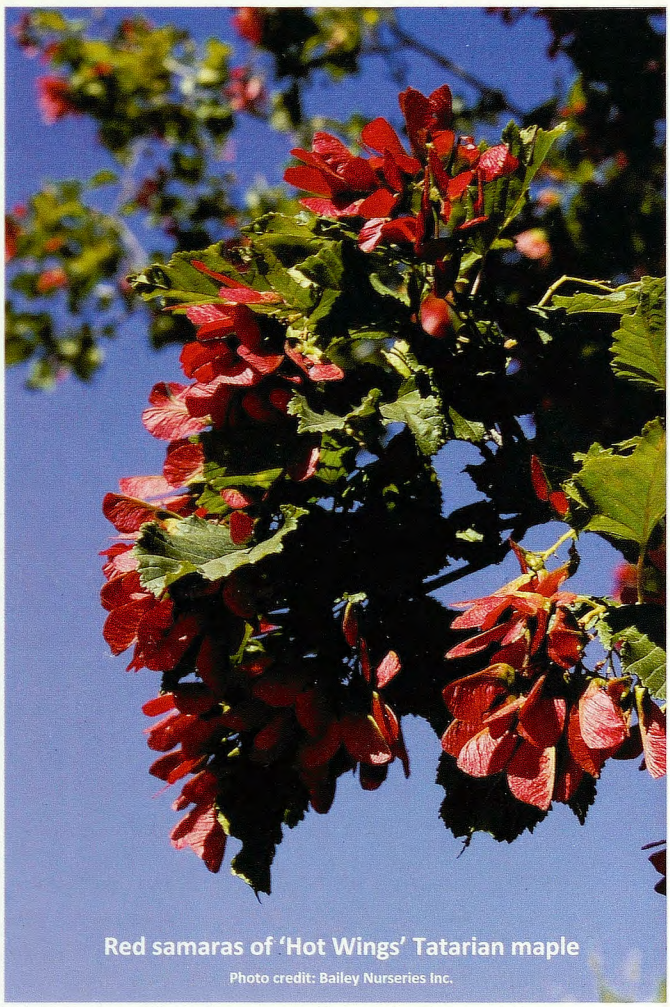
FRUIT

Fruit can be a desirable or undesirable feature depending on the tree species. Many of our deciduous shade tree cultivars have been selected as seedless, male specimens to avoid the problem of excess seed production and the volunteer seedlings that often accompany it. However, fruit that is colourful and/or retained after leaf drop has aesthetic value in the fall and winter landscape and also benefits wildlife including birds and squirrels.

'Hot Wings' Tatarian maple is an example of a small tree with colourful, non-fleshy fruits. The schizocarps of 'Hot Wings' are brilliant, fire-engine red in mid-summer and contrast well with the green foliage. 'Starlite' flowering crabapple produces red, bead-like, fleshy fruits that are retained throughout the winter and are attractive to song birds. European and showy mountain ash produce large clusters of orange-red fruit that remain through winter.

Species whose large fruit are generally perceived as a nuisance include Ohio buckeye, butternut, black walnut, bur oak and Ussurian pear. Several rosybloom crabapple cultivars ('Shaughnessy Cohen' and 'Royal Mist') drop their ripe fruit quickly and should be sited away from sidewalks and carparks. The 'Spring Snow' flowering crabapple has become one of the most popular flowering trees due to its female sterility and absence of fruit.

Tiny red berries of 'Starlite' flowering crabapple
Photo credit: Jeffries Nurseries



Red samaras of 'Hot Wings' Tatarian maple
Photo credit: Bailey Nurseries Inc.

FOLIAGE

Foliage is the predominant ornamental feature when considering deciduous trees for the prairie landscape. Deciduous trees produce new leaves each spring that will adorn their branches until the first killing frosts of fall. For the majority of tree species, summer foliage occurs in shades of green. However, there are hardy trees with purple (e.g. rosybloom cultivars 'Gladiator' and 'Indigo Spire') and silver (e.g. Russian olive) foliage that is excellent for contrast in the prairie landscape.

Fall colour is a unique feature of deciduous trees that should be considered in landscape design. As leaves prepare for abscission in autumn, many of their internal components are broken down and drawn back into the tree. The loss of chlorophyll from the leaf reveals interesting pigments that were previously masked, including carotenoids and xanthophylls. In other cases, anthocyanin pigment accumulates in the leaves causing them to turn from green to purple. Some candidates for fall colour in the prairie landscape include:

Orange / Red Fall Foliage:

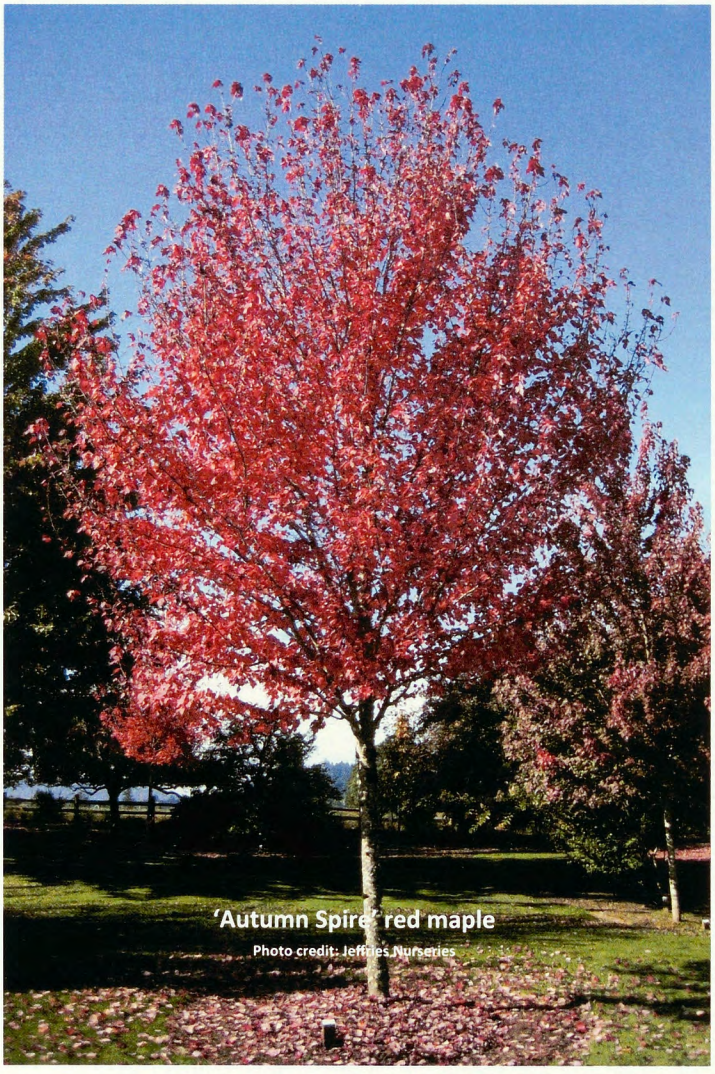
- Amur maple
- 'Regal Celebration' Freeman maple
- 'Prairie Rouge' red maple
- 'Inferno' sugar maple
- Lord Selkirk sugar maple
- 'Autumn Splendor' buckeye
- Ohio buckeye
- Northern pin oak

Golden Fall Foliage:

- Paper birch
- Asian white birch
- Delta hackberry
- Ironwood
- Trembling aspen
- 'Goldspur' Amur cherry
- 'Klondike' Amur cherry
- American linden
- 'Golden Cascade' linden
- 'Harvest Gold' linden

Purple Fall Foliage:

- 'Nobility' white ash
- 'Purple Spire' rosybloom crabapple


'Autumn Spire' red maple
Photo credit: Jeffries Nurseries

Evergreen trees are unique for their ability to hold their foliage year-round and can offer much needed colour and texture in the barren winter landscape. Among coniferous trees, foliage is classed as either needles (larch, pine, spruce) or scales (cedar, juniper). Named for their cone-like fruits, conifers offer a number of valued ornamental features.

FOLIAGE

Larch are unique among the conifers in that their foliage is not evergreen; rather their needles turn golden in the fall before abscission. Colorado spruce is renowned for its intense silver-blue needles that can be found in both cultivars (e.g. 'Hoopsii') and seed strains (e.g. 'Baby Blue') . Pines stand apart from larch and spruce since their needles are grouped in bundles called fascicles with 2 (e.g. Scots), 3 and 5-needled (e.g. Swiss stone) forms.

FORM

Many tree-form cultivars of eastern white cedar grow to be outstanding columnar specimens. 'Skybound' cedar is an improved selection with dense, dark-green foliage that resists splaying caused by heavy winter snows. Pyramidal form is characteristic of white and Colorado spruce, with the latter tending to be taller and wider. Narrow pyramidal describes the form of 'Medora', the most winter hardy cultivar of Rocky Mountain juniper.

FLOWERS & FRUIT

Conifers produce both spring-flowering cones and fall-fruiting cones, the latter bearing seeds. Fruiting cones require 1 or 2 years to mature depending on the genus. While neither type of cone is as ornamental as the flowers and fruit seen among their deciduous counterparts, cones on coniferous evergreens do provide some aesthetic value.

BARK

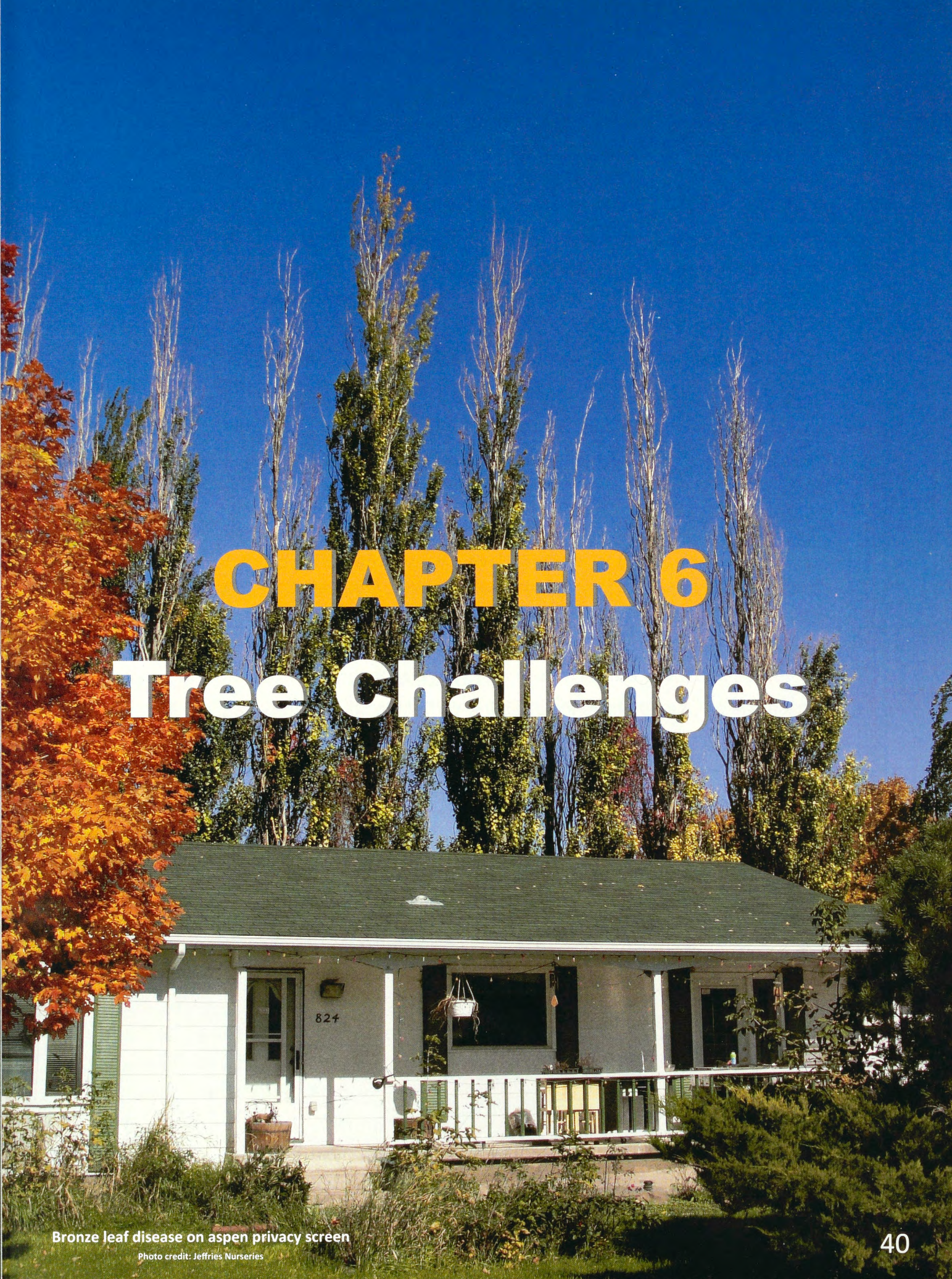
Many of the pines produce scaly bark. Scots pine features exfoliating orange bark that is especially obvious in the upper half of mature tree canopies. Mature, non-cultivated specimens of eastern white cedar show unique bark that sheds in long strips.

Outstanding silver blue foliage on 'Baby Blue' Colorado spruce

Photo credit: Jeffries Nurseries

Pollen cones on Scots pine in spring

Photo credit: Sosna Zwyczajna



CHAPTER 6
Tree Challenges

Bronze leaf disease on aspen privacy screen

Photo credit: Jeffries Nurseries

There are an assortment of biotic and abiotic challenges that threaten tree survival. On the abiotic side we can consider factors such as a plant's innate response to the climate and soil conditions in which it is growing.

COLD TEMPERATURES

We generally consider temperature and precipitation as the two most limiting factors for tree survival. In many landscapes a lack of precipitation can be readily overcome by supplemental irrigation, however ambient temperature truly limits a species. Temperature variables that affect a tree's survival include: summer heat units for development, timing of first killing fall frost, freeze/thaw cycles in spring and minimum winter temperature.

A hardy tree is one that responds well to environmental cues such as changes in photoperiod and temperature in spring and fall. By responding to its surroundings in a timely manner, the normal development of flowers, fruit and fall colour are possible. Furthermore, a truly hardy tree shows the absence of winter kill, frost cracking, sunscald and root damage.

Extended periods of severe winter cold can develop in any given year; such severe winter weather is known as a "test winter". Severe winters can often produce results that contradict a hardiness zone map by a full zone and cause extensive damage to marginally-hardy plants, including severe foliage burn on evergreens.

SUNSCALD

Sunscald is an abiotic challenge affecting certain deciduous trees that can be traced to weather conditions, as well as the siting of a particular tree in the landscape. Also known as "Southwest injury", sunscald affects deciduous tree species with thin, smooth bark, particularly at the juvenile phase of their lifecycle.

Sunscald typically occurs in early spring when afternoon sunshine causes localized heating of the bark and vascular tissue on the southwest side of affected trees. This solar heating may be further strengthened by surrounding snow-cover which reflects incoming radiation. Once the sun sets, the temperature in this exposed area of the trunk drops rapidly causing blisters and fissures. Over time, a rather large wound can develop or the tree may be killed in extreme cases.

Certain tree species vary in susceptibility to sunscald depending on their age and associated bark characteristics. For example, juvenile hawthorn and mountain ash have smooth, thin bark that is easily damaged by solar radiation. As these species age, their bark changes in colour and texture, offering more protection against sunscald. Sunscald can be minimized on high-risk species through the use of tree guards that wrap around exposed stems, or applying white spray paint to the southwest side of the trunk in autumn.

The importance of soil conditions on tree survival cannot be overstated. Soil, the medium in which a tree's root system is found, provides the plant with water and nutrients. However, a soil's ability to deliver these components to the growing tree depends on soil properties. Soil properties can be classed as: 1. physical (e.g. water-holding capacity) and 2. chemical (e.g. pH). These characteristics of a native soil type are difficult to change and ultimately determine what tree species can thrive at a particular location.

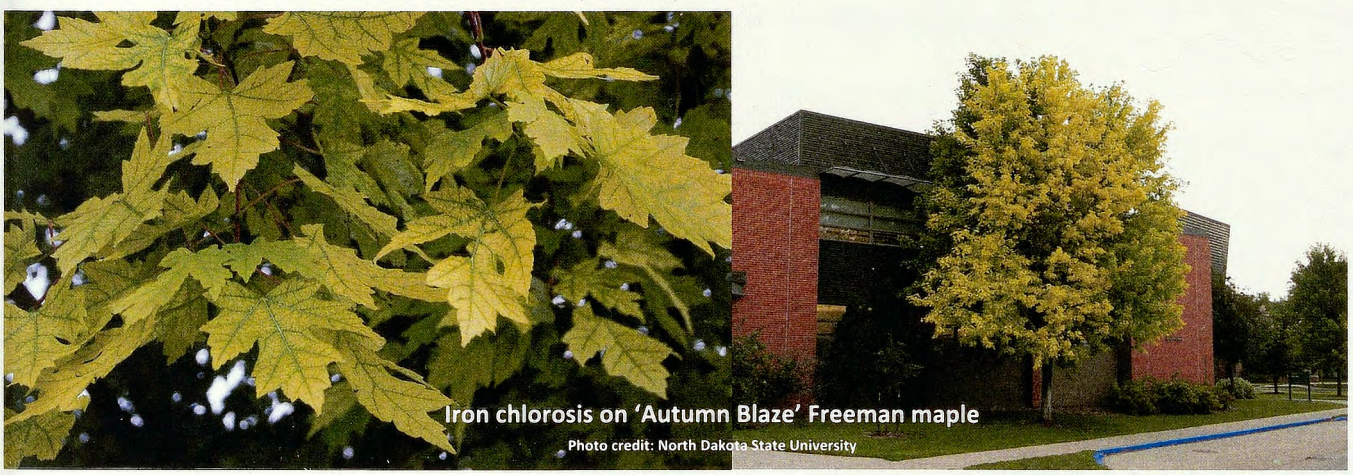
Other soil considerations include the long-term effects of road salt (see following page) and the problem of water saturation on clay soils.

LIME-INDUCED IRON CHLOROSIS

Iron chlorosis describes the response of certain tree species to alkaline soil types. At high pH levels, certain micronutrients (e.g. iron, manganese, copper) become less available to a plant's feeder roots in the soil. Trees and shrubs that are not adapted to these conditions will suffer micronutrient deficiency which is expressed in chlorotic foliage and suppressed growth. Depending on severity, foliage may range from pale green to fully yellow leaves with contrasting green veins. Foliar necrosis is also possible in extreme cases.

Iron chlorosis is best managed through proper selection of tree species for a particular locale. Parts of Alberta, Saskatchewan, Manitoba and the adjoining state of North Dakota are characterized by alkaline soil conditions (see page 8). This high pH soil limits the use of many deciduous tree species including red maple, red oak and swamp white oak as well as coniferous species such as red pine and eastern white pine. These species possess sufficient cold hardiness but lack the ability to draw up micronutrients from alkaline soils.

Temporary remediation of alkaline soil is possible through amendment with acidic peat moss, sulfur or the application of iron chelates. Chelated iron is protected from soil binding and remains available to feeder roots in the soil solution. Concentrated micronutrient solutions can be purchased, diluted with water and applied to the root zone. However, these modifications must be continued year-after-year to ensure the survival of sensitive trees.



Iron chlorosis on 'Autumn Blaze' Freeman maple

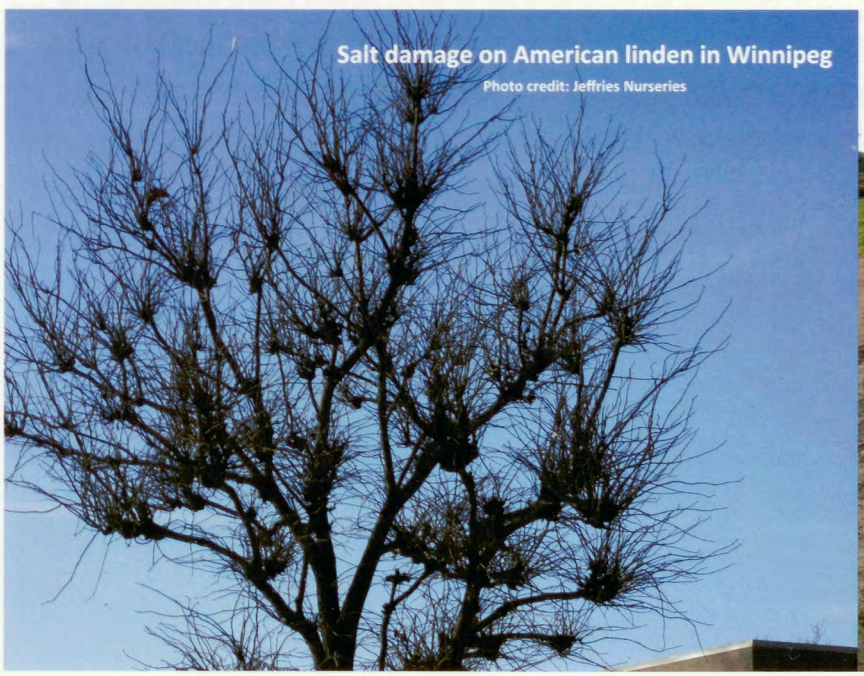
Photo credit: North Dakota State University

SALT STRESS

The damage to trees from roadside salt is a by-product of the sodium chloride salt used to make our roads more suitable for high speed traffic during the cold, icy winter months. With higher volumes and speed of traffic, trees are exposed to increasingly damaging salt effects unforeseen 50 years ago. The effects are also more noticeable as tree plantings have shifted from salt-resistant tree species (e.g. elm) to more salt-susceptible lindens, maples and oak. This change in tree planting resulted from the arrival of Dutch Elm Disease.

As sodium chloride dissolves in water, the chloride and sodium ions separate and the chloride ions are absorbed by the plant and build to toxic levels. Two mechanisms have been proposed for how salt damage takes place. Firstly, salt uptake through the roots can occur when trees are as close as 5 m (15') to the roadway or if the tree is in a depression or downhill from salt-contaminated runoff. Damage is seen when buds fail to open or developing leaves turn brown and die. Often late leaf flushing is noted after salt effects have partially dissipated following spring rains. The second and perhaps more serious damage to trees takes place from salt water spray produced along high speed throughways. Salt-laden spray causes salt accumulation on dormant twigs and buds in the canopy, resulting in tip dieback and the "witches broom" effect (see photo below). On evergreens, salt damage is seen as tip and needle browning or complete browning of the foliage with partial recovery later in the growing season. This type of damage is associated with heavy, high speed traffic and is more noticeable downwind to the source as well as on lower branches. Often a combination of soil uptake and aerial drift is at work.

There are several approaches to limiting salt damage on trees. Some effort has been made to use less salt or less harmful, but more expensive, forms of salt such as calcium chloride. In addition, urban planners can develop greater set back of trees from roadways and use more tolerant species in areas of consistent damage. Elms, *Elaeagnus* and caragana are considered most salt-tolerant; *Fraxinus*, *Quercus*, *Acer* and *Betula* moderately tolerant and the lindens least tolerant to sodium chloride damage.



Salt damage on American linden in Winnipeg
Photo credit: Jeffries Nurseries

'Silverado' hybrid olive
Photo credit: Jeffries Nurseries

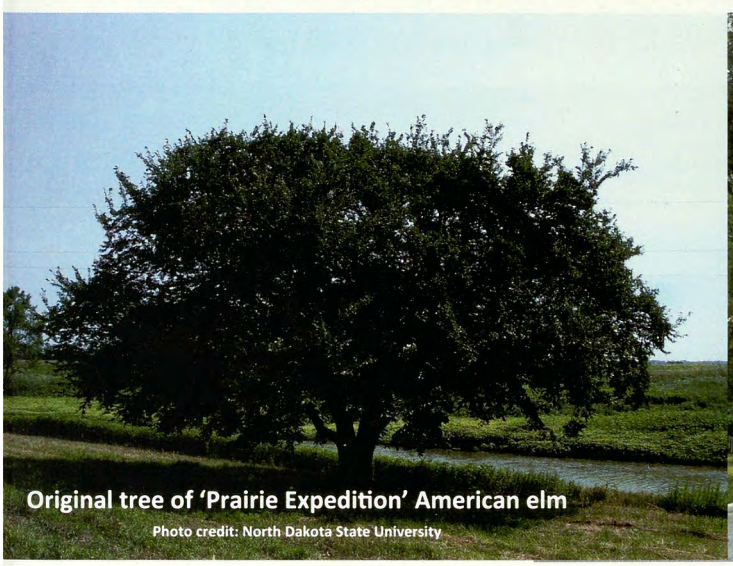
On the biotic side, the primary enemies of trees are diseases (fungi, bacteria and viruses) and insects. It should be mentioned, in passing, that some animals including rabbits and sapsuckers also inflict heavy damage on trees. Biological enemies of trees can be classed as general or specific pests. General pests have a broad host-range and are usually non-lethal (e.g. aphids, powdery mildew). Specific pests often affect only one plant species / genus / family and tend to be lethal (e.g. bronze birch borer - *Betula*, black knot - *Prunus*).

DUTCH ELM DISEASE (DED)

Dutch elm disease is a vascular wilt caused by the introduced fungal pathogen *Ophiostoma ulmi*. The fungus is efficiently vectored by both native and Asian elm bark beetles and has done catastrophic damage to urban street plantings of American elm across North America since its introduction to the continent in 1928. DED exposed the danger of monocultures in the urban forest and highlighted the need for diversity to protect against invasive species.

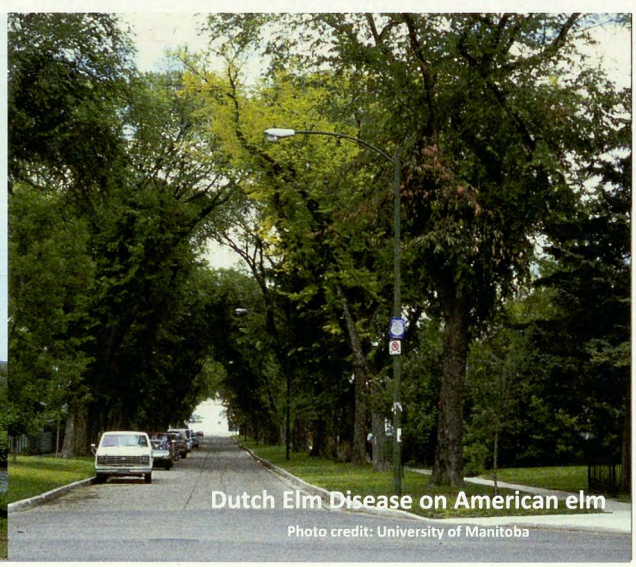
Resistance to DED exists in many of the Asian species including Japanese, Wilson and Siberian elm. DED-resistant Asian elm cultivars have been selected at the species level (e.g. 'Discovery', 'Northern Empress') or derived by interspecific hybridization (e.g. 'Accolade', 'Triumph'). There are also surviving specimens of American elm that have remained after the onslaught of DED. Some of these have proven to be truly resistant to the disease and have been cloned as cultivars (e.g. 'Prairie Expedition', 'St. Croix').

The city of Winnipeg, Manitoba has developed an effective management strategy against DED that combines surveillance (diseased trees, elm firewood), sanitation (rapid removal of diseased trees), vector control (basal insecticidal treatment on elm trees) and fungicide application. With these comprehensive efforts, Winnipeg has managed to retain the largest mature elm population in North America with close to 200,000 trees. Despite the presence of DED in the prairie region, elm is still the species of choice in many new developments due to its outstanding growth habit and tolerance to urban conditions.



Original tree of 'Prairie Expedition' American elm

Photo credit: North Dakota State University



Dutch Elm Disease on American elm

Photo credit: University of Manitoba

APPLE SCAB

Apple scab is a fungal disease affecting ornamental and fruiting *Malus*. Ornamental crabapples are of ever-increasing importance as small flowering trees in the residential landscape. However, the pathogen (*Venturia inaequalis*) can cause severe leaf blight and result in complete defoliation in susceptible cultivars. It appears that host resistance to scab may break down over time, since once-resistant cultivars (e.g. 'Thunderchild') are now severely affected in warm, wet regions of the prairies. Fortunately, new ornamental cultivars such as 'Gladiator' and 'Starlite' offer a high degree of foliar resistance to scab.

BLACK KNOT

Black knot, caused by the fungus *Apiosporina morbosa*, is named for the abundance of black fruiting bodies observed on diseased trees. Large quantities of wind-blown spores are produced by knots in the spring leading to fresh infections. The fungus appears to move systemically throughout the tree, making control by pruning difficult. Black knot afflicts native stands of common chokecherry and has also moved into the landscape targeting cultivars of the same species. Hybrids between *Prunus virginiana* and *Prunus padus* including 'Midnight' and 'Shubert Select' are even more susceptible to black knot infection. Fortunately the original 'Shubert' shows moderate tolerance to black knot, while Amur chokecherry (*Prunus maackii*) is immune to the disease. The city of Winnipeg has chosen to remove large numbers of diseased chokecherries and replace with new species.

FIRE BLIGHT

Caused by a bacteria, *Erwinia amylovora*, this disease afflicts a number of genera within the Rosaceae family including *Malus*, *Pyrus*, *Sorbus*, *Cotoneaster* and *Amelanchier*. Fire blight can become extreme under rainy, humid conditions in early summer when new growth is especially subject to infection. This disease need not be the problem it was in the past as new disease-resistant cultivars are available in some of the species which once had the most serious infection. Among flowering crabapples, the new cultivars including the Spire series, 'Gladiator', 'Starlite', 'Royal Mist' and 'Thunderchild' are all resistant to fire blight. If you plant an older cultivar such as 'Royalty' which is susceptible to fire blight, then you should be careful to use it in a limited way and to plant it where it is separated from other sources of infection and where there is good air movement.

Foliar symptoms of apple scab on 'Pink Spires'
Photo credit: Jeffries Nurseries

Common chokecherry branch infested with black knot
Photo credit: Jeffries Nurseries

BRONZE LEAF DISEASE (BLD)

Bronze leaf disease, caused by the fungus *Apioplagiostoma populi*, is a relatively recent invader into the prairie landscape. Spores are produced in spring from fruiting bodies on overwintered leaves leading to new infections. Symptoms include late-summer browning of foliage on infected branches. Bronze leaf disease spreads through the tree systemically, resulting in death within 3-5 years (see photo on page 40). BLD has had a significant impact on the use of Swedish and 'Tower' aspen in the prairie region. These once-popular, fast-growing columnar trees had been used extensively as shelterbelts and screens.

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There are also a number of specific tree pests that are insects. Some of these are invasive alien species (e.g. Emerald Ash Borer) while other insects are North American natives that especially attack introduced tree species (e.g. Bronze Birch Borer).

BRONZE BIRCH BORER (BBB)

Bronze birch borer (*Agrilus anxius*) is a wood-boring beetle, native to North America, that targets old and stressed birch trees. Adults are small, olive-brown beetles that lay eggs in bark crevices at the top of the tree. Larvae hatch and begin to bore through the phloem and cambium layers, gradually eating their way down the tree. A sure sign of BBB infestation is a birch tree with a dead top.

Many seedling specimens of paper birch show good tolerance to BBB, while the cultivar 'Prairie Dream' has been selected with above-average tolerance to the insect. However, the European and Asian birch species have little to no resistance to BBB. The best means to limit infestation by BBB across birch species is to maintain optimum tree health and rapidly remove any BBB-infested trees. The application of mulch to the root zone helps to cool the soil and lock in moisture. Ample watering during periods of summer drought will also keep birch trees healthy and stress-free.

EMERALD ASH BORER (EAB)

No insect has cast a larger shadow over North America than the invasive alien species known as Emerald Ash Borer. Probably introduced into Michigan through untreated wood crating from China, EAB has since moved steadily across our continent in all directions.

As with BBB, it is the larval form of EAB that damages the host tree. Tunneling through the phloem, these larvae rapidly cut off the plumbing connecting the tree's food producing canopy to the root system below ground. As the root system is starved the tree declines rapidly over several years. Following several larval stages, pupation takes place and shortly thereafter an adult insect emerges from the dying tree to continue the cycle of destruction.

There appears to be little EAB resistance among native ash species with complete mortality observed on infested green, black and white ash, regardless of size. Only the blue ash has shown the ability to continue to survive under attack. Manchurian ash, brought to North America from Asia, has shown a high level of resistance to the pest. This is not surprising, as the pest and host have co-evolved over a long time period in their native range in China.

It is important to note that some tree species have innate features that detract from their use in the prairie landscape. In fact, some negative features have brought an end to the use of certain plants. Issues such as seediness, suckering and fruit drop are all of concern. Other problems such as fruit drop can be mitigated by careful siting of trees in the landscape.

SEEDINESS & WEEDINESS

Trees that produce large quantities of seed can be a bane to the surrounding landscape. For species where the seed germinates at a high rate under average conditions, volunteers can emerge at a high density in unwanted places including landscape beds. Some examples of tree species that exhibit this problem include Manitoba maple, Siberian elm and green ash. Where these species are required, only male cultivars should be planted.

Invasiveness is an extreme form of weediness where unwanted plants begin to displace native species. Common buckthorn, Russian olive and common caragana are species of concern in some regions of the prairies. Sterile hybrid forms of these species such as 'Silverado' olive and 'Green Spires' caragana have real justification is such jurisdictions.

EPICORMIC SHOOTS & SUCKERS

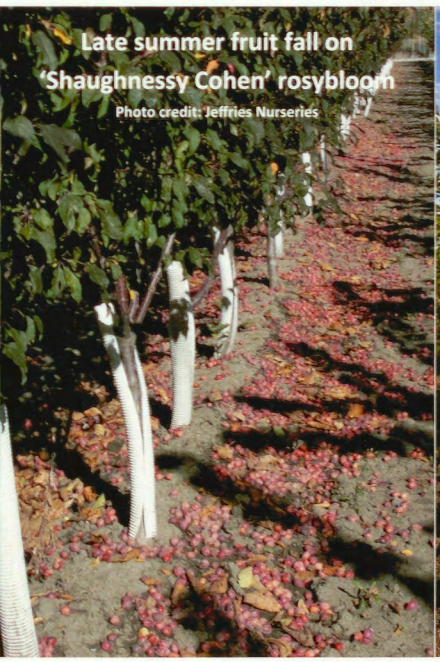
Epicormic shoots / sprouts form at the base of trees and require constant pruning. Suckering can be an issue on shallow-rooted tree species such as common chokecherry, white poplar and northwest poplar. Any soil disturbance around mature trees promotes the emergence of fast-growing shoots from the root system. Suckers are very difficult to manage and in the case of chokecherry can turn a single tree into a thicket over time.

LEAF / FRUIT / TWIG DROP

The fallen leaves of some trees are slow to degrade and must be raked and collected (e.g. bur oak, silver maple). Other trees (Ohio buckeye, butternut, black walnut, bur oak and Ussurian pear) produce copious quantities of fruit that are generally perceived as a nuisance, although they may attract wildlife. Trees that show heavy fruiting can be effectively used in parks. Willows are notorious for dropping twigs after strong winds or freezing rain.

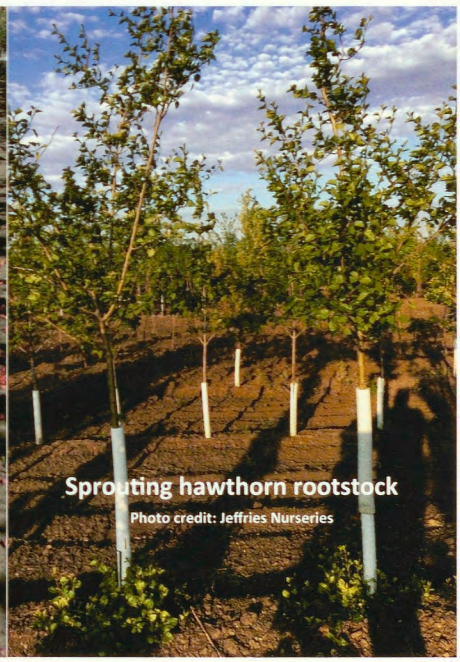
Volunteer seedlings of green ash at the front of a landscape bed

Photo credit: Jeffries Nurseries



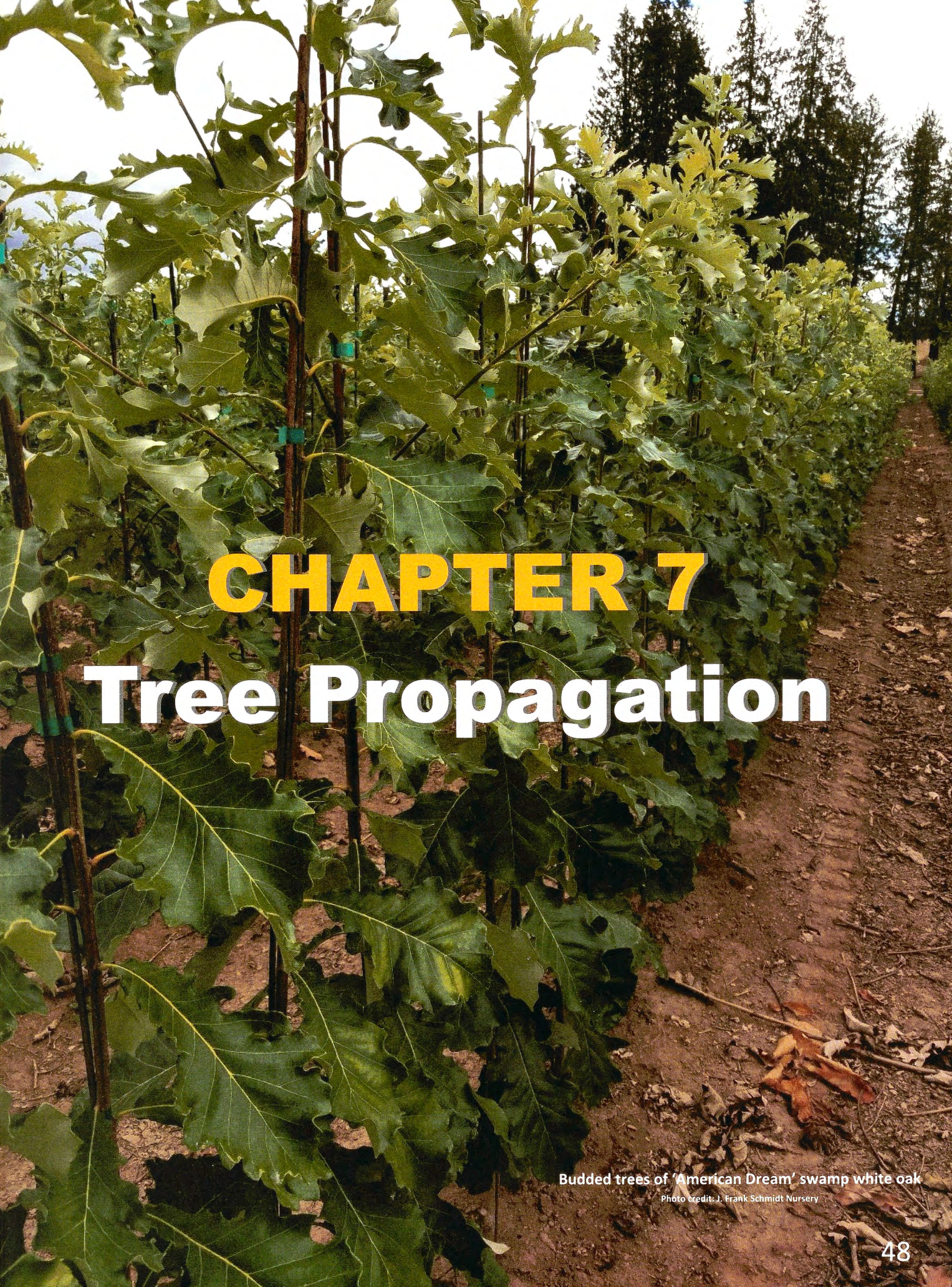
Late summer fruit fall on 'Shaughnessy Cohen' rosybloom

Photo credit: Jeffries Nurseries



Sprouting hawthorn rootstock

Photo credit: Jeffries Nurseries



CHAPTER 7
Tree Propagation

Budded trees of 'American Dream' swamp white oak
Photo credit: J. Frank Schmidt Nursery

Seedling trees provide a valuable source of diversity in our urban forests, particularly in zones 2 and 3 where choices are limited. For example, most of Winnipeg's elm forest is composed of seedling trees planted in the early 1900's. At the present time, less than 10% of deciduous landscape trees produced in North America are true seedlings. This number has fallen markedly over the last half century as nursery growers and landscape architects have migrated to cultivars in the search for consistent performance. Only a few deciduous tree genera remain that are primarily seed-propagated, including *Aesculus*, *Celtis* and *Quercus*. However, most coniferous trees are seed-propagated.

The process of tree seedling propagation begins with quality seed, collected from a desirable maternal tree or perhaps from a seed nursery of superior trees grown in isolation. In field production, most tree seeds are fall-planted in seedbeds so as to achieve natural stratification. After one or two growing seasons, dormant seedlings are lifted from the seedbed as bareroot plants and graded by size prior to sale.

Exceptions to the general statements above, include silver maple and American elm, which show immediate germination from seed produced in early summer. Furthermore, tree species with double dormancy will germinate 18 months after fall sowing or alternatively, seed that is summer-sown will germinate the following spring. Finally, some tree species such as American linden (basswood) benefit from immediate sowing at the mature green stage in early September to enable spring germination (see notes on pages 143-145).

A more recent trend in nursery production is the production of tree seedlings in soiless mix under greenhouse conditions. The controlled indoor environment, in combination with ideal moisture and fertility allows nurseries to optimize growth of tree seedlings. This is especially true for tap-rooted species such as bur oak where nurseries stratify and germinate seed in root-pruning pots to eliminate the primary tap root and promote a fibrous root system. The resulting seedling plug can be routinely upshifted to produce larger potted trees.

Many of the deciduous tree seedlings produced in nurseries today are used as rootstocks in budding including *Fraxinus*, *Malus*, *Pyrus*, *Sorbus* and *Tilia*. Others are replanted in nursery fields and allowed to size up to caliper trees for container or B&B production. Unlike budded trees, seedling replants may display slower annual growth and usually require a cutback to produce the rapid vertical growth needed for straight trunk formation. Most of the coniferous tree seedlings produced in nurseries are planted in reforestation efforts.

Any article on seedling propagation should include a discussion of seed provenance or place of origin. Nurseries have learned the value of locally-tested, proven seed sources. In an era of continental trade, it is essential that nurseries track seed provenance at least by the province or state of origin. Working with superior northern seed strains (e.g. 'Black Hills' white spruce, 'Lord Selkirk' sugar maple and 'Delta' hackberry) pays dividends in vitality and longevity of the resulting mature trees in the landscape.

Oak seedlings in root-pruning pots at Bylands Nurseries, Kelowna, B.C.

Photo credit: Bylands Nurseries

Seedling oak trees two years after cutback - J. Frank Schmidt Nurseries, Oregon

Photo credit: Jeffries Nurseries

Approximately 20% of deciduous landscape trees produced in North America at the present time are true clones originating through own-root production. Forms of own-root production include rooted cuttings and tissue culture, also known as micro-propagation. Semi-hardwood cuttings are used in the clonal production of certain tree cultivars from evergreen species such as Rocky Mountain juniper and eastern white cedar.

Cuttings are usually grouped into softwood (e.g. *Acer x freemanni*) and hardwood (e.g. *Salix pentandra*) types. A successfully rooted cutting is the result of adventitious rooting from stems that have been wounded and treated with rooting hormone to promote callus development. Under optimal conditions the callus is able to differentiate into a fully functional root system. This method of tree propagation is both rapid and economical. Rooted cuttings are completely clonal, compared to budded or grafted trees which often feature a rootstock of a different species.

Softwood cuttings are collected from actively-growing mother plants in early summer and rooted in sand or small pots of soilless medium under warm, humid greenhouse conditions. Intermittent mist is applied for several weeks after cutting to reduce transpiration and ensure proper root development. Bare-root softwood cuttings in sand are usually harvested in the fall, a process that involves shaking sand from the fibrous root system and bundling plants for winter storage. Softwood cuttings in pots or plugs can be field-planted in late summer or placed in winter storage following the onset of dormancy.

Hardwood cuttings are collected from parent trees during the winter dormancy period and typically rooted in the spring in pots of soilless medium under greenhouse conditions. Once rooted, the plants can be grown for a single-growing season to produce a plug, or transplanted into the field or a larger container. Alternatively, unrooted hardwood cuttings can be directly field planted. Rooting success from hardwood cuttings is very high for most hybrid poplars and willows due to the fast-growing nature of these tree species.

Tissue culture involves the multiplication of plantlets under sterile, *in vitro* conditions. While facilitating rapid propagation, this procedure is costly with major investments of labor and materials. However, for some tree cultivars (e.g. 'Parkland Pillar' birch) tissue culture represents the predominant means of clonal propagation. Since tissue culture occurs in an artificial environment free from solar and climatic cues, it is important that plants emerging from this system have a chance to acclimate to outdoor conditions prior to further transplant.

Rooted cuttings and tissue culture plantlets are usually field planted in spring. The preliminary year of field growth allows a measure of root development but often fails to drive vertical trunk development. For this reason, own-rooted liners often require a cutback after their first year in the field. In the growing season following cutback, these transplants can show the same rapid vertical growth characteristic of a 1 year budded whip.

'Goldspur' Amur cherry in tissue culture at Agri-forest Biotechnologies, Kelowna, B.C.

Photo credit: Jeffries Nurseries

'Autumn Blaze' Freeman maple cuttings at Bailey Nurseries

Photo credit: Jeffries Nurseries

Approximately 70% of deciduous landscape trees produced in North America at the present time originate through budding and grafting. Both methods involve the fusion of a scion from the desired cultivar with a rootstock of seedling or clonal origin. As tree cultivars are increasingly preferred by landscapers for their consistent quality, optimizing budding and grafting techniques has become essential for nursery producers.

Propagation by budding provides an opportunity for "trunk building" since the rapid first year growth is staked to form what will be the bole of the mature tree. For budding, the scion consists of a single bud borne on a small, shield-shaped piece of bark. The most common budding procedure in prairie areas has been T-budding or shield-budding. However, in west coast production, many nurseries prefer chip budding.

The timeline for tree propagation by budding can be described as follows. Once the scion is inserted into the base of the actively-growing rootstock in the summer of year 1, a healing process takes place that slowly links the new bud to the vascular system of the rootstock. In spring of year 2, the rootstock is severed just above the point of bud attachment. The new scion, fed by the established rootstock, shows rapid vertical growth in the summer of year 2, producing a branchless or lightly-branched stem of 6 feet (2 m) under ideal growing conditions. In the summer of year 3, this whip produces more secondary branches resulting in a finished tree that will be harvested bare-root in the fall.

Grafting is considered a more labor intensive operation than budding. It's nursery application is limited to deciduous tree species where budding has proven difficult (e.g. *Aesculus*). The scion in the case of grafting is a larger stem piece typically possessing two or more buds. The grafting process is usually done indoors with dormant stock in early spring. Many nurseries favour the whip & tongue method of grafting, where matching cuts in the scion and root stock allow close contact and healing of the two when pushed together.

Superior genotypes of coniferous tree species can also be produced by side-veneer grafting on potted rootstock. Cultivars of fir, spruce (e.g. 'Hoopsii'), pine and larch (e.g. 'Oasis') are presently being increased in this way. Due to the technical difficulty of grafting conifers and the slow growth of the resulting grafts, these cultivars command a premium price in the marketplace compared to their seed-grown counterparts.

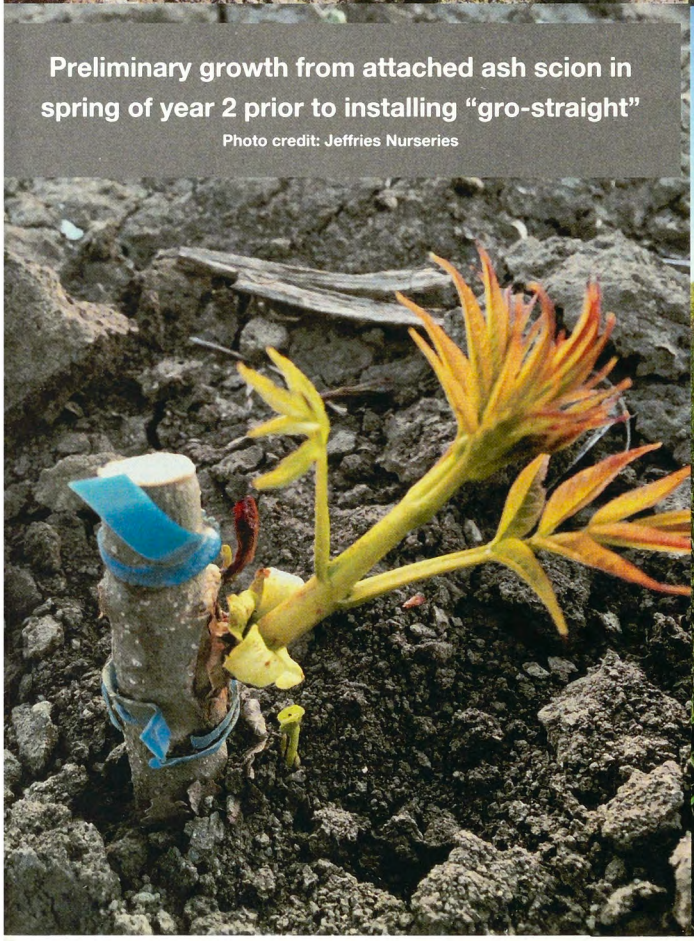
Budding and grafting provide unique opportunities to modify above-ground tree performance through the intelligent application of rootstock. A unique example is the propagation of a cultivar of northern pin oak, known as 'Shooting Star' (see page 55). Grown as a seedling in alkaline soils, northern pin oak often shows considerable foliar chlorosis. However, budding scions of 'Shooting Star' onto seedling roots of an alkali-tolerant species such as bur oak results in a unique combination tree that showcases the strengths of both species. Limited testing also indicates that silver maple rootstock imparts some chlorosis resistance to hardy red and Freeman maple cultivars.

Freshly budded swamp white oak rootstock

Photo credit: Jeffries Nurseries

Emerging bud of linden scion in spring of year 2 following rootstock removal

Photo credit: Jeffries Nurseries



Preliminary growth from attached ash scion in spring of year 2 prior to installing "gro-straight"

Photo credit: Jeffries Nurseries

Whips of white ash in fall of year 2

Photo credit: Jeffries Nurseries

Healthy bur oak seedlings (back) compared to chlorotic northern pin oak seedlings (front)

Photo credit: Jeffries Nurseries

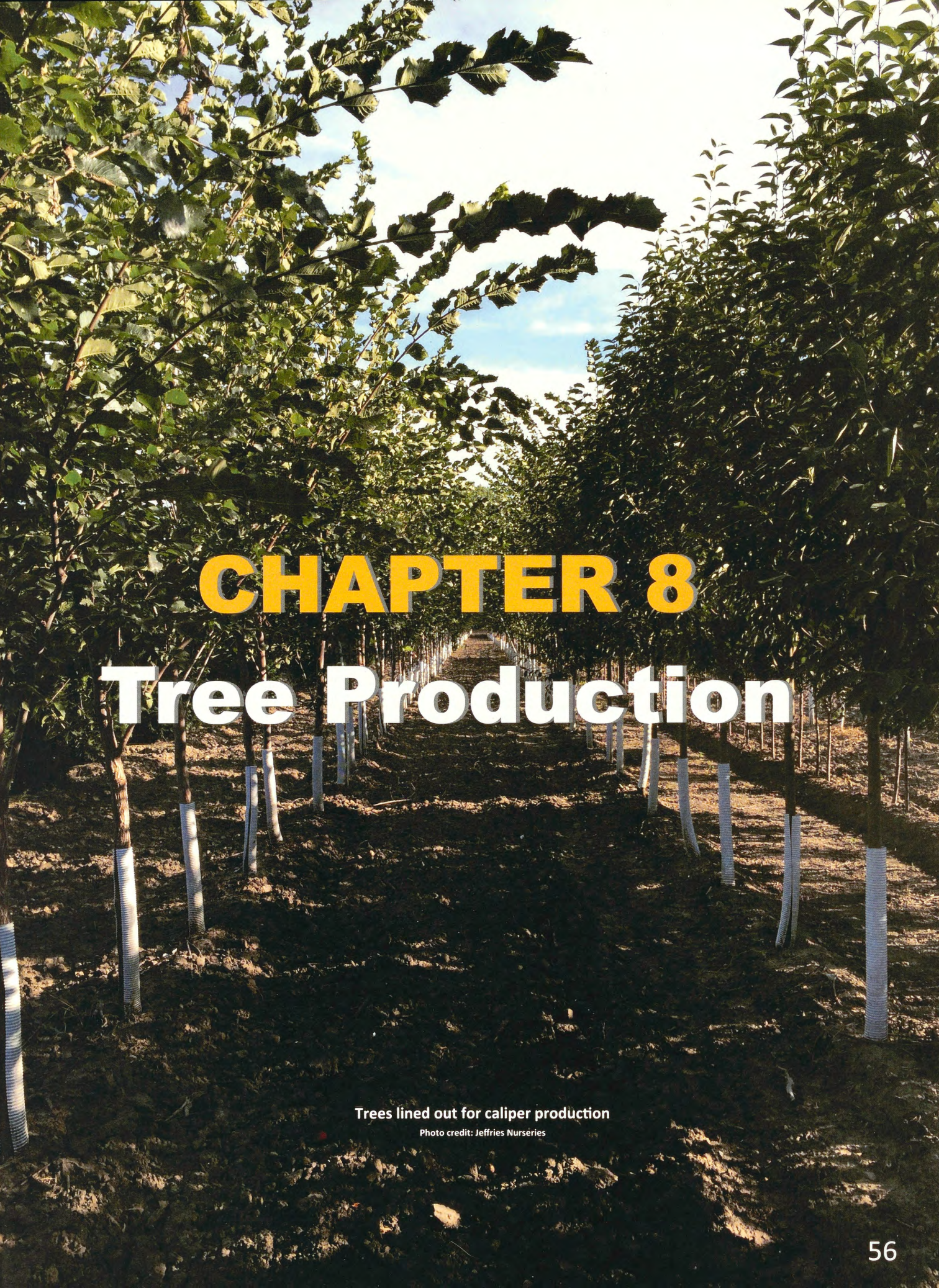
'Shooting Star' northern pin oak reminds us of the potential of budding to overcome soil-based tree challenges. Although northern pin oak is one of the most alkali-tolerant species in the red oak group, it is no match for alkaline soil types with pH higher than 8. The roots of bur oak, a native tree in Manitoba and Saskatchewan, provide a solution to this soil pH problem. Budding or grafting scions of 'Shooting Star' onto seedlings of bur oak results in a unique "combination tree" that performs very well on dry, alkaline soils.

Graft union on 'Shooting Star' oak

Photo credit: Jeffries Nurseries

Scarlet fall colour of 'Shooting Star' oak

Photo credit: Jeffries Nurseries



CHAPTER 8
Tree Production

Trees lined out for caliper production

Photo credit: Jeffries Nurseries

Bare-root production results in a field-grown, soil-free tree that is ready to serve as a "liner" for container or wire-basket production. The bare-root tree begins its journey as a seedling or own-root plantlet (from cutting or tissue culture) produced at a primary grower. The secondary grower then lines out these starter plants in field nursery rows and facilitates their growth over a 2 to 4 year period, depending on the vigor of the species and the growing method utilized. Root pruning is increasingly applied during the growing period to promote a fibrous root system and reduce unwanted top growth.

There are numerous pathways for the further development of these starter plants. In the case of seedlings for budding, plants are lined out in the spring of year 1 and may be used that same summer as rootstocks. The process of budding produces a 1 year whip or 2 year branched, bare-root tree over a 3 year production cycle. Alternatively, seedlings may be cutback in the spring of year 2 or 3 to train up a straight-trunked, own-root specimen. Mature trees (e.g. bur oak) are produced over a 3 or 4 year production cycle with the basal cutback coming in the spring of year 1 or 2 after transplanting the seedlings. For rooted cuttings and tissue culture plantlets, the basal cutback method is also used to better channel the vertical growth of the liner and produce a straight trunk.

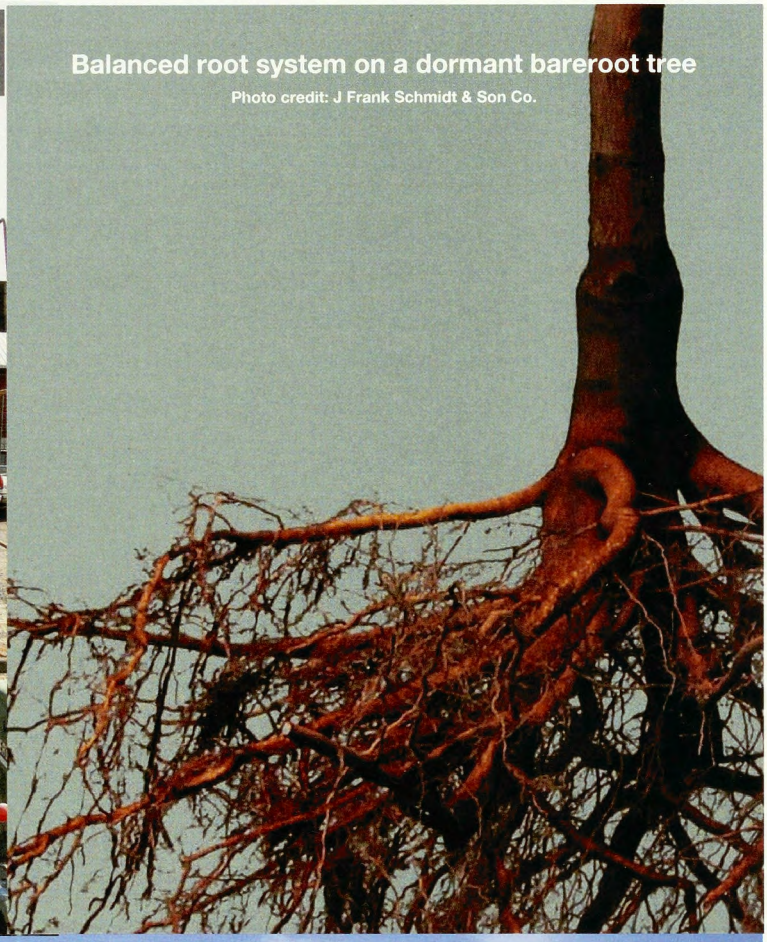
Finished bare-root trees are harvested in the spring or fall using a mechanical tree lifter with a U-shaped blade. The U-shaped blade severs lateral roots and lifts the tree from the soil while shaking any remaining field soil from the root system. These trees are quickly gathered from the field and bundled by size, prior to being held in storage until further size grading can occur. Grading involves imposing a size and quality standard on bare-root stock so as to ensure consistency in the finished product.

In locales with frequent precipitation and mild winters (e.g. Oregon), outdoor storage of bare-root stock is often implemented . This method involves covering the root system with 2-3 feet of moist sawdust. Outdoor storage works best for tree species that exhibit deep dormancy. Most cold zone nurseries practice indoor storage when overwintering bare-root trees. With this method, trees are maintained at 1 to 4 C with 98 to 100% humidity. Fumigation may be necessary to control diseases that develop under such conditions. Indoor storage removes the danger of animal or winter damage and holds the stock in a readily accessible condition for early spring potting or shipping.

Bare-root trees can be planted in landscape sites or grown on in nursery containers or field sites. However, planting of bare-root trees is limited to the dormancy period in early spring or late fall. Even at these times, bare-root trees must be handled with care at all times to avoid desiccation of roots and buds. One advantage of planting bare-root trees is the ability to assess overall root health including the presence of root defects and the position of the root flare. These pre-plant assessments have gained emphasis in recent years as a means to counteract stem-girdling roots.

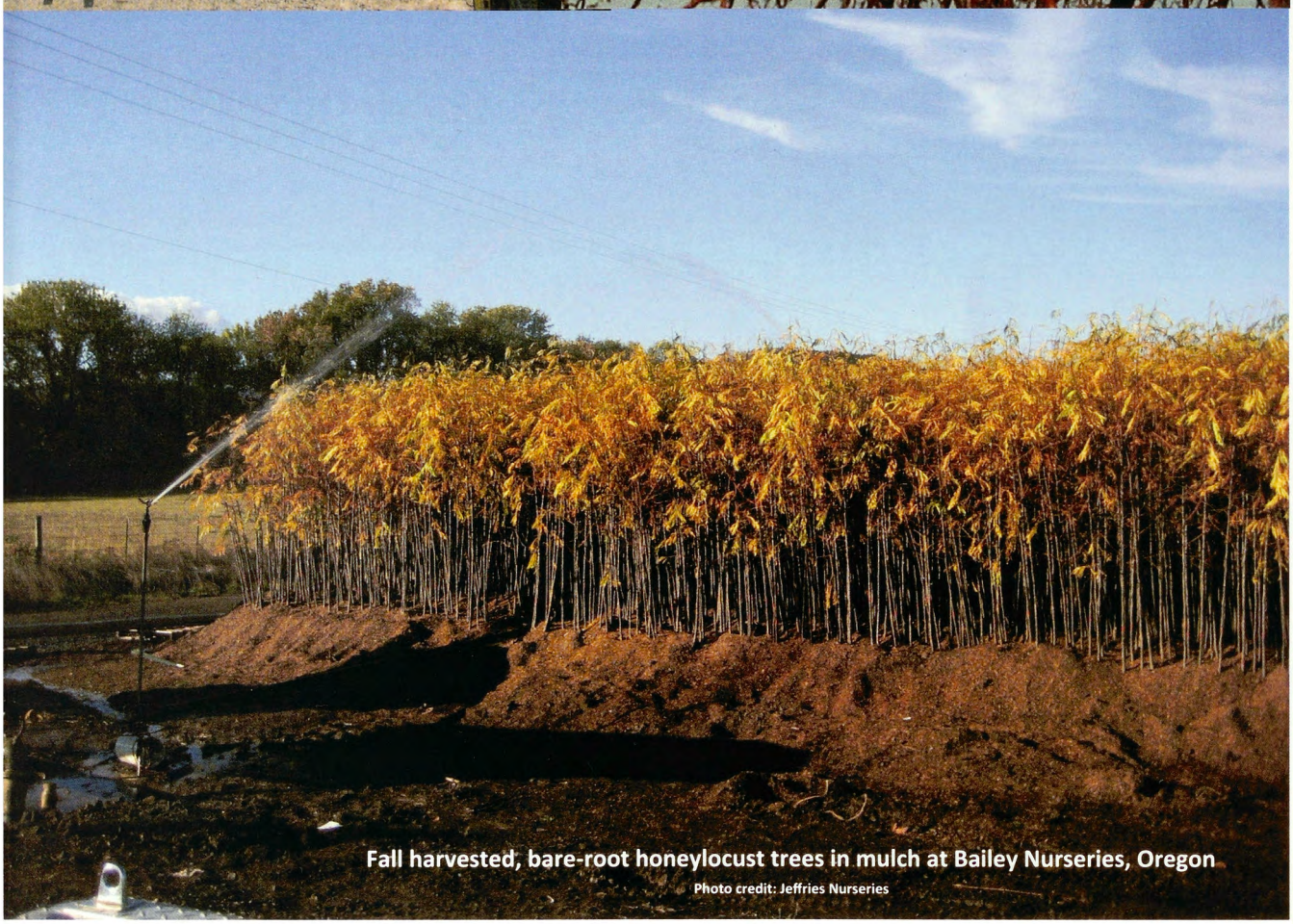
Double row tree lifter at Bailey Nurseries

Photo credit: Jeffries Nurseries



Balanced root system on a dormant bareroot tree

Photo credit: J Frank Schmidt & Son Co.



Fall harvested, bare-root honeylocust trees in mulch at Bailey Nurseries, Oregon

Photo credit: Jeffries Nurseries

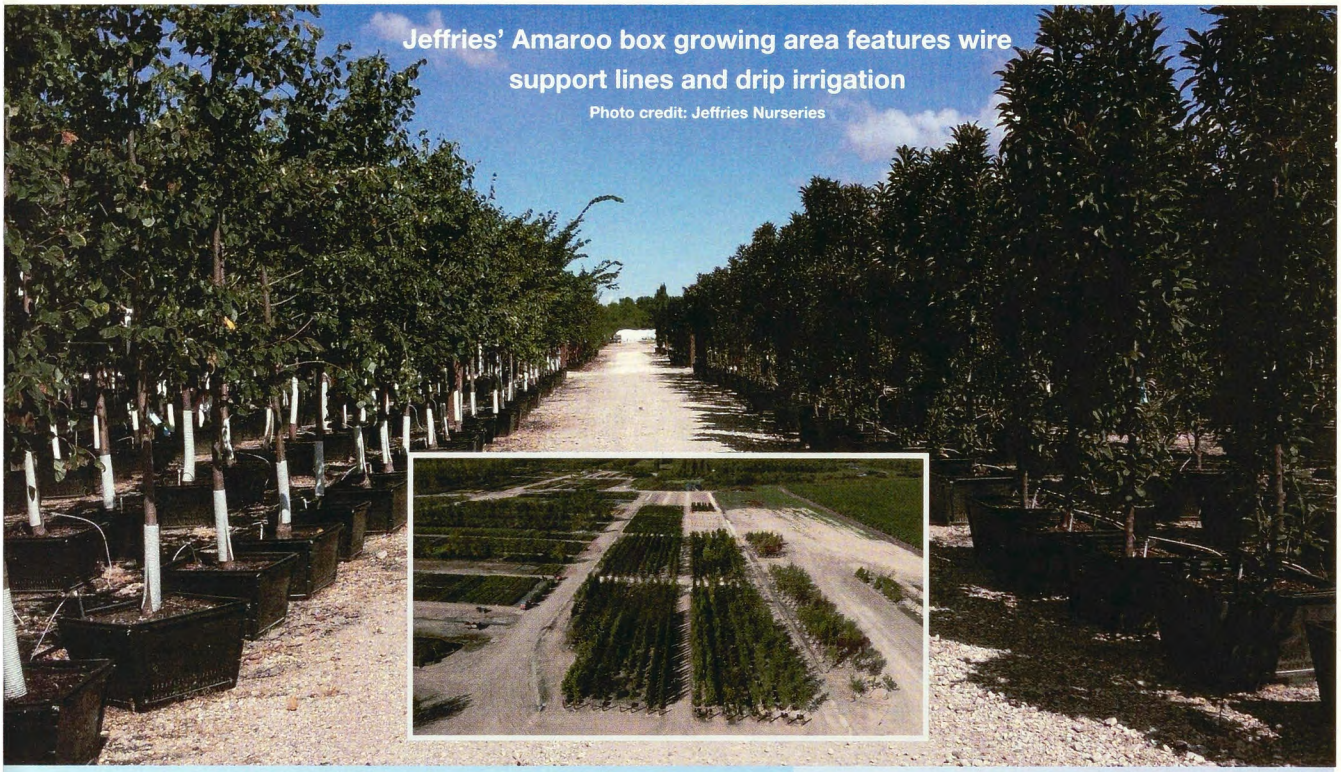
Container production of trees has become a rapidly expanding sector of modern nursery production. This form of production involves the establishment of nearly finished, field-grown, bare-root trees in plastic containers. The process of adding a fibrous, container-grown root system to a well-formed tree has been refined in recent years to ensure a quality product for retail and commercial sales. Container-grown trees are especially attractive to landscapers since they are available throughout the spring, summer and fall.

Dormant, bare-root trees from 4-8 feet (1.25 m to 2.5 m) in height are potted in appropriate-sized containers in the spring. Some root pruning is required prior to potting to ensure the tree's root system fits neatly into the circumference of the pot. For large scale producers, mechanization is necessary to deliver the soil mix quickly and efficiently to each pot. Planting depth is important and pot size, particularly pot depth, is often customized to a particular tree species. Once the pot is filled, the soil is tamped and the potted tree is transported to a nursery growing area for initial root-in under overhead watering. Evergreen trees are usually not handled bare-root but rather upshifted to larger pots as justified by top growth.

Container trees are grown under optimal conditions including ample water supply and soil-borne, slow-release fertilizer. Spacing and staking take place in mid-summer to ensure proper canopy development and, where possible, a strong central leader. In situations where the liner is a vigorous species with a fine-textured root system (e.g. silver maple), the container-grown tree can be sold 3 to 4 months after potting. However, slow-growing, course-rooted species (e.g. hackberry, oak) may require close to two growing seasons in northern zones to develop a fully consolidated root system suitable for transplanting.

The concept of pot-in-pot production is especially useful for container tree production. This system involves placing the soil-filled pot holding the tree inside a separate permanent socket pot. The socket pot is usually installed in the ground so that its lip is flush with the surface. There are a number of benefits to pot-in-pot production including: cooler temperatures in the root zone, elimination of damage from blow downs and the option for in-ground overwintering in colder climates. However, the set up costs of pot-in-pot must be considered and the potential site tested for proper soil drainage.

In recent years we have witnessed the advent of larger containers known as tree boxes. Tree boxes enable out-of-ground production of caliper trees in rigid plastic boxes that contain 40 to 125 gallons of growing mix. Trees grown in these boxes are considerably lighter in weight than B&B trees grown in field soil. Furthermore, tree boxes open up a wider timeframe of availability for deciduous caliper trees which can only be field dug during spring and fall dormancy. Many nurseries upshift their largest #10 and #15 container-grown trees into boxes to produce a finished boxed tree in one season.

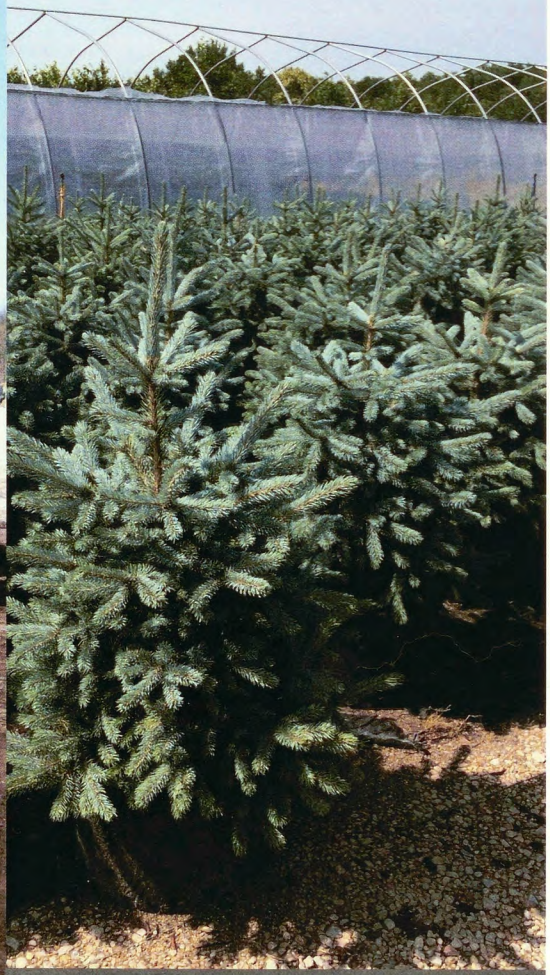


Jeffries' Amaroo box growing area features wire support lines and drip irrigation

Photo credit: Jeffries Nurseries

Bare-root tree lilac are potted into #5 pots using a hydraulically-driven auger bucket to deliver soil

Photo credit: Jeffries Nurseries



'Baby Blue' Colorado spruce in #10 pot

Photo credit: Jeffries Nurseries

The production of caliper or wire-basket trees represents the most labour-intensive method discussed in this book. Caliper trees are the largest nursery stock (2 to 8" cal.) often used on city streets and in commercial landscapes.

Caliper tree production begins with a 6-8' (2-3 m) bare-root or container-grown tree liner that is transplanted into field soil using a large, 3-point hitch planter. The planter features a wide shank that opens up a 14" planting trench in the field soil into which the roots of the tree can be placed. Once the tree is planted, field soil is channelled around the root system and packed to ensure the tree remains upright. Staking may be necessary in the first year of field production until the tree has developed sufficient caliper and proper trunk taper.

Over the next 2-4 years the transplanted tree is allowed to root out into the surrounding field soil, while developing an attractive canopy and suitable trunk diameter. This timeframe provides an opportunity for nurseries to fine-tune the canopy eliminating co-dominance and establishing proper balance in the crown. Most caliper trees are spaded when they feature a stem caliper of 2 to 4" (50 to 100 mm). Tree spading of deciduous trees generally occurs during spring (April) and fall (October) dormancy to limit the stress caused by root loss.

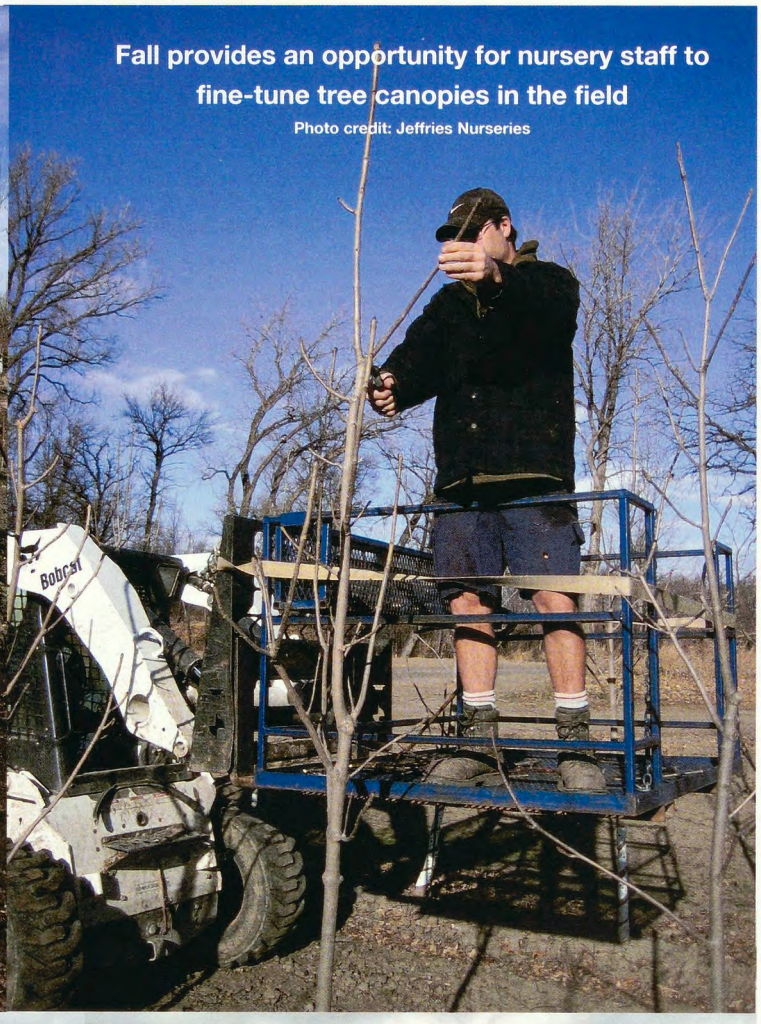
Tremendous progress has been made in the development of compact skid steer loaders and appropriate tree spade equipment. The design of wire baskets has shifted to truncated shapes that allow for improved handling and storage. The fit of wire baskets to spaded root balls is also much improved so that the old-fashioned technique of wire crimping is no longer necessary. Once dug in the field, many wire-baskets are immediately loaded on flat-bed trailers for shipping. Other trees, dug for landscape sales, can be held under irrigation during the summer months. Above-ground storage of caliper trees in wire baskets works well, provided that overhead watering is sufficient. Treated burlap liners are often used if trees are to be stored throughout the summer months. Bark mulch applied over tree root balls adds even more protection from heat and desiccation.

One concern in caliper tree production is the amount of root capture at the time of digging. Careful attention to the quality of the original liner tree as well as the size of spade at the time of digging, help to ensure the capture of a higher percentage of the root system. It is well documented that extensive root loss at the time of digging can lead to transplant shock, since a proper root-to-shoot ratio must re-establish after transplanting. For some course-rooted tree species (e.g. bur oak), there may be a benefit in field planting a container-grown liner to promote a fibrous root system early in the process. A standard recommendation is to use a larger root ball size when spading more difficult-to-transplant trees such as bur oak and Ohio buckeye.

Survival of spaded trees in the landscape is very high and the heavy root ball makes for good stability following installation. Viewpoints differ on the benefits of partial or complete removal of wire baskets at the time of planting. Our experience is that the wire basket does not significantly hinder tree establishment or reduce longevity. Nevertheless, it is important to remove any strapping or twine that could eventually cut into the growing tree trunk.

Caliper trees begin their journey as spring-planted liner trees

Photo credit: Jeffries Nurseries



Fall provides an opportunity for nursery staff to fine-tune tree canopies in the field

Photo credit: Jeffries Nurseries

Skidsteer-mounted tree spade digs tree from row

Photo credit: Jeffries Nurseries

Skidsteer transports spaded tree to tying station

Photo credit: Jeffries Nurseries

Root balls are wrapped in burlap and tied

Photo credit: Jeffries Nurseries

Basketed trees are loaded for transport

Photo credit: Jeffries Nurseries

Deciduous and coniferous trees in wire baskets must be handled with care after digging. Typically recently dug trees are transported from the field to a gravelled holding area in spring while they are still dormant. Regular overhead watering throughout the summer months promotes root growth and results in a consolidated soil ball that can be successfully shipped and transplanted at landscape sites.

Many nurseries make use of skidsteers and forklifts when loading wire-basketed trees onto flatdeck or enclosed trailers. Jeffries Nurseries pioneered the use of loading forks which are ideal for lifting and moving wire-basketed trees. These forks provide reach and angled fit to avoid damage to burlap and can be slid over the forks of any forklift or skidsteer. Tree dollies can be useful at the landscape location to move a wire-basketed tree from street side to a backyard planting site.

Depending on the time of year, wire-basketed trees are shipped in vans or on flat deck trailers. Vans are the preferred mode of transport for leafy specimens that would be very subject to wind damage. Flatbed trailers can be successfully used to move dormant and semi-dormant stock in spring. Once loaded and anchored on flat deck trailers, wire-basketed trees are often tarped to prevent bud desiccation caused by highway speed transport.

Spring-dug wire-basketed trees with consolidated root balls await shipment

Photo credit: Jeffries Nurseries

Basketed trees are shipped in vans or on flatdecks

Photo credit: Jeffries Nurseries

CHAPTER 9
Tree Planting

Planting of white ash in downtown Winnipeg, Manitoba

Photo credit: Jeffries Nurseries

There have been many changes in tree production and handling techniques over the past 35 years as container-grown tree production has moved to the forefront and compact skid steer tree spading and wire-basketing equipment has been developed in place of hand digging. Concerns have been expressed over root quality, planting depth, root flare, mulching depth and wire basket removal. At times it seems that the basics of tree hardiness, suitable placement, planting conditions (soil, fertility and moisture) have been lost in the pursuit of other issues. Tree nurseries produce thousands of trees every year and it is important that they provide quality, long-lived, healthy trees. However, tree nurseries often have little input or control in the planting process after the tree leaves their property.

Bare-root trees for container growing or field planting should have straight stems and a balanced root system. There should be no encircling roots and there should be sufficient root mass to support the crown. Many nurseries have developed equipment and procedures to prune the roots of field-grown liner trees between the first and second year of top growth. This root pruning is done in the dormant season and results in a more fibrous root system while slowing the top growth of the tree in the following year.

There have been examples of extreme root encirclement when overgrown trees have been left in small pots for several years. Many of these examples have been taken from uncared-for growing stock and do not represent "real world" growing conditions. Nurseries must upshift container stock on a regular basis and cut any circling roots around the root ball when trees are upshifted.

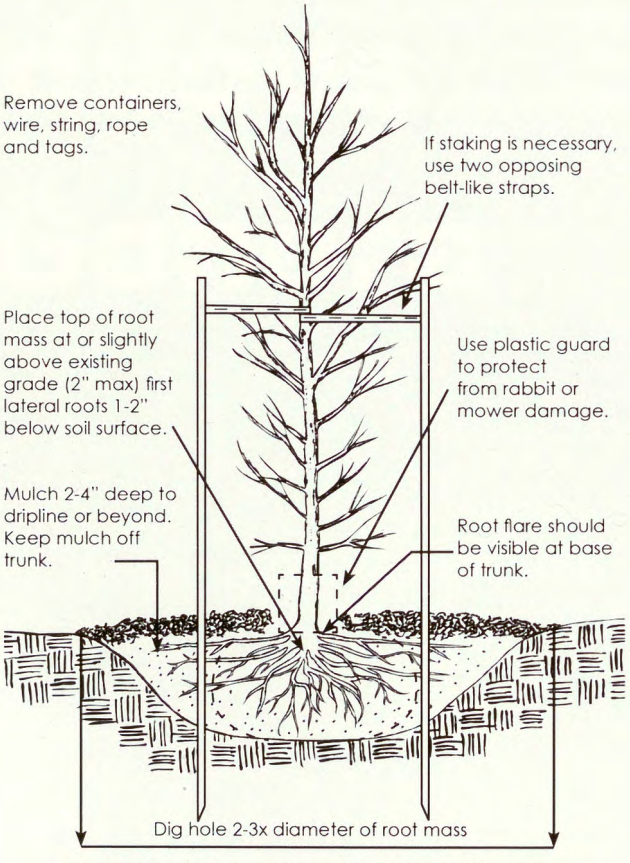
Healthy root system of a container-grown tree prior to planting

Photo credit: Jeffries Nurseries

The depth of root placement is a concern both in container/field planting of nursery trees as well as at the time of landscape installation of finished trees. Shallow planting of young stock in a nursery row can lead to frost heaving and subsequent plant damage, while on older stock it can over-expose the roots so that they are damaged in cultivation. When nursery planting is excessively deep, there is the danger that roots may develop above the root flare. Tree roots that end up too deep in wire baskets or containers, often result in trees being planted too deeply in the landscape. Ideally, the tree's root flare should be visible at the soil surface. What critics of planting depth do not realize is that the root flare, as seen in older forest trees, takes years to develop and is often not obvious in young nursery trees.

The role of the wire basket around the root ball has been hotly debated through the years since tree spading became the dominant method of digging larger trees. The question about the long term effects of leaving the wire basket in place when the tree is planted has led to people lining up on two sides. Some believe the tree's roots will not be harmed by the large wire openings and that the wire will disintegrate over time. Studies by Dr. Glen Lumis (University of Guelph) and our own transplant efforts of hundreds of trees in baskets would seem to back this up. Nevertheless, others believe the basket should be totally removed or at least the top third of the basket removed during planting in an effort to encourage healthy root growth. In truth, the soil ball of freshly dug trees, especially those with a course root system, will often disintegrate if the wire basket is removed, resulting in considerable harm to the tree. If the tree has been spring-dug and held for several months of the growing season, then the tree's root system is "consolidated" and should not be harmed by cutting off the wire basket. A solid tree root ball is a key component in reducing the effects of drought stress and withstanding the wind damage common to the northern plains and prairies.

It is recommended that all tying string be removed from the tree ball when the tree is planted or soon after. The common practise in Canadian nurseries is not to circle the stem with string when tying wire-basketed root balls. In addition, the burlap should be unfolded and cut from the top of the root ball to allow for maximum water infiltration after planting.



Guidelines for a properly-planted tree

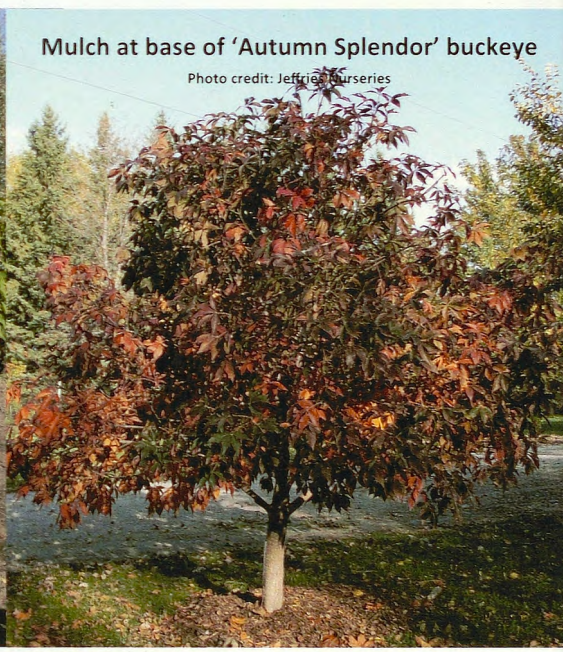
Photo credit: http://nfs.unl.edu/Tree-plantingSuccess2016.png

Tree staking with metal or wooden stakes and wire ties has been recommended to stabilize trees from wind and equipment damage. Often poorly installed staking efforts are nothing more than cosmetic and do more long-term harm than good. On many occasions we have been called to investigate sick trees only to find the original staking wire imbedded into the tree trunks. Landscapers generally do not go back to maintain their staking of trees in the long term either due to distance or the fact that they have moved on to other work. Experience has shown that an unstaked, but well-planted, tree in a wire basket or large container will often remain vertical and as healthy as a staked tree. Occasionally, newly planted trees will have to be straightened in the first year due to severe winds accompanied by heavy rainfall.

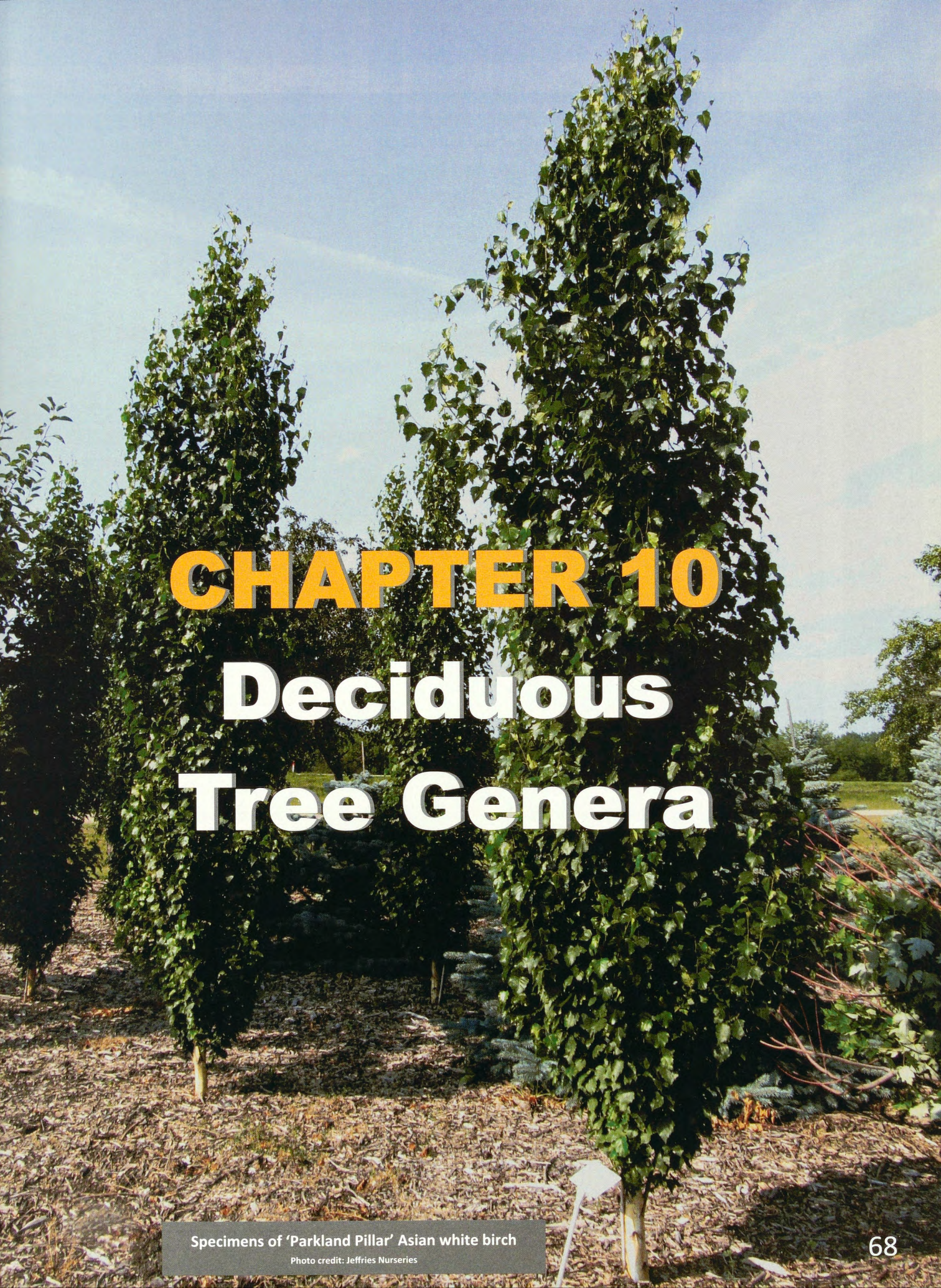
Elaborate tree harness in Europe
Photo credit: Jeffries Nurseries

Trunk protection is one of the most important aspects of tree planting. In fact, even in field plantings, trunk protection has shown value in limiting some of the damage to smaller trunks caused by rodents and rabbits. In landscape settings it is not uncommon to see tree trunks completely girdled due to the use of weed trimmers; something that tree guards would likely have prevented. We no longer recommend spiral tree guards which can cause constrictive damage to trunks. Most nurseries now use a fully expandable tree guard which opens with the growth of the trunk. These tree guards typically have a 5 year lifespan. The use of bark mulch around the tree is often effective in limiting damage from weed trimmers, but does not stop other bark damage from rodents. Bark mulch has a additional benefits including weed/grass control and moisture retention, especially on newly planted trees. Some concerns have been expressed over the depth of bark mulch, but depths of 10-15 cm (4-6") have traditionally worked well.

Tree guards on recently planted liner trees for caliper production
Photo credit: Jeffries Nurseries



Mulch at base of 'Autumn Splendor' buckeye
Photo credit: Jeffries Nurseries



CHAPTER 10
Deciduous Tree Genera

Specimens of 'Parkland Pillar' Asian white birch

Photo credit: Jeffries Nurseries

There are few tree genera more commercially important than maple in the prairie region. Despite only a single native, tree species (Boxelder) being present in the area, numerous introduced species thrive under the prevailing weather and soil conditions. They range in size from medium to large shade trees (Boxelder, Silver, Sugar) to small flowering trees (Amur, Tatarian). Maples are often recognized by their samaras which can be brilliantly coloured in the case of Amur and Tatarian maple.

Acer ginnala – AMUR MAPLE

Amur maple is a very common small tree in the prairie region. Attractive ornamental features include 3-lobed leaves with red fall colour, creamy-white flower clusters in early summer and attractively-coloured samaras. Amur maple grows naturally as a shrub, but can be tree-formed. Most Amur maples are grown from seed and include named seed strains such as 'Flame'.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Royal Crown'** (H: 20' W: 15') - alkaline-tolerant selection; purple-red fall colour; zone 2

⇒ **'Ventura'** (H: 20' W: 15') - attractive tree-form; orange-red fall colour; zone 2

Acer negundo – BOXELDER MAPLE

Boxelder maple is a native tree throughout the prairie region. It is a fast-growing species with cold hardiness and tolerance to a range of soil types. However, it can be a prolific seed producer making it a "weed tree" in many areas. Only seedless, male cultivars should be planted in landscapes.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Baron'** (H: 50' W: 30') - seedless selection of the species; zone 2

Acer platanoides – NORWAY MAPLE

Norway maple is well adapted to alkaline soils but typically lacks cold hardiness for the prairies. Many surviving landscape specimens in zone 3 show multiple stems from successive winter dieback. Some success has been had with Norway maple in southern Alberta where mild winters and reduced precipitation late in the growing season lead to improved survival. In other areas of the prairie region, Norway maple benefits from growing in sod that helps trees shutdown in the fall.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Deborah'** (H: 40' W: 30') - purple spring foliage - green summer foliage; zone 3b

⇒ **'Prairie Splendor'** (H: 40' W: 30') - purple foliage throughout the growing season; zone 4

⇒ **'Emerald Lustre'** (H: 40' W: 40') - dark green foliage; zone 4

Acer rubrum – RED MAPLE

Red maple is a slow-growing species with 3-lobed leaves that offers early red fall colour. Generally not recommended in areas known to have alkaline soil types.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Autumn Spire'** (H: 50' W: 25') - broadly columnar; from northern MN.; red fall colour; zone 3b

⇒ **'Autumn Flame'** (H: 40' W: 40') - rounded form; small leaves; red fall colour; zone 4

⇒ **'Prairie Rouge'** (H: 30' W: 20') - upright selection; alkali-tolerant; early red fall colour; zone 2

⇒ **'Red Rocket'** (H: 30' W: 15') - upright selection from northern MN.; red fall colour; zone 3

⇒ **'Scarlet Jewel'** (H: 70' W: 30') - upright selection from northern MN; crimson fall colour; zone 3

'Royal Crown' Amur maple

Photo credit: Jeffries Nurseries

'Baron' boxelder maple

Photo credit: University of Manitoba

'Deborah' Norway maple

Photo credit: Bailey Nurseries

'Prairie Rouge' red maple

Photo credit: Jeffries Nurseries

Acer saccharinum – SILVER MAPLE

Silver maple is a true shade tree with an excellent growth rate. It is recognized for its deeply-cut 5 lobed leaves which feature a unique silver underside. When proper seed sources are used, silver maple has proven cold hardy throughout zone 3, but less so in zone 2. Although seedlings of the species are traditionally vase-shaped, decurrent trees, the cultivar 'Silver Cloud' offers improved crown shape and seedlessness.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Silver Cloud'** (H: 50' W: 40') - a seedless selection with strong central leader; zone 3
- ⇒ **'Silver Queen'** (H: 50' W: 40') - oval with upright spreading branches; zone 4
- ⇒ **'Skinner's Cutleaf'** (H: 50' W: 40') - oval with deeply-cut leaves; zone 4

Acer saccharum – SUGAR MAPLE

Sugar maple is a medium shade tree with a slower growth rate but offering dense shade and unique orange-red fall colour. Seedlings from the northwestern limits of the species have been the basis for the development of cultivars (e.g. 'Inferno') and seed strains ('Lord Selkirk') with hardiness for zones 2 and 3. An excellent choice for diversity in the urban forests across much of the prairie region.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Fall Fiesta'** (H: 40' W: 30') - broadly oval; orange, red and yellow fall colour; zone 4
- ⇒ **'Inferno'** (H: 40' W: 30') - improved fall colour and cold hardiness over 'Unity'; zone 2
- ⇒ **'Northern Flare'** (H: 40' W: 30') - broadly oval; orange-red fall colour; zone 3b
- ⇒ **'September Flare'** (H: 40' W: 30') - red fall colour; NDSU introduction; zone 3
- ⇒ **'Unity'** (H: 40' W: 30') - first cultivar with prairie hardiness; yellow fall colour; zone 3

Acer tataricum – TATARIAN MAPLE

Until recently, Tatarian maple was largely superseded in the prairie landscape by its cousin Amur maple. Compared to Amur maple, Tatarian maple grows slightly larger and is naturally more tree-like in growth habit. However, Tatarian maple does not develop the outstanding red fall foliage colour of Amur maple. The release of improved cultivars such as 'Hot Wings' and 'Pattern Perfect' has led to renewed interest in this species.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Hot Wings'** (H: 25' W: 20') - outstanding red samaras retain colour all summer; zone 2
- ⇒ **'Pattern Perfect'** (H: 20' W: 20') - excellent tree form; red samaras in July; zone 2
- ⇒ **'Ruby Slippers'** (H: 23' W: 15') - excellent tree form; red samaras in July; zone 3
- ⇒ **'Rugged Charm'** (H: 23' W: 18') - improved crown form; red samaras in July; zone 2

Acer x freemanii – FREEMAN MAPLE

Freeman maple is a naturally-occurring hybrid species between red and silver maple. Many of the American cultivars of Freeman maple grow late into the fall and are not sufficiently hardy to survive the prairie winter. New germplasm developed in Manitoba is leading to cultivars with improved hardiness (e.g. 'Regal Celebration') for zones 2 and 3. See special tree story on page 73.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Autumn Blaze'** (H: 50' W: 40') - seedless; fast growing; oval; red fall colour; zone 4
- ⇒ **'Firefall'** (H: 50' W: 35') - seedless; upright oval; orange-red fall colour; zone 4
- ⇒ **'Matador'** (H: 40' W: 30') - seedless; upright oval; late red fall colour; zone 4
- ⇒ **'Regal Celebration'** (H: 40' W: 30') - seedless; alkali-tolerant; early red fall colour; zone 2

'Silver Cloud' silver maple

Photo credit: Jeffries Nurseries

'Inferno' sugar maple - fall colour

Photo credit: Jeffries Nurseries

'Hot Wings' Tatarian maple

Photo credit: Bailey Nurseries Inc

'Regal Celebration' Freeman maple - fall colour

Photo credit: Jeffries Nurseries

The rise of Freeman maple, a hybrid between red maple (*Acer rubrum*) and silver maple (*A. saccharinum*), has become one of the biggest nursery success stories in zones 4 and higher. 'Autumn Blaze' Freeman maple, which originated in Ohio at Jeffers Nursery, has been one of the most popular cultivars in this group noted for its red fall foliage. This cultivar has strong growth rate, balanced crown form, chlorosis resistance and has become the top-selling tree in zones 4, 5, 6 and 7 of the northern Midwest states. It propagates well from cuttings and its use as an own-rooted cultivar gives it an advantage over budded cultivars of somewhat similar maples. Unfortunately, 'Autumn Blaze' lacks full hardiness in zone 3 and can be marginal in northern parts of zone 4; occasional plants can be found in sheltered locations under ideal conditions. In zone 3 field production we have seen trunk sunscald, branch die back and total death of 'Autumn Blaze' maple following test winters.

The search for hardier Freeman maples suited to zones 2 and 3 began in the Lake of the Woods area of Ontario and Minnesota, less than 50 miles east of the Manitoba border. Red maples and hybrids with silver maple are found in several areas of northwestern Ontario but most of these sources are not tolerant of prairie alkaline soils. These native northern maple populations appear to be a hybrid swarm of the two parent species so they offer considerable variation for breeding and selection. Maple trees collected in these locations and grown in the higher pH soils (8.0 or more) at Portage la Prairie have shown some variation in alkali tolerance and several have maintained very green foliage over 10 years.

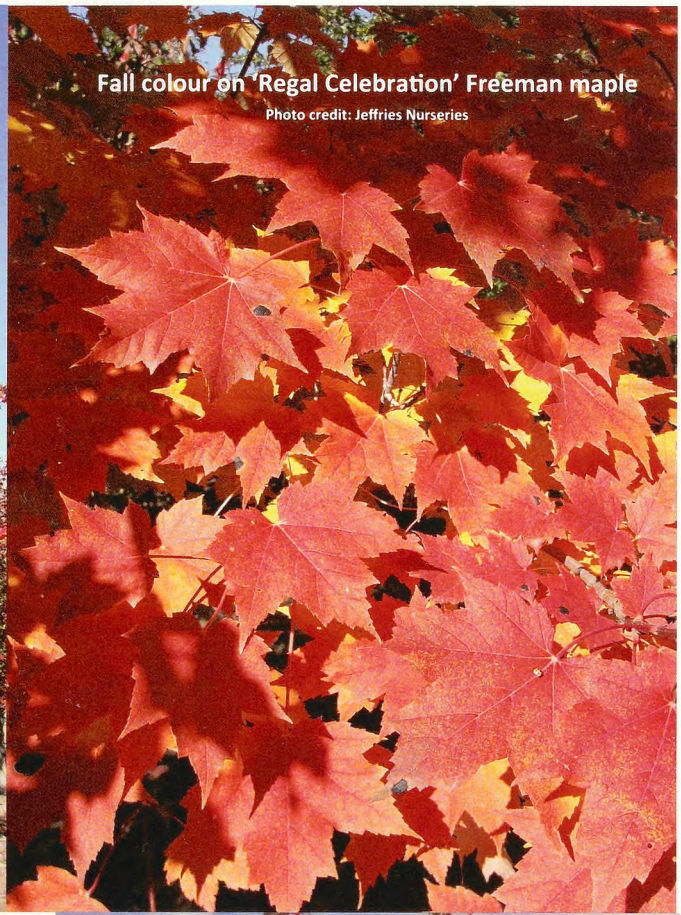
Hardiness and fall colour can be variable in these northern provenances of maple. Naturally the tree breeder is looking for a male seedless tree with a good crown and moderate growth so careful selection for fall colour and early maturity is essential. Two outstanding selections ('Prairie Rouge' and 'Regal Celebration') possess most of the required factors for growing success in the alkaline soils and cold regions of the prairie and northern states. Interestingly, there are regions in the prairies where the native soil is not as alkaline, but where winter hardiness becomes the greater concern. There are also some regional areas, such as pockets in Manitoba's Interlake region, where the alkalinity is well above 8.0 and even the most alkali-tolerant maple selections will be a challenge to grow. The ongoing work with Freeman maples will no doubt lead to better cultivars in future years and the day is coming when they will be popular trees in zones 2 and 3.

Freeman and red maple seedlings under evaluation in Manitoba

Photo credit: Jeffries Nurseries

Fall colour on 'Regal Celebration' Freeman maple

Photo credit: Jeffries Nurseries



Fall colour on 'Regal Celebration' Freeman maple

Photo credit: Jeffries Nurseries

Winter dieback on 'Sienna Glen' Freeman maple

Photo credit: Jeffries Nurseries

Fall colour on 'Autumn Blaze' Freeman maple

Photo credit: Jeffries Nurseries

Sugar maple, Canada's national flag emblem for 50 years, have been grown at the Morden Research Station since the 1930's. These early seedlings were sourced from Detroit Lakes, MN., east of Fargo, N.D., in what is clearly a zone 4 hardiness area. Seedlings grown from the superior trees at Morden formed the basis for further second generation selections and a later third generation, trees of which were planted along boulevards in Morden.

In 2005, a superior sugar maple was selected from among these boulevard seedlings and propagated by budding. In honour of national harmony, this selection was named 'Unity'. In 2014, 'Inferno' sugar maple was introduced by Jeffries Nurseries as a superior seedling with orange-red fall colour and improved winter hardiness. These northern sugar maple cultivars potentially open up the use of the species to much of zone 3 as well as sheltered sites in zone 2. Such advances help make sugar maple more of a truly national Canadian tree.

Seedlings of northern sugar maple populations were named the 'Lord Selkirk' strain in 2012 in honour of the 200th anniversary of the Selkirk settlers, who came as the first Europeans to what is now the province of Manitoba. The Lord Selkirk grant of 116,000 square miles captures the northwestern limit of the sugar maple's range and includes native populations with prairie adaptation. It is important to establish a reliable seed supply from this area that can serve the demand from prairie Canada and the northern great plains.

More recently, even more northern provenances of sugar maple have been introduced to the prairies through Philip Ronald's seed collections in Polk and Clearwater counties in northwestern Minnesota. Several hundred seedlings from these collections have been under evaluation in Portage la Prairie, Manitoba for 8 years at the time of this publication. Many of these seedlings have been sold as 'Lord Selkirk' sugar maple to communities across the prairies. One selection with outstanding red fall colour (#1515) has been made from among these seedling populations.

Sugar maple cultivars are propagated by budding on seedling rootstock that is transplanted to the field one season before budding. This well-established rootstock produces reasonable budding success especially under warm, moist, west-coast conditions. In the past, some nurseries chose to use tender sugar maple rootstock from the eastern U.S. for its improved succulence and bud-take. However, there are legitimate concerns about tree longevity when a northern cultivar from zone 3 is budded on a rootstock from zone 5.

Collecting native sugar maple in northern Minnesota
Photo credit: Jeffries Nurseries

Same seedlings after 7 years of growth in Manitoba
Photo credit: Jeffries Nurseries

Fall colour on mature sugar maple - Henderson highway in Winnipeg, MB.

Photo credit: Jeffries Nurseries

Area known as the Lord Selkirk Grant (Assiniboia)

Photo credit: Royal Society of Canada

Dormant scion of sugar maple cultivar three months after budding

Photo credit: Jeffries Nurseries

It is surprising that members of the genus *Aesculus* can thrive in zone 3, far removed from their native range in the eastern United States. One of the secrets to their success is the ability to confine the majority of their growth to the early months of summer so that trees are well prepared for the onset of winter. This genus offers unique palmately-compound leaves that are not seen in any other deciduous trees in North America.

Aesculus glabra - OHIO BUCKEYE (H: 40' W: 30' - zone 2)

Ohio buckeye is an underused species in the prairie landscape with many exceptional features. Its potential for orange-red fall colour is unmatched by other zone 3 tree species. Spring flowers are arranged in large, yellow-green panicles that contrast with palmately compound leaves. Perhaps the only negative feature of this species is its large, sometimes prickly fruit that fall to the ground in late-September. When buckeye is planted in park settings rather than boulevards or residential spaces, the fruit is no longer an annoyance but can serve as a source of food for wildlife.

Aesculus x - HYBRID BUCKEYE

Interspecific hybrids between Ohio buckeye (*Aesculus glabra*), yellow buckeye (*Aesculus flava*) and red buckeye (*Aesulus pavia*).

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Autumn Splendor'** (H: 35' W: 25') - a dense, rounded tree that has been described as *Aesculus x arnoldiana*. Released by the University of Minnesota, this cultivar has glossy green, disease-resistant foliage that turns maroon-red in fall. Outstanding panicles of flowers are produced in early summer. 'Autumn Splendor' has proven to be winter hardy in zone 3. We have observed limited fruit production on this cultivar suggesting partial sterility.

⇒ **'Homestead'** (H: 35' W: 25') - SDSU introduction with orange fall colour; zone 4

⇒ **'Lavaburst'** (H: 35' W: 15') - NDSU introduction with dense, narrow canopy; zone 3

'Autumn Splendor' hybrid buckeye
Photo credit: unknown

'Lavaburst' buckeye - fall colour
Photo credit: North Dakota State University

The Speckled alder (*Alnus incana*) is native throughout the prairie region but has not been commercialized. Manchurian alder (*Alnus hirsuta*) represents a new genus for the prairie region. Evaluation work with Manchurian alder at NDSU has led to the release of a superior clone cultivar known as 'Prairie Horizon'.

Alnus hirsuta **'Harbin' - 'PRAIRIE HORIZON' MANCHURIAN ALDER (H: 30' W: 20' - zone 2)**
In addition to its rapid growth and outstanding drought tolerance, 'Prairie Horizon' features unique olive-green bark and attractive summer foliage. Purple spring catkins are followed by clusters of brown, cone-like fruit that add interest to the tree throughout winter. 'Prairie Horizon' is best described as a medium-sized tree with an upright, oval form.

A unique feature of alder is its ability to fix atmospheric nitrogen into plant-available forms in the soil. This property enables 'Prairie Horizon' to perform well in nutrient-poor soils. However, an inherent weakness to this species is its susceptibility to sap-sucker bird damage which can be disfiguring and lethal. One mode of prevention for sap-sucker damage is to install a large diameter stake beside the trunk, which will often disrupt the bird's feeding pattern as it makes it rotation around the circumference.

'Prairie Horizon' Manchurian alder
Photo credit: North Dakota State University

'Prairie Horizon' - foliage
Photo credit: North Dakota State University

Betula papyrifera - PAPER BIRCH

Paper birch is a native tree with a range that covers much of Canada's boreal forest region. It has been widely planted as an ornamental tree due to its striking white bark. Site selection in the landscape is a crucial consideration when using paper birch in the dry regions of the prairies. Drought-stressed specimens are susceptible to Bronze Birch Borer (BBB).

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Chickadee'** (H: 50' W: 25') - an upright selection from Alberta; zone 2

⇒ **'Prairie Dream'** (H: 50' W: 35') - a stress-tolerant selection from NDSU; zone 2

Betula nigra - RIVER BIRCH

Native in eastern North America, river birch can be found as far west as Eau Claire, WI. This species offers outstanding shaggy bark and the best resistance to Bronze Birch Borer.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Northern Tribute'** (H: 35' W: 30') - western North Dakota seedling selection from the largest tree of this species observed in the upper Northern Plains.; zone 4

Betula pendula - CUTLEAF WEEPING BIRCH

Weeping birch is a European-native that was brought to North America for its unique cascading crown. Cutleaf, green foliage and white bark are other desirable features. However, cutleaf birch is highly susceptible to Bronze Birch Borer when stressed in the landscape.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Laciniata'** (H: 40' W: 25') - full sized weeping tree; attractive white bark; zone 2

Betula platyphylla - ASIAN WHITE BIRCH

Asian white birch is a relatively recent addition to the prairie palette of tree species. It features attractive beige-white bark and golden fall colour in late fall. Drought-stressed specimens are susceptible to Bronze Birch Borer.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Dakota Pinnacle'** (H: 30' W: 12') - narrow pyramidal selection; zone 2

⇒ **'Parkland Pillar'** (H: 30' W: 9') - columnar selection; zone 2

Betula populifolia - GRAY BIRCH

Native to eastern North America, the gray birch is highly resistant to Bronze Birch Borer.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Whitespire Sr.'** (H: 40' W: 25') - pyramidal selection; zone 4

Betula tianshanica - TIANSHAN BIRCH

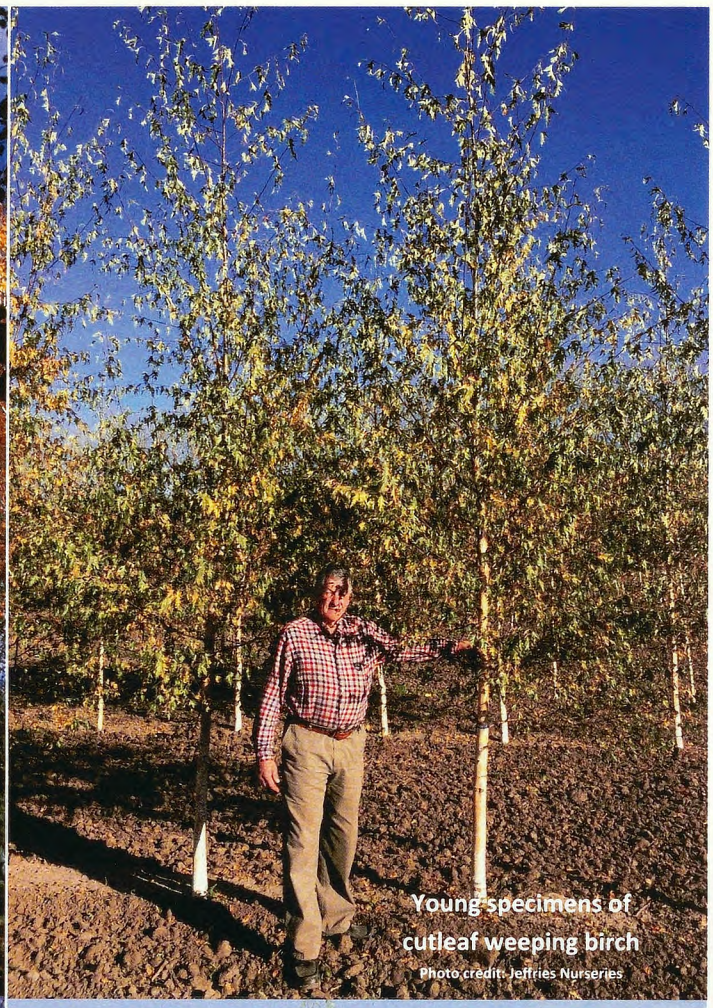
Summer foliage is of high quality without blemishes resulting from birch leaf miner or leaf spot. During summer drought conditions, 'Emerald Flare' exhibits no foliar stress symptoms such as leaf scorch or early leaf drop which is seen on many other birch species.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Emerald Flare'** (H: 30' W: 12') - narrow pyramidal selection from NDSU; zone 3b

Fall colour on 'Prairie Dream' paper birch

Photo credit: North Dakota State Unviersity



Young specimens of cutleaf weeping birch

Photo credit: Jeffries Nurseries

Exfoliating bark on 'Northern Tribute' river birch

Photo credit: North Dakota State Unviersity

'Emerald Flare' Tianshan birch

Photo credit: North Dakota State Unviersity

'Parkland Pillar' Asian white birch (*Betula platyphylla* 'Jefpark') is perhaps the most distinctive new birch cultivar in a generation. In an age when smaller yards call for compact plant materials, this columnar tree can play a distinctive accent role and requires a very small footprint in which to make an architectural impression.

This cultivar was discovered as a variant among tissue-cultured trees of 'Dakota Pinnacle' birch cultivar in a field at Parkland Nurseries and Landscape Services in Red Deer, Alberta. It has been commercialized by Jeffries Nurseries and also introduced in the U.S. under Bailey Nurseries' First Editions brand. The plant is genetically stable and has been propagated by tissue culture and occasionally by rooted cuttings. It forms a dense columnar tree with dark green foliage and golden fall colour. The bark turns white at an early stage and plants at 6 years of age are about 1 meter (3') wide and 5 meters (16') tall.

'Parkland Pillar' is not resistant to bronze birch borer or leaf miner so it is recommended to use it as an accent tree rather than a dense hedge planting which would place stress upon the trees. With adequate moisture and mulching we have observed good success in the prairie landscape. 'Parkland Pillar' shows the same upright form as Swedish aspen which has been ravaged by Bronze Leaf Disease in the eastern prairies.

Columnar form - 'Parkland Pillar' Asian white birch

Photo credit: Jeffries Nurseries

Fall colour on 'Parkland Pillar' Asian white birch

Photo credit: Jeffries Nurseries

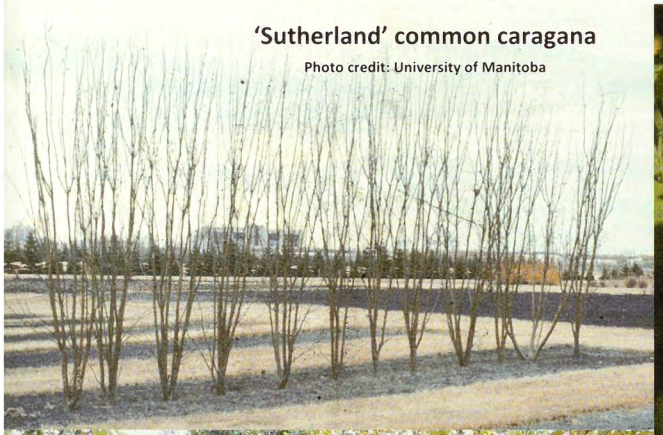
Caragana arborescens - COMMON CARAGANA

With desirable features including drought and salt tolerance, common caragana is one of the toughest plants that can be grown in the prairies. Caragana was used extensively by early settlers to establish primary shelter in grassland areas. Long regarded as a shelterbelt shrub, refined selections of common caragana have enabled it to gain new status as a small tree in zones 2 and 3. There are many practical sites in prairie cities for caragana, including roadsides and interchanges.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Sutherland'** (H: 20' W: 8') - developed decades ago in Saskatchewan, can be grown as an attractive privacy screen; zone 2.

⇒ **'Green Spires'** (H: 12' W: 8') - offers attractive upright form, pest-free foliage, yellow spring flowers and most importantly fruitlessness; zone 2.



'Sutherland' common caragana
Photo credit: University of Manitoba

Common caragana flowers
Photo credit: University of Manitoba

'Green Spires' hybrid caragana
Photo credit: Jeffries Nurseries

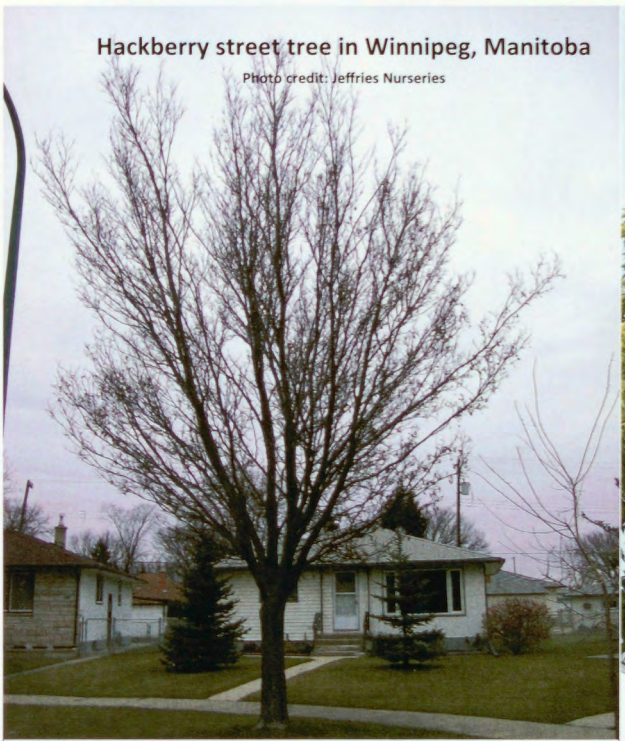
'Green Spires' - foliage
Photo credit: Jeffries Nurseries

Celtis occidentalis - HACKBERRY

Hackberry is an underused shade tree in the prairie region and represents an excellent choice for communities in the eastern prairies seeking to enhance diversity. Hackberry is a durable species with tolerance to alkaline soils and urban stresses. In addition to golden fall colour and tiny purple fruit, hackberry displays rough corky bark that can contribute to winter value. Although a member of the elm family, hackberry is immune to Dutch Elm Disease.

'Delta' hackberry represents a seed strain sourced from the native population on the south shore of Lake Manitoba. These seedlings have consistently proven winter hardy throughout zone 3 and represent the best adapted material for prairie landscapes. As with any seed-propagated species, knowing the provenance is crucial when sourcing planting material at the northern limits of a species.

The columnar cultivar 'Prairie Sentinel' was introduced by J Frank Schmidt Nurseries in Oregon. Sourced in Kansas, 'Prairie Sentinel' survives in southern Manitoba but shows reduced growth rate and some winter damage. It should be a good cultivar for zone 4.



Hackberry street tree in Winnipeg, Manitoba
Photo credit: Jeffries Nurseries

Hackberry fruit in late summer
Photo credit: University of Manitoba

Hackberry
Photo credit: Bailey Nurseries Inc.

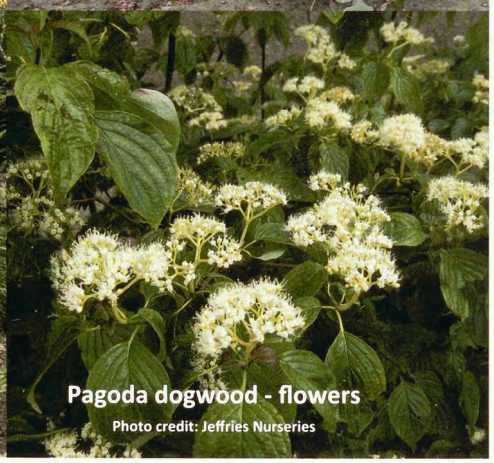
Cornus alternifolia - PAGODA DOGWOOD

Pagoda dogwood represents one of those unusual species that straddles the dividing line between "tree" and "shrub". Pagoda dogwood can reach a mature height of 20 feet (6 m) but is often void of a single dominant trunk, tending rather to show a clump-like habit. Native to southern Manitoba, this dogwood is found as far north as Riding Mountain National Park and along the Pembina escarpment. It is generally an understory tree, occurring on well-drained soils. It produces unique horizontal branches giving it a distinct pagoda appearance. In addition to its unique form, pagoda dogwood produces fleecy, white flower clusters in late spring that are followed by blue-black fruit in the fall.

In recent years, hardy seed strains of pagoda dogwood have been established from native Manitoba populations. Proper provenance should allow this species to thrive in zones 2 and 3. The cultivar 'Golden Shadows' offers golden variegated foliage but has not been properly tested in the prairie region.

Pagoda dogwood - summer form
Photo credit: Bailey Nurseries Inc.

Pagoda dogwood - fall colour
Photo credit: Jeffries Nurseries



Pagoda dogwood - flowers
Photo credit: Jeffries Nurseries

Crataegus x mordenensis - MORDEN HYBRID HAWTHORN

Two hawthorns introduced from the Morden Station have become widely commercialized in the nursery industry. 'Toba', introduced in 1949, is a hybrid of native fleshy hawthorn (*Crataegus succulenta*) with the southern cultivar 'Paul's Scarlet'. The hybrid retains some of the pink, double-flowered characteristics of the 'Paul's Scarlet' parent and some of the hardiness of the native parent. In our growing fields we have consistently seen winter kill and stem damage on 'Toba' such that few if any trees are harvestable. Occasionally 'Toba' trees are found in zone 3 landscapes, but the tree really performs best in zone 4.

'Snowbird', a second generation seedling of 'Toba' hawthorn, is a full zone hardier and retains double, white flowers and shiny green foliage. This cultivar was introduced in 1969 by the Morden Research Centre. 'Snowbird' has good crown form and produces very little fruit so it is not a messy tree. It has become the most important hawthorn cultivar in northern zones 3, 4, and 5. It is widely grown and although not always budded on northern understock such as *C. arnoldiana*, it has generally thrived throughout most of zone 3 and in many areas of zone 2.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Crimson Cloud'** (H: 15' W: 15') - English hawthorn; bright red flowers; zone 4
⇒ **'Snowbird'** (H: 20' W: 15') - Morden hybrid; double, white flowers; zone 2
⇒ **'Toba'** (H: 20' W: 15') - Morden hybrid; pink flowers; zone 3b

'Snowbird' hawthorn - flowers
Photo credit: Jeffries Nurseries

Elaeagnus angustifolia - RUSSIAN OLIVE (H: 20' W: 20')

Russian olive is an introduced species that grows as a small tree or large shrub. Desirable ornamental features include silver foliage, fragrant yellow flowers and peeling, shaggy bark. Furthermore, Russian olive is an excellent xeriscape plant with very low water requirements. It also features salt tolerance that make it an excellent candidate for high speed boulevards. The major downside to Russian olive has been its ability to naturalize in areas outside of the landscape. Although likely not described as invasive in the prairie region, its seediness and aggressiveness are undesirable.

Elaeagnus x - HYBRID OLIVE

Interspecific crosses are possible in the genus *Elaeagnus* and can be valuable in terms of producing seedless hybrids. One unique hybrid combination is a cross between wolf willow (*Elaeagnus commutata*) and Russian olive (*Elaeagnus angustifolia*). Most recently, research in North Dakota has lead to the development of a seedless selection known as 'Silverado'.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Silverado'** (H: 10' W: 10') - medium-sized shrub with pyramidal form; silver-gray foliage and limited suckering; seedless (female sterile); tolerant of salt and drought; zone 2

Russian olive - foliage & flowers
Photo credit: Bailey Nurseries Inc.

Russian olive - mature bark
Photo credit: Bailey Nurseries Inc.

'Silverado' hybrid olive
Photo credit: Jeffries Nurseries

Recognized for their tolerance to dry, alkaline soils and urban stresses, the ash genus (*Fraxinus)* continues to be a very significant deciduous tree group in parts of zones 2 and 3. However, ash has been overplanted in many urban forests and concern abounds about Emerald Ash Borer, an invasive alien insect species, that has done much damage to native stands of ash across the eastern half of the United States and continues to move west.

Fraxinus americana - WHITE ASH

White ash has similar foliage to the native green ash, but with thicker stems, excurrent habit and unique purple fall colour. White ash is resistant to cottony psyllid, an insect pest which deforms the leaves of certain ash species. This species is susceptible to Emerald Ash Borer but may still be relevant in the western prairies where stands of native ash are limited and colder winter temperatures may restrict the spread of EAB.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Nobility'** (H: 50' W: 30') - upright, oval canopy; early purple fall colour; zone 2
- ⇒ **'Northern Blaze'** (H: 50' W: 30') - upright, oval canopy; yellow fall colour; zone 2
- ⇒ **'Tuxedo'** (H: 40' W: 30'); broad oval canopy; purple fall colour; zone 4

Fraxinus mandschurica - MANCHURIAN ASH

Manchurian ash is an introduced species from Asia with a dense oval canopy, large compound leaves and olive-green stems. Recent studies in the U.S. have shown that Manchurian ash is highly resistant to Emerald Ash Borer. When grown on green ash rootstock Manchurian ash has performed well in zones 2 and 3, however frost cracking can be an issue especially where wet conditions persist into late fall.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Mancana'** (H: 40' W: 30') - rounded canopy; seedless; resistant to EAB; zone 3

Fraxinus nigra - BLACK ASH

Black ash has been relegated to the bottom of the list of ash species for the prairies. As a moisture-loving tree native to eastern North America, black ash has been challenged by lengthy periods of drought. It has also proven to be very susceptible to cottony psyllid.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Fall Gold'** (H: 50' W: 25') - upright, oval canopy; golden fall colour; zone 2

Fraxinus pennsylvanica - GREEN ASH

Green ash is considered by many to be the best species of this genus for the harsh growing conditions of the prairie region. It is typically among the top three species in abundance in most prairie communities. Many variable seedlings were planted in the past, but new seedless cultivars offer improved form and consistency. This species is susceptible to Emerald Ash Borer, but may still be relevant in the western prairies.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Foothills'** (H: 50' W: 35') - open, rounded canopy; yellow fall colour; zone 3
- ⇒ **'Patmore'** (H: 50' W: 35') - open, rounded canopy; yellow fall colour; zone 3
- ⇒ **'Prairie Spire'** (H: 50' W: 30') - upright, oval canopy; yellow fall colour; zone 2
- ⇒ **'Summit'** (H: 50' W: 30') - wide oval canopy; yellow fall colour; zone 3
- ⇒ **'Trojan'** (H: 50' W: 30') - upright, oval canopy; yellow fall colour; zone 2

Fraxinus x - HYBRID ASH

Hybrid ash cultivars, including 'Northern Gem' and 'Northern Treasure', were derived from an interspecific cross between the native Black ash and the exotic Manchurian ash. These cultivars possess the dense canopy of Manchurian ash, but show excellent vigor, thicker stems and larger leaflets. Unfortunately, hybrid ash trees are susceptible to cottony psyllid which has limited their usefulness in Saskatchewan and Alberta.

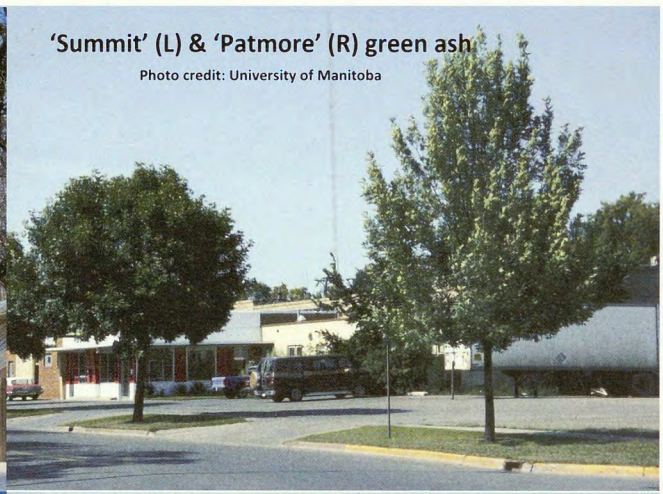
CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Northern Gem'** (H: 50' W: 40') - rounded canopy; golden fall colour; zone 3

⇒ **'Northern Treasure'** (H: 50' W: 35') - oval canopy; golden fall colour; zone 3

Green ash street planting - Winnipeg

Photo credit: Jeffries Nurseries



'Summit' (L) & 'Patmore' (R) green ash

Photo credit: University of Manitoba

'Prairie Spire' green ash

Photo credit: Bailey Nurseries

'Northern Treasure' hybrid ash

Photo credit: Jeffries Nurseries

The development of new tree cultivars takes on many forms. New selections may be the result of interspecific hybridization (see chapter 4). Alternatively, we can hunt for improved genotypes in seedling populations grown from superior trees. Such is the story of 'Nobility' white ash, a new shade tree selection with prairie cold hardiness and outstanding purple fall colour. In the paragraphs below, Philip Ronald describes the circumstances that lead to the discovery of the seed source and ultimately the selection of this cultivar.

Back in December 2002, my wife and I were travelling to southern Ontario from Manitoba. Our scenic route had us travelling east through Minnesota on highway 2 to Superior, Wisconsin then south on Highway 53 towards Eau Claire, Wisconsin. A careful examination of the North American range map for white ash (*Fraxinus americana*), revealed several isolated native population of the species in northwestern Wisconsin, including Washburn county. This was confirmed by an online search of the Wisconsin State Herbarium which referenced five findings of white ash throughout the county.

We pulled off the highway beside a forest that contained a mixture of deciduous trees including ash. Were they green ash or white ash? My goal was to locate a superior female white ash tree with seed set that could serve as a genetic base for future evaluation. I found such a tree but to my dismay it was nearly limbless 5 meters up from ground level. With a bit of effort I managed to pull myself into the canopy to several of the branches bearing seed. Approximately 200 seeds were collected along with several dormant branches in order to confirm species identity.

Those precious seeds made their way back to Manitoba where they were immediately stratified in view of spring germination in the greenhouse. The resulting seedlings were field planted in 2004 near Portage la Prairie, Manitoba. We made our first comparisons among the white ash seedlings on the basis of fall colour in September of 2006. The seedling trees were now three years old, many reaching heights of 6 to 8 feet. Each seedling was rated for cold hardiness, vigour and fall colour in 2006, 2007 and 2008. One seedling stood out as superior to the others for early purple fall colour, combined with an excellent growth rate and cold hardiness. After further evaluation, large-scale propagation of the selection began in 2010. The name 'Nobility' was chosen for the royal purple fall foliage colour.

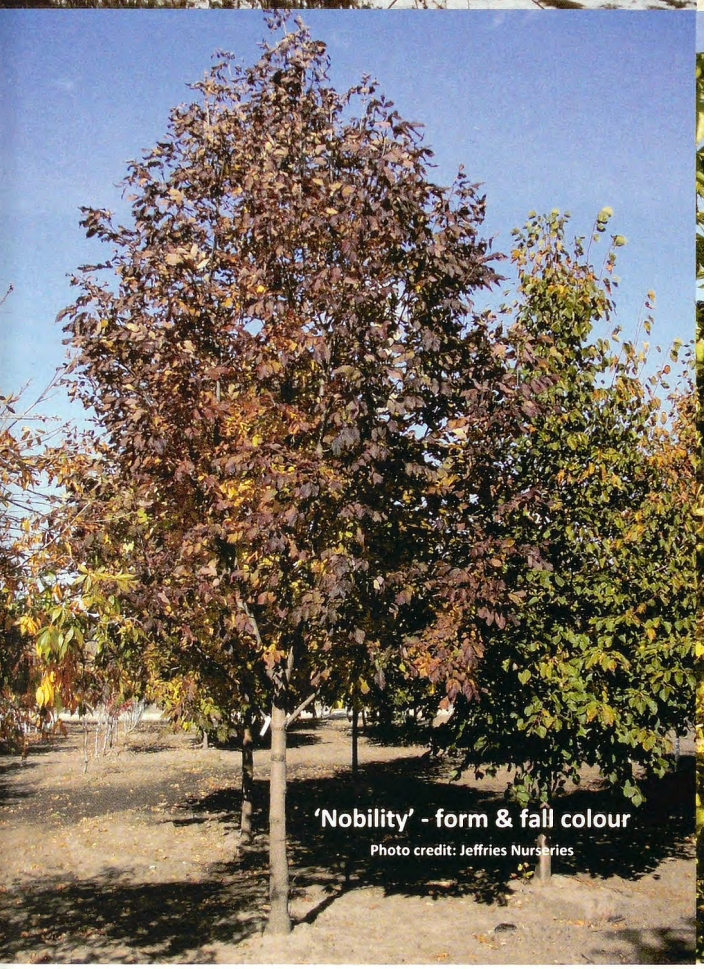
Today, 'Nobility' is propagated by several of the large nurseries in western Canada. It is considered to be most winter hardy cultivar of white ash with purple fall colour. Among the five cultivars tested in the WNGG prairie tree trial, 'Nobility' was the only white ash to be recommended at all four test sites. Resistant to cottony psyllid, 'Nobility' can be used as an attractive seedless street tree in zones 2 and 3. However, as Emerald Ash Borer spreads westward, Nobility's use may be limited to areas of the prairies that do not have native stands of ash, especially Saskatchewan and Alberta.

White ash at their northwestern limits near Minong, Wisconsin

Photo credit: Jeffries Nurseries

'Nobility' - single leaf (fall)

Photo credit: Jeffries Nurseries



'Nobility' - form & fall colour

Photo credit: Jeffries Nurseries

'Northern Treasure' (L) and 'Nobility' (R) as 2 year budded trees

Photo credit: Jeffries Nurseries

The tree from which the many thousands of budded 'Mancana' Manchurian ash trees have originated arrived in 1940 at the Morden Research Centre as a small, single plant from the USDA Plant Introduction Station in Glenn Dale, Maryland. Fortunately, the only tree of this introduction was a healthy, male tree which survived what might have been considered a long tenuous journey. There were a few other ash trees of this species at Morden that Dr. F L. Skinner had sent to the station from Asian sources in Manchuria, but the individual that was named 'Mancana' was distinctive.

The interest in ash as a shade tree developed when Dutch Elm Disease began to move west across North America destroying the commonly used American elm. The very successful nursery procedure of summer budding superior ash clones was a second stimulus to ash use. Finally, there was a new market, a sure way to propagate and available individual trees with desirable hardiness, seedless male characteristics and crown form. 'Mancana ash', named for its Manitoba, Canada origin was introduced in 1979 and along with other green and black ash introductions, became one of the most popular shade and street trees of the 1980's through to the early 2000's.

There is wide interspecific bud compatibility in ash so the use of the universal green ash rootstock helped to make vegetative propagation a success. 'Mancana' has a broad oval crown with dense branching often from one stem point so the crown can be very crowded unless proper pruning is done. As a male clone, this tree bears no seed.

'Mancana' has received great attention as a possible Emerald ash borer (EAB) resistant ash. In field trials at Novi, MI in the heart of the EAB hot-zone, a field trial by Dr. Daniel Hermes compared the response of ash species and cultivars exposed to EAB. It was noted that 'Mancana' was clearly resistant to EAB showing limited mortality in the multi-year trial (and in 3 other plots at different locations). Manchurian ash seedlings were also very resistant to EAB.

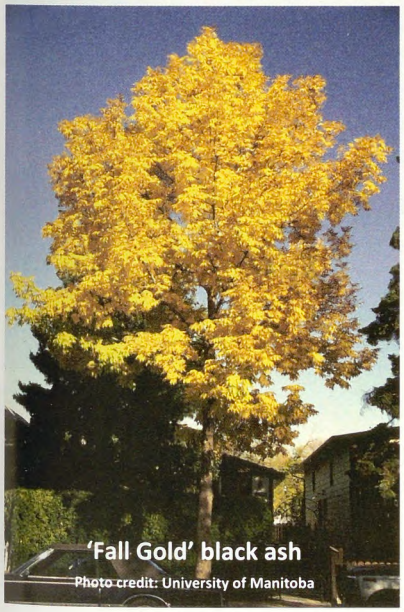
'Mancana' Manchurian ash
Photo credit: USDA

One of tree breeding objectives when Wilbert Ronald joined the staff of the Morden Research Station in 1968 was to widen the choice of trees that could be grown to replace American elm which was threatened with the approaching DED epidemic. One tree group of top interest was the ash (*Fraxinus*) genus including black ash (*F. nigra*), Manchurian ash (*F. mandchurica*), white ash (*F. americana*) and green ash (*F. pennsylvanica*).

Today we have acceptable seedless cultivars in all the above species and one major interspecific species which came from a 1969 hybrid cross between a female black ash parent and the then unnamed male 'Mancana' clone of Manchurian ash. This cross resulted in about 100 seedlings of which two male selections were ultimately named and introduced in the early 1990's as 'Northern Treasure' and 'Northern Gem'. These two new trees show hybrid growth and are slightly hardier than the male parent while being better in crown form and drought tolerance than the female parent. 'Northern Treasure' and 'Northern Gem' became very popular in the nursery industry until the advent of the Emerald ash borer (EAB) threat in 2001 when most ash production was dropped or drastically reduced. There is not a great difference between the two cultivars so most growers ended up growing the 'Northern Treasure' clone.

'Fallgold' black ash is a male clone with good fall colouring which was introduced by Morden in 1976. Production of 'Fallgold' has dropped off due to the EAB threat, ash flower gall mite damage and the general decline of ash.

Recent research indicates that 'Mancana' ash is highly resistant to the introduced EAB and that the two hybrids derived from 'Mancana' also have partial resistance to EAB. It will take time for all this to be sorted out, but growers in the eastern region of the prairies are certainly interested in cultivars that will thrive in spite of the presence of this invasive insect. In the western area of the prairies there continues to be more interest in the green and white ash cultivars which are not affected by cottony psyllid.


'Fall Gold' black ash
Photo credit: University of Manitoba


'Mancana' Manchurian ash
Photo credit: Bailey Nurseries Inc.

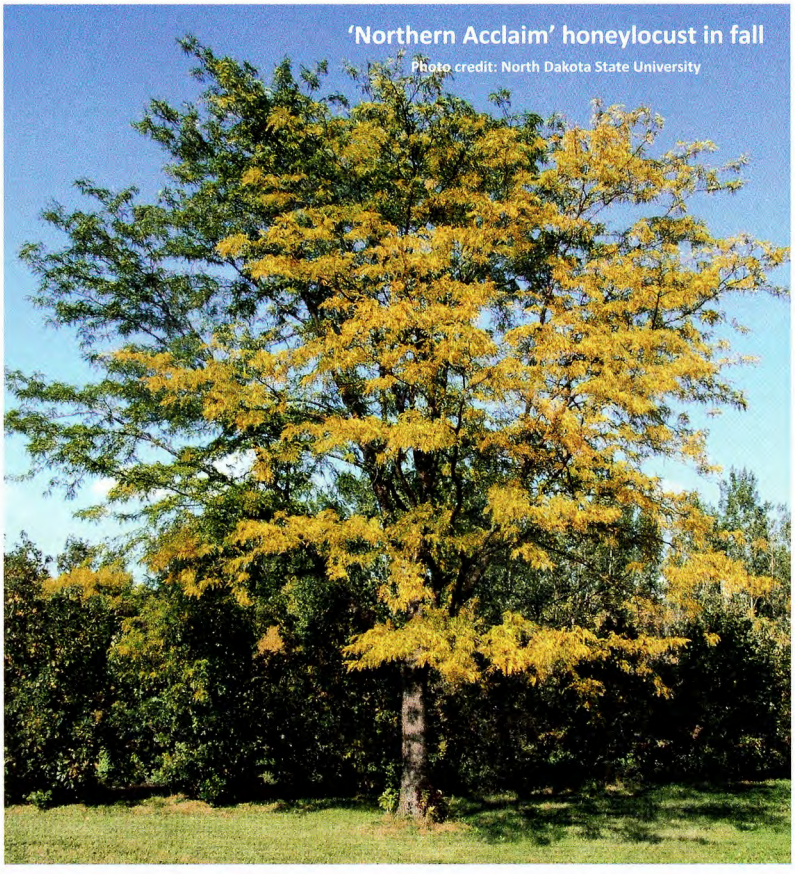

'Northern Gem' hybrid ash
Photo credit: University of Manitoba

Gleditsia triacanthos - HONEYLOCUST (H: 40' W: 35')

Honeylocust is valued for its lacy foliage and open canopy that allow good penetration of sunlight. It also features excellent tolerance to typical urban stresses including a restricted root zone, heat, drought and winter salt spray. Honeylocust generally don't have sufficient winter hardiness to survive in northern zones, especially as juvenile trees.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Northern Acclaim'** (H: 40' W: 30') - NDSU selection; performs well in southern Manitoba when sited in a well-protected location with good heat accumulation



'Northern Acclaim' honeylocust in fall
Photo credit: North Dakota State University

Kentucky coffeetree in Portage la Prairie, MB.
Photo credit: Jeffries Nurseries

Gymnocladus dioica - KENTUCKY COFFEETREE (H: 50' W: 40')

Kentucky coffeetree occurs over a limited range in North America, pushing northward as far as Minnesota. Mature, planted specimens are found as far north as Bismarck, N.D. (zone 4) and a few young trees are performing well at locations in southern Manitoba (zone 3). It would appear that Kentucky coffeetree grown from northern-limits seed sources could survive in sheltered sites in the southern prairies. Kentucky coffeetree features outstanding doubly-compound leaves and unique scaly bark. This species is tolerant to alkaline soils, pest-free and develops into an exceptional shade tree over time.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Stately Manor'** (H: 50' W: 20') - upright canopy; seedless selection; zone 4

Juglans cinerea - BUTTERNUT (H: 45' W: 30')

Despite being a non-native species, the butternut has shown good resiliency in zone 3 of the prairie provinces, particularly in sheltered landscape sites. Its large compound leaves produce a dense summer canopy. The oval nuts, shed in late fall, are attractive to wildlife but represent additional maintenance work for the homeowner. Butternut is produced by prairie nurseries in small numbers and may be best used in a park setting.

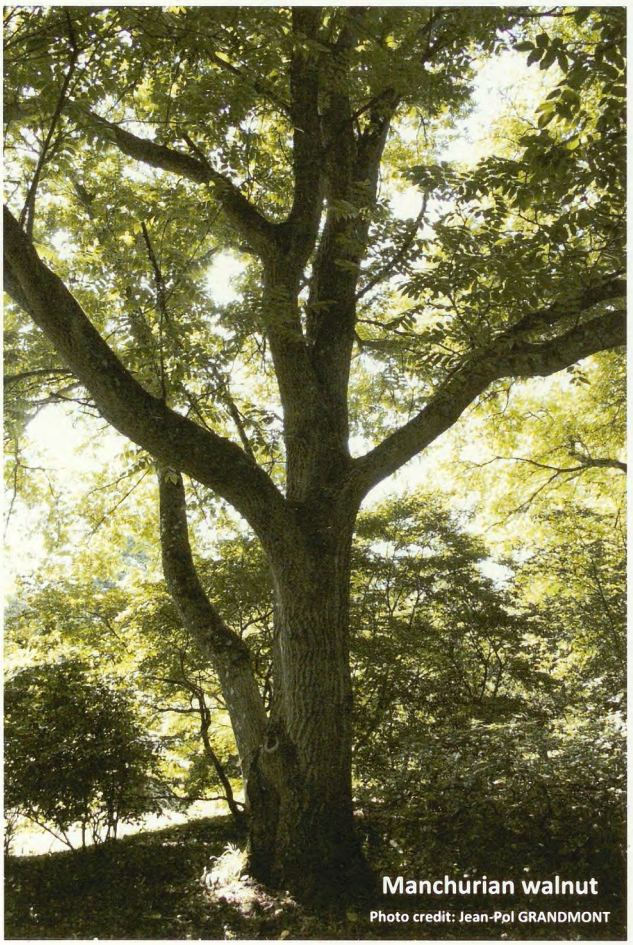
Juglans nigra - BLACK WALNUT (H: 45' W: 30')

Slightly less hardy than butternut, the black walnut is a tree for collectors in zone 3. Large specimens of this species can be found at the Manitoba Legislature in Winnipeg's downtown core. The large round nuts, shed in late fall, are attractive to wildlife but represent additional maintenance for the homeowner. Difficult to transplant due to its dominant taproot, Black Walnut is a minor item in the prairie nursery trade.

Juglans mandshurica - MANCHURIAN WALNUT (H: 45' W: 30')

A very rare species, occasional specimens can be found in prairie arboreta. Its leaves are larger than butternut and black walnut with up to 19 leaflets. Suitable provenances appear to be sufficiently winter hardy to persist in zones 2 and 3. Compared to other walnuts, Manchurian walnut has a relatively short vegetation period and exudes much lower quantities of allelopathic compounds (e.g. juglone) in the rootzone.

Butternut in fall
Photo credit: Jeffries Nurseries



Manchurian walnut
Photo credit: Jean-Pol GRANDMONT

Maackia amurensis - AMUR MAACKIA

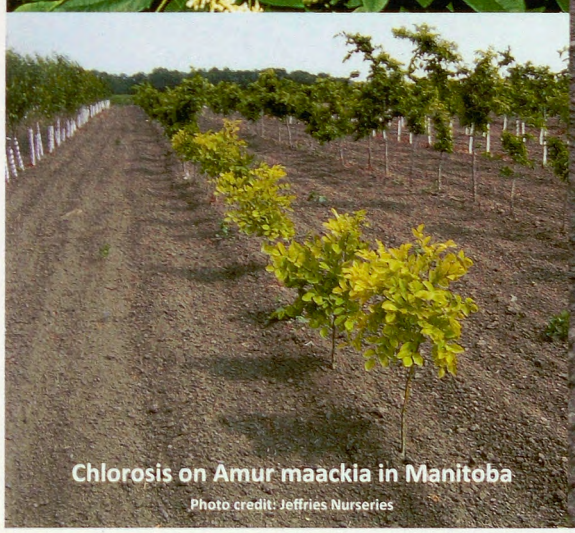
Amur maackia is a small, upright, vase-shaped tree with a rounded crown. This species tolerates severe drought, winter cold and heavy soils. Like caragana, maackia is a legume, with the ability to fix atmospheric nitrogen into usable soil-borne forms. Amur maackia has no serious disease or insect problems.

As an ornamental, Amur maackia produces abundant white blooms in July-August. Even more interesting than the summer flowers are the unfolding buds in spring which are covered with a silvery pubescence, becoming green with maturity. The bark of Amur maackia is shiny brown and peels as it matures.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Starburst'** (H: 20' W: 15') - denser and more uniform than the species; zone 4
- ⇒ **'Summertime'** (H: 20' W: 15') - University of MN introduction; failed in trials across the prairie provinces; zone 4
- ⇒ **'Summer Frost'** (H: 15 W: 12') - a Manitoba selection; compact tree; may hold potential in zone 3

Summer flowers of Amur maackia
Photo credit: Bailey Nurseries Inc.



Chlorosis on Amur maackia in Manitoba
Photo credit: Jeffries Nurseries

Winter damage on 'Summertime' Amur maackia after one winter in Portage la Prairie, Manitoba
Photo credit: Jeffries Nurseries

Malus baccata - SIBERIAN CRABAPPLE (zone 2)

The Siberian flowering crabapples offer white flowers and green foliage. They include older cultivars such as 'Rosthern' and 'Spring Snow' as well as more recent introductions like 'Starlite'.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Rosthern'** (H: 20' W: 6') - older cultivar; upright oval form;

⇒ **'Spring Snow'** (H: 25 W: 15') - rounded form, female sterile - no fruit

⇒ **'Starlite'** (H: 25' W: 15') - pyramidal form, tiny retained fruit, scab-resistant foliage

Malus x adstringens - ROSYBLOOM CRABAPPLE

Rosybloom crabapples continue to be among the most popular small-statured flowering trees in the prairies. They offer desirable ornamental features including pink spring flowers and purple-tinged foliage. More details on rosyblooms can be found in the special story on page 99. The recommended cultivars listed below vary in crown form, fruit retention and are considered winter hardy to zone 2.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Courageous'** (H: 25' W: 15') - broad oval crown; pink flowers; few fruit

⇒ **'Gladiator'** (H: 20' W: 13') - upright form; glossy purple foliage; pink flowers

⇒ **'Kelsey'** (H: 20' W: 15') - older cultivar; double-petaled pink flowers; large fruit

⇒ **'Makamik'** (H: 25' W: 15') - rounded crown; rosy-red flowers; scab resistant

⇒ **'Pink Spires'** (H: 20' W: 15') - upright form; abundant flowers and fruit

⇒ **'Royal Mist'** (H: 20' W: 15') - upright form; fuschia-pink flowers; fruit drop issue

⇒ **'Royalty'** (H: 20' W: 15') - older cultivar; dark-pink flowers; abundant fruit

⇒ **'Rudolph'** (H: 20' W: 15') - older cultivar; abundant flowers and fruit

⇒ **'Selkirk'** (H: 20' W: 20') - older cultivar; vase-like habit; pink flowers

⇒ **'Shaughnessy Cohen'** (H: 20' W: 15') - fuchsia pink flowers; fruit drop issue

⇒ **'Thunderchild'** (H: 20' W: 15') - vase-like habit; suitable for less humid areas

Malus x adstringens - SPIRE COLUMNAR CRABAPPLE (zone 3)

Derived by crossing 'Wijick' with rosybloom cultivars, the Spire series offer new possibilities for landscape placement and summer privacy screens. Spire crabapples offer slow columnar growth and excellent foliar disease resistance. Flowering varies with cultivar but is generally sparse compared to rosyblooms. Fruit is large but the upright crown form ensures that fruit falls directly around the base of the trunk.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Emerald Spire'** (H: 20' W: 8') - dark-green foliage; abundant pink flowers

⇒ **'Purple Spire'** (H: 20' W: 6') - purple foliage in late summer; sparse pink flowers

⇒ **'Indigo Spire'** (H: 20' W: 6') - glossy, indigo-purple foliage all summer

⇒ **'Green Wall'** (H: 20' W: 8') - glossy-green foliage, sparse white flowers

Who would have thought a non-fruiting, lowly Siberian crabapple seedling grown at the nursery outpost of Bert Porter in northern Saskatchewan would become the leading crabapple cultivar in North America and widely famous for its female sterility genetics? Where there are concerns about excessive fruit drop from certain flowering crabapples, the cultivar 'Spring Snow' still shines as a completely fruitless tree. The sterility is in the female flower parts only and the plant does produce beautiful white flowers and has been used as a male parent in controlled crosses.

The Sjulin brothers of Interstate Nursery in Hamburg, Iowa heard of the plant at Bert Porter's and realized its commercial attributes. They introduced the tree into the United States and soon large numbers were grown, a practice which continues to this day. The name 'Spring Snow' was suggested by the Sjulins as a descriptive name. The cultivar has stood the test of time as a fire blight resistant plant with minor disease problems.

It is reported that the Porters received a cheque in 1968 for $453.50 representing 10 cents per plant for the first 4,535 plants grown. Unfortunately the Interstate Nursery would go out of business due to a decline in the number of mail order companies. If these payments had continued to date and from all growers, then many hundreds of thousands dollars would have flowed to support Porter's plant breeding work.

It is estimated that well over 150,000 'Spring Snow' plants are grown annually and used widely from climatic zones 2 to 7 in both the U.S. and Canada. In 2013, one of the writers was visiting a Oregon nursery company and saw 23,000 1 year old 'Spring Snow' budded liners in a single field. It is probable that more than 3 million 'Spring Snow' crabapple have been produced and sold in North America since its release. This cultivar's popularity can be traced to the steady demand for flowering crabapples, especially one that is not invasive.

'Spring Snow' flowering crabapple

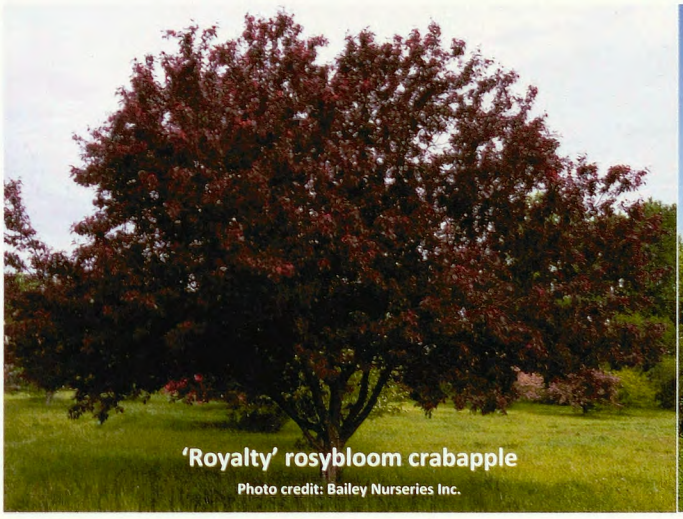
Photo credit: Bailey Nurseries Inc.

The popular rosybloom crabapples have become the tree of choice as a spring flowering tree in northern zones. Developed from hybridization between the eastern Asiatic sources of *Malus baccata* and the red-fleshed, Asian species *Malus pumila* 'Niedzwetzkyana', a wide range of cultivars have been developed with pink to fuschia flowers and green to purple foliage. Because the northern regions are largely lacking in trees with good purple foliage, it became a widespread objective of northern breeders to develop tree cultivars with dark purple foliage that would give bright colour contrast in the prairie landscape.

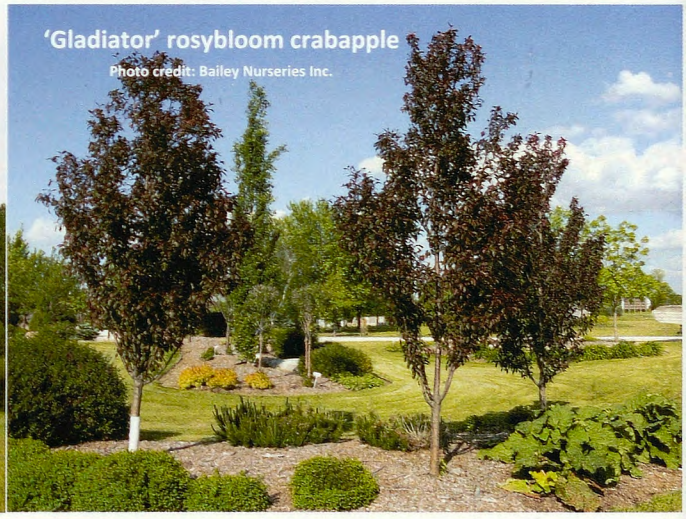
Les Kerr, formerly a plant breeder at the station at Morden from 1932 to 1942, became manager at the Sutherland Forest Nursery Station near Saskatoon, Saskatchewan in 1942. He was keenly interested in plant improvement and flowering crabapples were very much in his plans. Starting with the 'Sutherland' flowering crabapple parent, he grew thousands of open-pollinated seedlings each year and kept the most purple-leafed types for the next generation. Dark-foliaged selections were continually improved until he ended up with the seedling that was named 'Royalty' for its dark purple flowers and shiny purple foliage. 'Royalty', introduced in 1958, became a sensation after it was introduced by the Interstate Nursery of Hamburg, IA, but its susceptibility to fire blight proved to be a limitation. 'Royalty' is still grown in limited numbers in U.S. and Canadian nurseries since its foliage colour remained unsurpassed, until recently.

The work of another Saskatchewan breeder, Percy Wright, resulted in a seedling that was noted for fire blight resistance and cold hardiness. Wright introduced this plant as 'Thunderchild' in 1974. While its foliage was not the glossy purple of 'Royalty', 'Thunderchild' became a top selling tree in the late 1980's and onward. However, 'Thunderchild' can be a difficult tree to train into a balanced crown and the canopy often takes on an open growth form. Furthermore, the apple scab susceptibility of 'Thunderchild' has become more of an issue with wet seasons causing heavy leaf defoliation.

The more recent development of 'Gladiator', introduced in 2006 by Rick Durand of Prairie Shade Nursery, has produced a cultivar with an ascending balanced crown, fire blight resistance, good scab resistance and shiny purple foliage. It has very high saleability both as a liner tree and larger specimen tree so it is truly a profitable tree for nursery growers.



'Royalty' rosybloom crabapple
Photo credit: Bailey Nurseries Inc.



'Gladiator' rosybloom crabapple
Photo credit: Bailey Nurseries Inc.

Columnar flowering crabapples are not totally new to the nursery industry but the fire blight susceptibility of one past cultivar known as Siberian columnar flowering crabapple (*Malus baccata*) kept it as an almost unknown collector tree. The new spur-type Spire series of rosybloom, including cultivars 'Purple Spire' and 'Emerald Spire', are fire blight resistant and represent an exciting addition to northern landscape plants.

David Lane, a fruit breeder at AAFC's Summerland Research Centre, crossed the spur 'Wijik' MacIntosh crabapple with the 'Thunderchild' rosybloom to develop a series of selections with spur growth and columnar form. These selections were tested at Jeffries Nurseries in Portage la Prairie, Manitoba for winter hardiness. The 'T6' selection stood out and was recommended for naming as 'Purple Spire'. 'Dreamweaver', another cultivar from the same series, was also grown but appeared to be slightly less hardy than 'Purple Spire'. 'Emerald Spire' is a pubescent, green-leafed cultivar developed by Rick Durand at Jeffries Nurseries out of the T4 Spire germplasm. 'Emerald Spire' was introduced in 2009 and is grown in the US and Canada.

'Purple Spire' and 'Emerald Spire' flowering crabapple cultivars have spur growth with distinct columnar form and fruit that is about 2.5 cm (1") in diameter. Their primary landscape value lies in their distinctive form and smaller stature rather than their spring flowering. The foliage has good resistance to leaf diseases and the foliage is held until late in the fall. The plants will be invaluable as an accent and screen tree for small modern yards. The fruit may be considered a detriment in certain landscape uses but it falls close to the trunk and in some years the fruit can be retained on the trees and is eaten by birds.

Further crossing at Jeffries Nurseries has led to other unique selections of columnar crabapples including pending cultivars 'Indigo Spire' (2018) and 'Green Wall' (2019).

Ostrya virginiana - IRONWOOD (HOPHORNBEAM) (H: 40' W: 25')

A difficult species to source in the nursery trade, ironwood grows as a native tree in southern Manitoba and eastern North Dakota. It is a slow-growing tree that prefers the understory in its natural habitat. Also named "hophornbean" due to the hop-like appearance of clusters of late summer fruit. Trunks on mature trees have peeling strips of gray-brown bark.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Autumn Treasure'** (H: 40' W: 20') - new release from J Frank Schmidt Nursery with upright crown; rated zone 4 for hardiness, but prairie evaluation is required

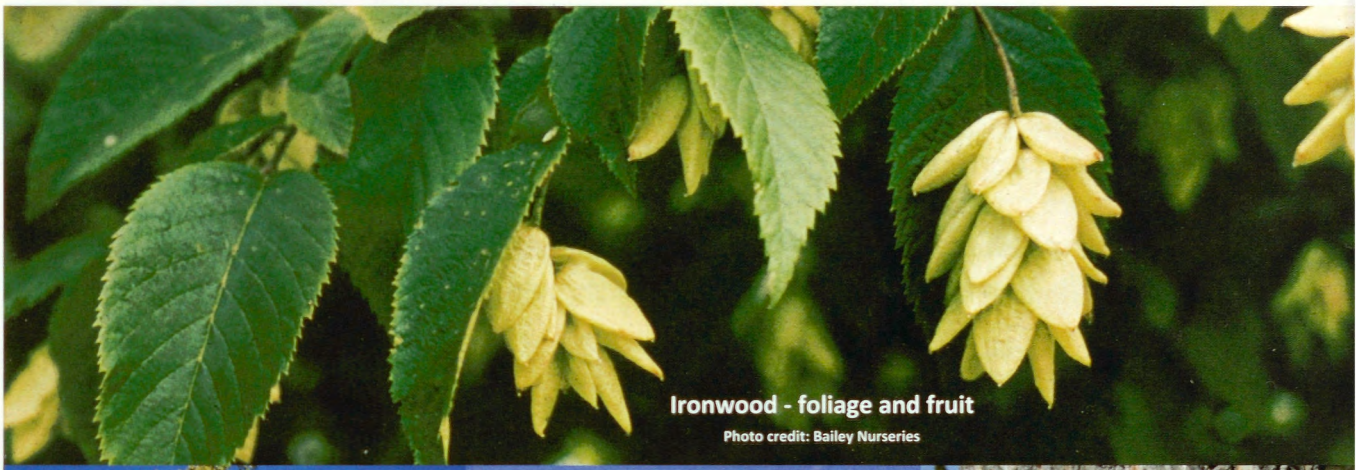
Phellodendron amurense - AMUR CORKTREE (H: 40' W: 25')

Another rare tree in the prairie landscape, Amur corktree is an introduced species with many unique features including aromatic compound leaves and spongy grey bark. Male specimens are preferred to prevent seed spread. Currently only seedling strains are used in northern zones 2 and 3.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Eye Stopper'** (H: 40' W: 35') - seedless selection from Wisconsin; zone 4

⇒ **'His Majesty'** (H: 40' W: 35') - seedless, Minnesota introduction; zone 4



Ironwood - foliage and fruit
Photo credit: Bailey Nurseries

Ironwood street tree in Winnipeg
Photo credit: Jeffries Nurseries

Amur corktree
Photo credit: Jeffries Nurseries

Spongy bark of Amur corktree
Photo credit: Jeffries Nurseries

The poplar genus is valued for its rapid growth, soil adaptability and winter hardiness. Unlike the aspen subgroup, the poplar subgroup (balsam, cottonwood and hybrids) is resistant to bronze leaf disease and tends to be longer-lived.

POPLAR GROUP

Populus angustifolia– NARROWLEAF POPLAR
Native to southern Alberta, narrowleaf poplar is a pyramidal grower with narrow, willow-like leaves. Prefers moist soils conditions and does have a tendency to sucker.

Populus x acuminata– LANCELEAF POPLAR
A hybrid of *P. angustifolia* and *P. deltoides*, this species has a dense pyramidal crown.

Populus balsamifera– BALSAM POPLAR
Native across Canada, balsam poplar avoids only the driest areas of the prairie region. It is one of the first trees to leaf out in spring and shows rapid growth on many soil types.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Paskapoo'** (H: 25' W: 25') - oval crown; seedless; disease-prone; zone 2

Populus deltoides - COTTONWOOD
The cottonwood is respected throughout the prairies as a fast-growing native tree. Often found in riparian areas, this species can tolerate temporary flooding and change in soil grade.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Skyfest'** (H: 80' W: 30') - oval crown; seedless; zone 2
⇒ **'Siouxland'** (H: 80' W: 40') - rounded crown; seedless; zone 3

Populus nigra– BLACK POPLAR
Native to Europe, black poplar has been used as a parent in generating hybrid poplars.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Italica'** = Lombardy - (H: 40' W: 10') - columnar; seedless; zone 3b
⇒ **'Afghanica'** = 'Theves' - (H: 50' W: 10') - columnar; suitable for screens; zone 3b

Populus x jaackii - BALSAM X COTTONWOOD HYBRID
A fast growing, shallow-rooted hybrid species that has a propensity to sucker. May play a useful role in riverbank stabilization and shelterbelts. Subject to wind damage.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Northwest'** (H: 50' W: 40') - seedless selection; zone 2

Populus x - HYBRID POPLAR
Fast growing, seedless, non-suckering trees are excellent for shelterbelts. 'Sundancer' was rated the best of the prairie cultivars for form, disease-resistance and hardiness.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Assiniboine'** (H: 50' W: 15') - oval; seedless; resistant to stem canker; zone 2
⇒ **'Okanese'** (H: 60' W: 25') - broad oval; seedless; disease resistant; zone 2
⇒ **'Prairie Sky'** (H: 65' W: 15') - oval; seedless; resistant to canker/rust; zone 2b
⇒ **'Sundancer'** (H: 50' W: 12') - narrow oval; seedless; disease resistant; zone 2

ASPEN GROUP

Populus grandidentata - LARGE-TOOTH ASPEN

A medium-sized, deciduous tree native to eastern North America including a few stands in Manitoba. Leaves are slightly larger than trembling aspen and possess much larger teeth. Golden fall colour is exceptional. This species has shown limited use in prairie landscapes.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Sabre'** (H: 40' W: 25') - oval form; seedless; susceptible to BLD; zone 2

Populus tremuloides - TREMBLING ASPEN

Trembling aspen is a common native species across much of the Parkland region of the prairie provinces. Large groups of adjacent trees in forested areas often represent a single genotype that has spread as a result of root suckers. For this reason, trembling aspen can be considered one of the largest living organisms on Earth. Named for its leaves that quiver or quake in the gentlest of breezes, trembling aspen shows excellent golden fall colour. However, in our experience, trembling aspen has proven to be a disease-prone and short-lived species whose use in the eastern prairies should be limited to naturalization.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Mountain Sentinel'** (H: 35' W: 8') - columnar selection; zone 3

⇒ **'Pike's Bay'** (H: 50' W: 25') - open, rounded selection; zone 3

⇒ **'Prairie Gold'** (H: 40' W: 15') - narrow oval form; golden fall colour; zone 4

⇒ **'Prairie Skyrise'** (H: 35' W: 5') - dense, columnar selection; zone 2

Populus tremula 'Erecta' - SWEDISH ASPEN (H: 35' W: 5')

Introduced from Europe, Swedish columnar aspen quickly became the best selling tree in the prairies due to its tidy, upright habit. Often used as a summer privacy screen, this tree is no longer recommended in the prairies due to its susceptibility to bronze leaf disease.

Populus x canescens 'Tower' - TOWER ASPEN (H: 35' W: 8')

'Tower' aspen is a unique hybrid between the Swedish aspen (*Populus tremula* 'Erecta') and the white poplar (*Populus alba*). Once valued for its columnar habit and fast growth rate, 'Tower' is no longer recommended due to its high level of susceptibility to bronze leaf disease. Other choices for fast growing privacy screens include 'Parkland Pillar' Asian white birch, 'Sundancer' hybrid poplar and 'Guardian' hybrid aspen.

Populus x 'Jefguard' - GUARDIAN HYBRID ASPEN (H: 40' W: 10')

A complex aspen-poplar hybrid with a demonstrated level of bronze leaf disease resistance. A male seedless tree, 'Guardian' provides a fast-growing, vertical element to the prairie landscape. Young trees may require some shearing to develop canopy fullness. The growth rate of 'Guardian' is similar to other columnar aspens.

Populus alba - EUROPEAN WHITE POPLAR (H: 50' W: 40')

An introduced species from Europe, white poplar features rapid growth and 3-lobed leaves with a silvery-white underside. Its shallow, competitive root system produces abundant suckers. Not recommended for landscape plantings.

'Guardian' aspen

Photo credit: Jeffries Nurseries

'Prairie Sky' hybrid poplar

Photo credit: Jeffries Nurseries

'Skyfest' cottonwood - fall colour

Photo credit: Jeffries Nurseries

Swedish columnar aspen

Photo credit: Jeffries Nurseries

Prunus maackii - AMUR CHERRY (zone 2)

Amur cherry is a small flowering tree with many desirable ornamental features including its golden-orange exfoliating bark and complete resistance to black knot. Cultivars such as 'Goldspur' and 'Klondike' represent major improvements over seedlings of the species.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Goldspur'** (H: 15' W: 10') - spur-type selection with dense peach-like foliage
⇒ **'Ming'** (H: 25' W: 15') - interesting hybrid with dark-red bark and dense foliage
⇒ **'Klondike'** (H: 25' W: 15') - full-size seedling of 'Goldspur' with excellent vigour

Prunus nigra - CANADA PLUM (zone 2)

Native in southern Manitoba, Canada plum is a small tree with outstanding white spring flowers and orange-yellow fall colour. Resistant to black knot.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Princess Kay'** (H: 15' W: 10') - selected in northern MN.; double, white flowers

Prunus x nigrella - MUCKLE HYBRID PLUM (H: 15' W: 10' - zone 2)

A small tree with slower growth rate, 'Muckle' plum is a sterile hybrid between *Prunus nigra* and *Prunus tenella*. Outstanding pink spring flowers are followed by glossy, green summer foliage and red fall colour.

Prunus padus – MAYDAY CHERRY (zone 2)

European species with high susceptible to black knot. It can only be recommended for the drier, western portions of the prairie region.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Merlot'** (H: 25' W: 20') - deep burgundy foliage; white flowers
⇒ **'Sweetheart'** (H: 20' W: 13') - upright form; leaf colour is red/purple; pink blooms

Prunus pennsylvanica – PIN CHERRY (zone 2)

Native cherry produces tiny red fruit. Limited commercialization and landscape use.

Prunus virginiana x Prunus padus – HYBRID CHOKECHERRY (zone 2)

These fast-growing hybrid cultivars are highly susceptible to black knot and can only be recommended for the drier, western portions of the prairie region.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Bailey Select'** (H: 25' W: 20') - purple summer foliage; white spring flowers
⇒ **'Midnight'** (H: 20' W: 13') - deep purple summer foliage; white spring flowers

Prunus virginiana – COMMON CHOKECHERRY (zone 2)

Native throughout Canada, common chokecherry is generally green-leafed with attractive raceme-type flower clusters and black fruit. Purple-leafed variants have been found including the popular 'Schubert' chokecherry. While still popular in the western prairies, intense black knot disease pressure has eliminated most landscape plantings of 'Schubert' chokecherry in southern Manitoba.

CULTIVARS FOR ZONES 2 TO 4:

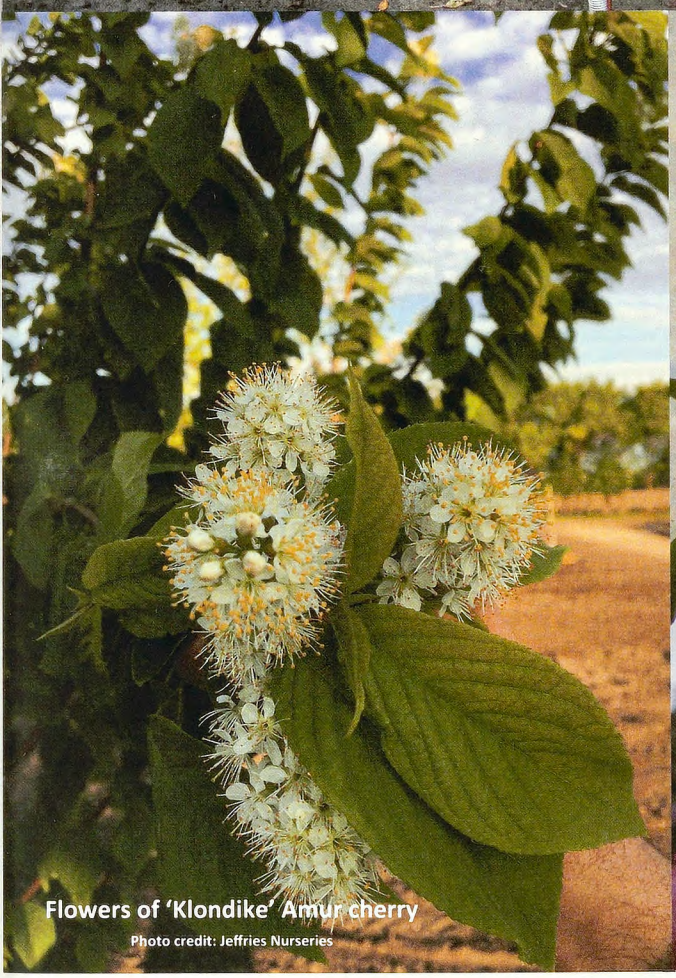
⇒ **'Schubert'** (H: 25' W: 20') - purple summer foliage
⇒ **'Spur Schubert'** (H: 20' W: 13') - purple summer foliage; improved crown

'Spur Schubert' chokecherry - summer foliage

Photo credit: Jeffries Nurseries

'Goldspur' (L) & 'Klondike' Amur cherry

Photo credit: Jeffries Nurseries



Flowers of 'Klondike' Amur cherry

Photo credit: Jeffries Nurseries

Flowers of 'Muckle' plum

Photo credit: Jeffries Nurseries

'Goldspur' is a selection of Amur cherry (*Prunus maackii*) with a uniquely compact growth habit. Compared to other seedlings of Amur cherry, this dwarf cultivar has shorter internodes between leaves that result in tufted foliage and a very dense canopy. 'Goldspur' produces white spring flowers and tiny black fruit in summer. Its green summer foliage turns a vibrant golden colour in the fall, while its exfoliating yellow-orange bark is especially obvious in the winter months, after leaf loss.

'Goldspur' was discovered in Saskatoon, Saskatchewan by Philip & Karen Ronald while collecting Amur cherry seed in the summer of 1999. This particular specimen stood out from the species due to its smaller stature and dense, peach-like foliage. After several failed attempts, the plant was successfully established in tissue culture using dormant buds in 2003. The first tissue-cultured plants of 'Goldspur' were lined out at Jeffries Nurseries in Portage la Prairie during the summer of 2005. It should be noted that 'Goldspur' can also be successfully propagated by softwood cuttings from vigorous growth on young trees.

'Goldspur' achieved CVI status and was added to Bailey Nurseries First Editions brand in 2013. Liners of the cultivar are now produced by several wholesale nurseries in Canada and the United States including Advance Nursery, Bylands Nurseries, J. Frank Schmidt Nurseries and Sester Farms. Caliper growers have been very pleased with saleability of 'Goldspur' with limited grade out seen in typical production rows.

'Goldspur' Amur cherry - summer foliage
Photo credit: Jeffries Nurseries

'Goldspur' Amur cherry - fall colour
Photo credit: Jeffries Nurseries

Pyrus ussuriensis - USSURIAN PEAR

One of the best trees for spring bloom, Ussurian pear is also extremely winter hardy and tolerates a wide range of soil types. Once frequently used as medium-sized tree, Ussurian pear is less welcome in landscapes today due to its spreading habit and the issue of fruit drop. Most mature trees in prairie cities are seedlings of the species.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Mountain Frost'** (H: 35' W: 25') - upright form; very dense canopy; zone 3
- ⇒ **'Navigator'** (H: 35' W: 20') - narrow pyramidal form; *P. commutata* hybrid; zone 3
- ⇒ **'Prairie Gem'** (H: 25' W: 25') - rounded form; very dense canopy; zone 3

'Mountain Frost' Ussurian pear - spring flowers
Photo credit: Bailey Nurseries

Ussurian pear - fallen fruit
Photo credit: Jeffries Nurseries

Ussurian pear - spring flowers
Photo credit: Iowa Arboretum

Quercus macrocarpa - BUR OAK (H: 65' W: 35')

Bur oak is a stately, long-lived tree, native to the eastern prairies. It is readily identified by its corky bark and broad crown. Bur oak is a drought-tolerant, pioneer tree that tolerates a wide range of soils. Bur oak is susceptible to transplant shock and should be handled with extreme care as a bare-root tree. After planting, it is sensitive to soil disturbance including compaction and change of grade.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Top Gun'** (H: 50' W: 20') - narrow, oval form; golden fall colour; zone 2

Quercus ellipsoidalis - NORTHERN PIN OAK

Northern pin oak represents the most northern species of the red oak group. Native stands can be found growing as far north as the Rainy River region of northwestern Ontario. Northern pin oak has sufficient cold hardiness for zone 3 but often lacks the ability to thrive on alkaline soils. A unique cultivar of northern pin oak is 'Shooting Star' which features a bur oak root system that enables it to perform well on drier, high pH soils.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Majestic Skies'** (H: 60' W: 45') - broad oval form; dark-red fall colour; zone 4

⇒ **'Shooting Star'** (H: 50' W: 35') - rounded open form; dark-red fall colour; zone 2

Quercus x - HYBRID OAK

Hybrid oak cultivars are common in the U.S. but rarely planted in the Canadian prairies due to a general lack of winter hardiness. Occasionally in the past a hybrid oak was mistakenly planted as bur oak (e.g. 'Admiration', a unique hybrid found growing in Saskatoon, SK).

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Admiration'** (H: 40' W: 30') - *Q. alba x Q. bicolor*, zone 2

⇒ **'Heritage'** (H: 60' W: 40') - *Q. robur x Q. macrocarpa*, zone 4

⇒ **'Prairie Stature'** (H: 40' W: 30') - *Q. robur x Q. alba*, zone 4

⇒ **'Regal Prince'** (H: 40' W: 20') - *Q. robur fastigiata x Q. bicolor*, zone 4

Winter form of mature bur oak
Photo credit: Greg Morgenson

'Regal Prince' hybrid oak
Photo credit: Bailey Nurseries

'Admiration' [*Quercus x jackiana* 'Jefmir'] is a unique hybrid oak discovered growing as a mature tree in Saskatoon, Saskatchewan. Based on leaf and fruit characteristics, the tree is believed to be a hybrid between white oak (*Q. alba*) and swamp white oak (*Q. bicolor*). The parent tree is likely close to 25 years old and is thriving in zone 2 conditions on alkaline clay soil. 'Admiration' hybrid oak has a pyramidal crown, and shows excellent vigor compared to seedling bur oak. Once established in a landscape site, summer growth spurts allow annual twig extension of up to 18 inches. We anticipate a mature size of 40' (12 m) x 30' (9 m).

'Admiration' produces dark-green, disease-free foliage. Leaves are lobed, but vary in the degree of lobing with some approaching the highly dissected foliage of white oak. Leaves turn golden in the fall and are retained into winter in a similar manner to northern pin oak. The tan coloured, retained foliage adds an element of interest to our somewhat mundane, often leafless winter landscapes.

Another notable characteristic of 'Admiration' hybrid oak is it's shaggy bark. Easily viewed on the main bole of mature trees, patchy scales of silver-grey bark exfoliate to reveal a beige-brown layer beneath. This feature, inherited from swamp white oak, adds another element of winter interest and is unique to oaks with prairie hardiness.

'Admiration' hybrid oak grows best in full sunlight and prefers well drained, medium-textured soils with adequate moisture. Budded on seedling bur oak rootstock, it shows excellent tolerance to the dry, alkaline soils found throughout much of the prairies.

Original tree of 'Admiration' hybrid oak
Photo credit: Jeffries Nurseries

Winter leaf retention on 'Admiration' hybrid oak
Photo credit: Jeffries Nurseries

Columnar oak cultivars such as 'Regal Prince' and 'Kindred Spirit' lack the winter hardiness to be serious contenders in zones 2 and 3. A plant breeder might ask several questions: "Can we hybridize tender, columnar oak cultivars with cold hardy local oak species? Is it possible to generate hardy upright oaks by crossing northern pin oak with 'Green Pillar' (*Q. palustris* 'Pringreen') or bur oak with 'Regal Prince' (*Quercus x warei* 'Long')?"

We attempted to answer this question in May 2008 when we obtained flowering container stock of 'Regal Prince' and hybridized the trees with a hardy, upright specimen of bur oak. Good seed set was observed on the young tree of bur oak. This seed was collected, stratified and planted in spring of 2009. By the end of the growing season it was clear, by leaf-type, that there were some hybrids among the bur oak seedlings.

All of the resulting seedlings were planted out in Portage la Prairie, Manitoba in the summer of 2009 and allowed to grow until they were dug in October 2015. It was at that time that several columnar hybrids were examined and the most vigorous was selected as #1502. This selection combines the genetics of *Q. robur fastigiata* (upright English oak) and *Q. bicolor* from 'Regal Prince' with the winter hardiness and soil adaptation of bur oak.

The 1502 selection is presently under increase by grafting and budding at Carlton Plants in Dayton, Oregon. While a cultivar release is a number of years away, it is hoped that this hybrid will serve as a columnar oak with reliable hardiness for zone 3.

Seed set on female bur oak parent following controlled hybridization with 'Regal Prince'
Photo credit: Jeffries Nurseries

1502 hybrid oak selection in fall of 2015
Photo credit: Jeffries Nurseries

The willow genus is well known for its fast growth and ability to quickly generate shelter and shade. However, it has also garnered a negative reputation for its shallow root system and tendency to invade water lines and septic beds.

Salix acutifolia - ACUTE LEAF WILLOW (H: 60' W: 30')

One of the best shelterbelt trees due to its fast growth and the fact that it does not drop branches as easily as other willows. Foliage is green and stems are red-brown.

Salix alba - WHITE WILLOW

Native to Europe, white willow has been the source of several important prairie cultivars.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Golden'** (H: 60' W: 30') - outstanding golden twigs in winter; zone 2
- ⇒ **'Silky White'** (H: 50' W: 30') - silver summer foliage; purple winter twigs; zone 2
- ⇒ **'Tristis'** (H: 50' W: 50') - fast growing with long pendulous branches; zone 4

Salix amygdaloides - PEACHLEAF WILLOW (H: 50' W: 30')

Found in riparian areas across the prairies, peachleaf willow has not been commercialized due to limited interest. It can be propagated by seed or softwood cuttings.

Salix pentandra - LAUREL WILLOW (H: 60' W: 30')

Native to Europe, laurel willow is hardy to zone 2 and features glossy, dark-green foliage.

Salix x - WEEPING WILLOW

Cascading form and colourful twigs make this hybrid species a year-round eye-catcher.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Lace'** (H: 40' W: 30') - fast growing; intensely weeping habit; zone 3
- ⇒ **'Prairie Cascade'** (H: 40' W: 30')- *S. babylonica* x *S. pentandra* hybrid; zone 3

Laurel willow
Photo credit: Bailey Nurseries Inc.

'Lace' weeping willow
Photo credit: Jeffries Nurseries

The mountain ash are valuable small flowering trees for the prairie region. Renowned for their large flower and fruit clusters, mountain ash offer exceptional aesthetic value at numerous times in the year. Once widely planted in the prairies, their use has been more restricted in recent decades due to concerns about disease and invasiveness.

Sorbus aucuparia – EUROPEAN MOUNTAIN ASH

European mountain ash is a small flowering tree introduced to the prairie region from Europe. Attractive ornamental features include compound leaves, large white flower clusters in early summer and orange-red fruit that is retained into winter. Some cultivars experience heavy trunk damage due to attacks by sapsuckers and woodpeckers.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Black Hawk'** (H: 25' W: 20') - pyramidal; dense; sunscald resistant; zone 2
- ⇒ **'Cardinal Royal'** (H: 30' W: 20') - pyramidal; dense; zone 3b
- ⇒ **'Rossica'** (H: 25' W: 15') - oval; dense; more resistant to fire-blight; zone 2

Sorbus decora – SHOWY MOUNTAIN ASH

Showy mountain ash is the hardiest and slowest-growing member of this genus. A native tree in Manitoba, this species also offers compound foliage, large flat-topped flower clusters and red fruit that is retained into winter. Showy mountain ash is resistant to fire blight and is not affected by sapsuckers.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Grootendorst'** (H: 25' W: 20') - rounded crown; open canopy; red fruit; zone 2

Sorbus hybrida – OAK LEAF MOUNTAIN ASH

Oak leaf mountain ash has not been reliably winter hardy in zones 2 and 3, but performs well in zone 4. It offers lobed leaves that resemble those of an oak.

Russian mountain ash - fall colour
Photo credit: Jeffries Nurseries

Showy mountain ash - fruit
Photo credit: Bailey Nurseries

Tree lilac is perhaps the most popular small flowering tree in the prairies. This tree group fits neatly into the compact landscapes found in many modern residential and commercial sites. Fragrant flower panicles are exceptional and flowering can persist for several weeks.

Syringa reticulata - JAPANESE TREE LILAC

Japanese tree lilac offers glossy green foliage and unique cherry-like bark as desirable features. In locations with less fall moisture, Japanese tree lilac shows improved longevity.

CULTIVARS FOR ZONES 2 TO 4:

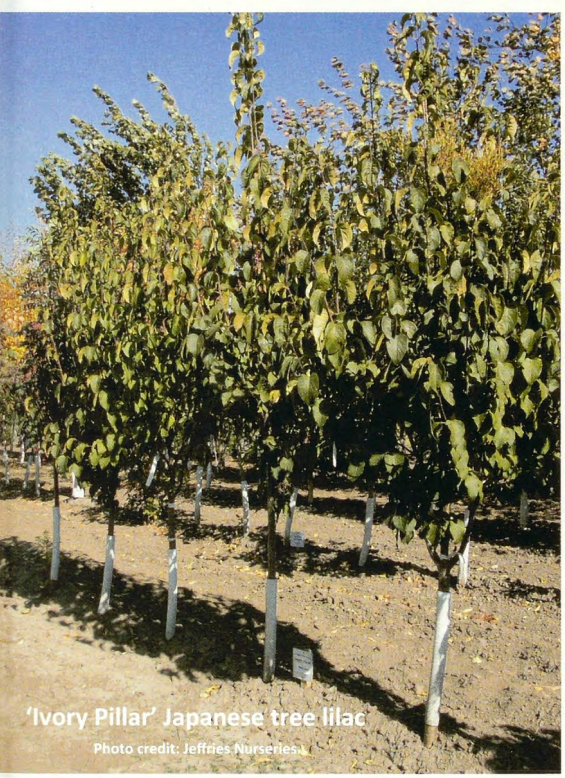
- ⇒ **'Golden Eclipse'** (H: 20' W: 12') - golden-green variegated foliage; zone 3b
- ⇒ **'Ivory Pillar'** (H: 25' W: 15') - large white panicles; improved longevity; zone 2b
- ⇒ **'Ivory Silk'** (H: 25' W: 20') - long-time industry standard; zone 2b
- ⇒ **'Shogun'** (H: 20' W: 15) - smaller panicles; purple fall colour; zone 2b
- ⇒ **'Snowdance'** (H: 20' W: 20') - vase-shaped, spreading habit; zone 3

Syringa pekinensis - PEKING TREE LILAC

Similar to Japanese tree lilac, but smaller in stature with a finer texture. The bark often exfoliates in brown flakes or sheets. Peking tree lilac is usually multi-stemmed and has an arching, loose and open appearance. The flowers are fragrant, small, and creamy white and bloom before Japanese tree lilac. Some Peking tree lilac cultivars have performed poorly in evaluation trials in zones 2 and 3, however further testing of new selections is needed.

CULTIVARS FOR ZONES 2 TO 4:

- ⇒ **'Copper Curls'** (H: 20' W: 15') - coppery-orange exfoliating bark; zone 4
- ⇒ **'Great Wall'** (H: 20' W: 12') - upright oval form; exfoliating bark; zone 3



'Ivory Pillar' Japanese tree lilac
Photo credit: Jeffries Nurseries

'Ivory Pillar' Japanese tree lilac - panicles
Photo credit: Jeffries Nurseries

Lindens are proven performers in southern Manitoba where heat units and summer humidity levels are high. For the most part this genus is underused across the southern prairies. Lindens represent an increasingly important tree species in the prairie region as ash plantings are reduced with the expected arrival of Emerald Ash Borer.

Tilia americana – AMERICAN LINDEN (BASSWOOD)

Native to southern Manitoba, basswood or American linden is a beautiful shade tree with prairie adaptation. Large leaves, fragrant summer flowers and golden fall colour make this a desirable landscape tree. Canopy shape is pyramidal as a juvenile, becoming oval with age. Limitations of this species include basal sprouting and sensitivity to road salt.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'American Sentry'** (H: 50' W: 30') - upright branching; pyramidal form; zone 3
⇒ **'Boulevard'** (H: 60' W: 30') - narrow pyramidal habit; ascending branches; zone 3
⇒ **'True North'** (H: 50' W: 25') - oval crown; strong central leader; zone 2

Tilia americana x mandschurica – AMERICAN-MANCHURIAN HYBRID LINDEN

A unique hybrid species between American and Manchurian linden. The original parent tree of *Tilia mandschurica* was planted at Skinners Nursery in Dropmore, Manitoba in 1930.

CULTIVAR FOR ZONES 2 TO 4:

⇒ **'Skinur'** (H: 40' W: 25') - new foliage is silver; large leaves; golden fall colour

Tilia cordata – LITTLE LEAF LINDEN

An introduced species from Europe that grows well in southern Manitoba. Trees are often stunted in other parts of the prairie due to shorter growing seasons and less heat units. Some cultivars ('Corinthian', 'Summer Sprite') lack sufficient hardiness for zone 3.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Golden Cascade'** (H: 50' W: 30') - slightly weeping; golden fall colour; zone 2
⇒ **'Greenspire'** (H: 50' W: 30') - pyramidal form; strong central leader; zone 3
⇒ **'Lone Star'** (H: 40' W: 25') - pyramidal form; dense canopy; zone 2
⇒ **'Norlin'** (H: 50' W: 30') - pyramidal form; resistant to sunscald; zone 3
⇒ **'Shamrock'** (H: 50' W: 30') - broad conical habit; stout branching; zone 4

Tilia mongolica x cordata – MONGOLIAN-LITTLE LEAF LINDEN HYBRID LINDEN

A unique hybrid species between Mongolian and little leaf linden. Mongolian linden offers unique features including golden bud scales, exfoliating bark and strong leaf serrations.

CULTIVAR FOR ZONES 2 TO 4:

⇒ **'Harvest Gold'** (H: 40' W: 25') - oval; exfoliating bark; golden fall colour; zone 2

Tilia x flavescens – AMERICAN-LITTLE LEAF HYBRID LINDEN

A hybrid species derived by crossing American and little leaf linden. These hybrids have a dense, conical shape and leaves that are intermediate in size between the two parents. In particular, the cultivar 'Dropmore' has shown excellent performance across the prairies.

CULTIVARS FOR ZONES 2 TO 4:

⇒ **'Dropmore'** (H: 50' W: 35') - dense, pyramidal crown; zone 2
⇒ **'Glenleven'** (H: 50' W: 30') - open, pyramidal crown; zone 3

'True North' American linden

Photo credit: Prairie Shade Nursery

'Skinur' hybrid linden

Photo credit: Jeffries Nurseries

'Golden Cascade' littleleaf linden

Photo credit: Greg Morgenson, NDSU

'Harvest Gold' Mongolian linden - fall colour

Photo credit: Jeffries Nurseries

The best selling and most adaptable linden in the prairie region was discovered as a superior seedling in a seedbed of lindens at the Skinner Nursery near the northern town of Roblin, Manitoba. Reported as a natural hybrid of the introduced European little leaf linden (*Tilia cordata*) and the native American linden or basswood (*T. americana*), the seedling was introduced in 1955 as 'Dropmore' hybrid linden. Skinner Nurseries named the cultivar after the original post office hamlet closest to their nursery site.

The cultivar has become popular as a very hardy prairie tree suited to the colder and drier zones in Alberta and Saskatchewan where many little leaf linden cultivars suffer from trunk sun scald and tip die back. Populations of seedlings we have grown out from seed of the 'Dropmore' cultivar validate its hybrid parentage by showing characteristics of both parents. While the tree is not a heavy producer of viable seed, it is certainly not a sterile hybrid. It flowers abundantly and the fragrant flowers are attractive to bees in mid summer.

'Dropmore' linden is a strong grower with no major disease problems and possesses resistance to the leaf gall mite which affects the native American linden. It has clean green foliage, which turns golden yellow in fall colour, dark brown bark, and showy fragrant flowers which appear in late July or early August. It propagates well by summer bud grafting on rootstocks of seedlings from either of its parents. The crown form is an oval upright form and the tree can keep a strong central leader with a minimum of training. Under nursery conditions it is considered a strong grower and transplants very well.

The lack of major disease or insects pests in the Canadian prairie region is finally giving a boost to the use of lindens. Supplemental moisture and good soil fertility are the keys to growth and crown development especially in the western Canadian prairies and western great plains of the U.S. where moisture is often limiting. Without ideal growth conditions, linden trees will often develop large trunks with a very stunted, wide crown.

'Dropmore' hybrid linden on residential street in Morden, MB.

Photo credit: Jeffries Nurseries

Two linden introductions, 'Golden Cascade' and 'Harvest Gold' came from related seedling stock grown from seed collected in Morden. They are gaining wider acceptance throughout the northern U.S. and Canada as easy-to-transplant trees. Both cultivars have survived winter temperatures as low as -40 degrees C or F. Lindens are becoming more important in the tree mix as ash production has decreased due to the threat of Emerald Ash Borer.

'Golden Cascade' is a cultivar with cascading branches and a wider crown pattern. It shows less characteristics of Mongolian linden and more of the *T. cordata* type parent grown from seed from eastern Asia. The bark colour is distinct from *T. cordata* and the fall maturity is reached two weeks ahead of the normal maturity of *T. cordata*. 'Golden Cascade' has performed very well in North Dakota and across the prairie region. The crown form is distinctive, branching is strong and it is reported as resistant to Japanese beetle.

'Harvest Gold' is a medium-sized cultivar with vigorous growth and ascending crown form. Its superior fall colour and earlier fall maturity combine to give it superior adaptation to northern areas. The influence of Mongolian linden parentage on 'Harvest Gold' is clearly seen in its traits of golden buds, exfoliating bark and strong leaf serrations. 'Harvest Gold' develops a straight stem with excellent resistance to sun scald which has often affected other *Tilia cordata* cultivars. The crown form of 'Harvest Gold' in young trees is ascending, but on 20 year old trees the form becomes more oval shaped with strong branches that are not subject to breakage. The smaller leaves and exceptionally clean foliage along with reported Japanese beetle resistance are strong features of this cultivar.

'Golden Cascade' Linden - weeping branches
Photo credit: Greg Mortenson

'Harvest Gold' Mongolian linden - fall colour
Photo credit: Jeffries Nurseries

Despite the impact of Dutch Elm Disease (DED), elm remains among the top genera in the large statured shade tree category.

Ulmus americana – AMERICAN ELM

Still a favorite of city foresters due to its outstanding adaptation to urban conditions.

RECOMMENDED PRAIRIE CULTIVARS:

⇒ **'Brandon'** (H: 65' W: 35') - DED susceptible; upright form; zone 2

⇒ **'Prairie Expedition'** (H: 60' W: 50') - DED resistant; challenging to shape; zone 3

Ulmus davidiana japonica – JAPANESE ELM

Initially touted as a DED-resistant replacement for American elm, Japanese elm does not have the stature to replicate the cathedral-like canopies of American elm. However, it does grow into an attractive medium-sized tree suitable for residential landscapes.

RECOMMENDED PRAIRIE CULTIVAR:

⇒ **'Discovery'** (H: 40' W: 30') - DED resistant; compact canopy; zone 3

⇒ **'Northern Empress'** (H: 30' W: 25') - DED resistant; red fall colour; zone 3

Ulmus pumila – SIBERIAN ELM

Planted extensively in the 1970's, Siberian elm has shown itself to be a poor choice due to seediness and twig dieback due to DED infection. Further plantings are not recommended.

Ulmus x – HYBRID ELM

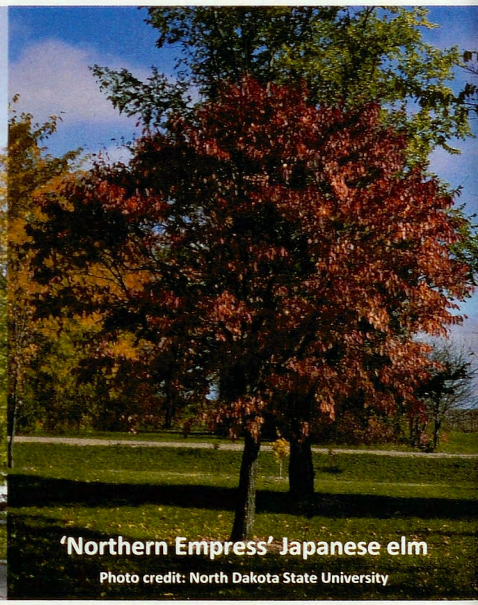
Hybrid elm have been developed at several institutions in the U.S. including the Morton Arboretum. Vigorous cultivars with DED resistance are the result of combining genes from *Ulmus wilsoniana*, *U. japonica*, and *U. pumila*.

RECOMMENDED PRAIRIE CULTIVARS:

⇒ **'Accolade'** (H: 70' W: 50') - upright, spreading canopy; zone 4

⇒ **'Triumph'** (H: 60' W: 40') - excellent growth rate; vase-like canopy; zone 3;

'Brandon' American elm
Photo credit: University of Manitoba



'Northern Empress' Japanese elm
Photo credit: North Dakota State University

No large shade tree is considered more adaptable to urban conditions than the American elm. It's cold hardiness, transplant success, as well as drought and salt tolerance provide this species with a formidable status in zones 2 and 3. However, many American elm (*Ulmus americana*) trees have faded away from prairie forest and landscapes with the spread of the virulent fungus causing Dutch Elm Disease (DED). There is, however, one area of North America where the disease is not endemic: the province of Alberta, where thousands of this popular tree are still planted each year.

The 'Brandon' American elm was introduced by Dick Patmore of Patmore Nursery in Brandon, Manitoba. Patmore Nursery was one of the pioneer prairie nurseries and traces its beginning to the late 1800's. It was well known as a grower of shade trees and many of the early fruit trees for colder zones. Dick Patmore selected the 'Brandon' elm for its well branched, vase-shaped form before the advent of DED in this region. Patmore Nursery grafted or budded the clone on seedlings of American elm. Many B.C. nurseries, who were not restricted from shipping elms to Alberta (as was Manitoba after 1975), began to propagate large numbers of 'Brandon' for the growing Alberta market. This cultivar has remained the predominant clone of American elm in the northern zones for more than 60 years. The absence of native elm trees has served to enforce Alberta's isolation and enable the continued use of a DED-susceptible, yet suitable tree in what is otherwise a "cultivar deficit" area.

'Prairie Expedition' American elm was selected by Dr. Dale Herman of North Dakota State University as a survivor tree along the Wild Rice river south of Fargo, N.D. Although highly resistant to DED, 'Prairie Expedition' has presented some challenges to nursery growers seeking to shape its canopy. Unfortunately, this cultivar does not have the consistent branching habit of its DED-susceptible counterpart, 'Brandon'.

'Prairie Expedition' American elm
Photo credit: North Dakota State University

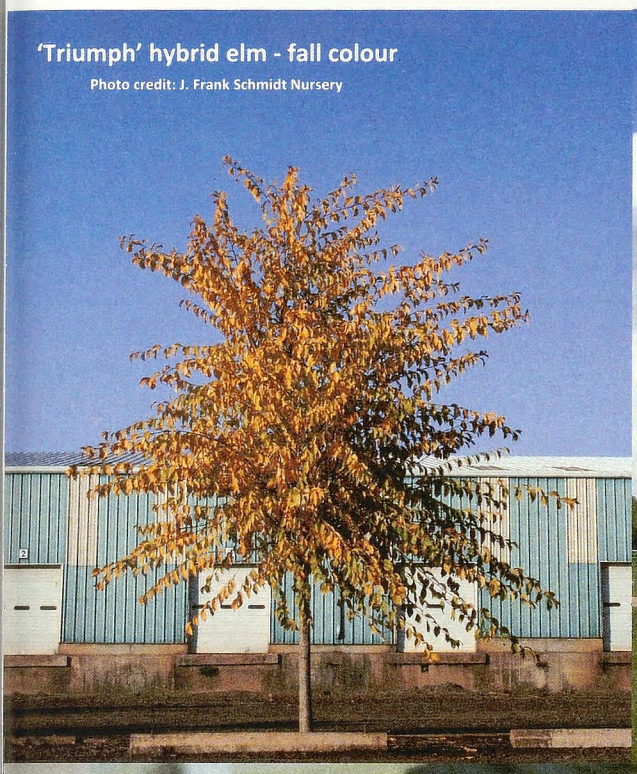
American elm at Manitoba legislature
Photo credit: University of Manitoba

The story on Asiatic elms in northern zones 2 to 4 goes back to 1939 when the Morden Research Station received 25 Japanese elm trees from the Indian Head Tree Nursery. Today, most of these trees are still alive after more than 75 years of growing. Skinner's Nursery must also have received seed from Manchuria about the same time, as four trees were passed on to the Morden Station in 1941 from this second source. The best one of these four plants was still alive after over 75 years of growing. In 1969, work was started at Morden Research Station to collect Japanese elm seed and graft superior trees onto Siberian elm roots. The objective was to build stock of Japanese elms as a recommended source of Dutch Elm Disease resistance even though DED was not yet present in Manitoba.

Probably the greatest interest in Asiatic elms was coming from the U.S. where DED was in full epidemic mode in the eastern midwest including Chicago. In 1969, I (Wilbert) visited Dr. George Ware, a tree breeder at the Morton Arboretum in Chicago. He was seeking to establish a program for DED-resistant elms. At his request, I was able to send scions and seed of the Asiatic elms growing at Morden Research Station. Ware used the Morden sources to cross with Siberian elm resulting in the 'Triumph' hybrid elm cultivar which we grow today in zone 3. I believe if a hardier Siberian elm had been used in crossing, that 'Triumph'-type hybrids would be even more hardy. The Morden breeding material may also have been used in the development of other Asiatic elm hybrids introduced from other institutions in the United States.

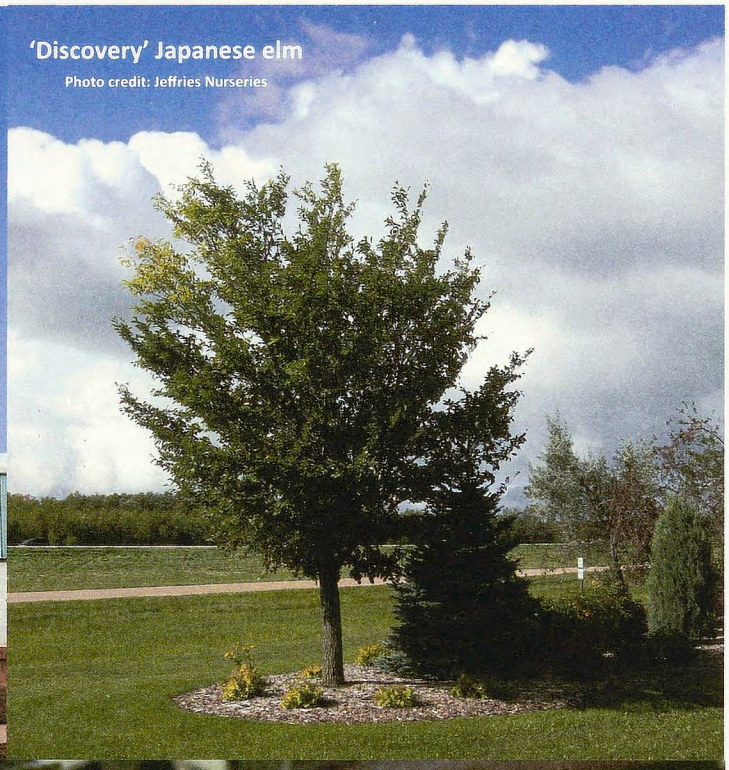
The result of work at Morden, Manitoba through the 1970's led to the introduction of 'Jacan', 'Mitsui Centennial' (recognizing the 100th anniversary of Mitsui Corporation), and 'Freedom' cultivars of Japanese elm. The Indian Head Tree Nursery introduced the 'Thompson' Japanese elm from their material. It was very difficult to get nurseries to produce the Asiatic elms as the Canadian government, upon the arrival of DED in Manitoba in 1975, prevented the shipment of any elm including DED-resistant cultivars to Saskatchewan and Alberta. This restriction limited the market for Japanese elm to about 20% of the prairie potential. Combined with propagation difficulties and the slower growth of Asiatic elms, it was a difficult market. The lack of tissue culture facilities and good softwood cutting procedures at that time only made the production of Japanese elms more tenuous.

In the late 1970's, Morden Reseach Station grew about 3000 Asiatic elm seedlings and distributed them to 10 Manitoba nurseries in an effort to encourage more propagation of DED-resistant elms. At his newly established Prairie Shade Nursey, Rick Durand was able to grow these seedlings for several years and select one tree which was named 'Discovery'. Rick was able to arrange movement of 'Discovery' into a DED-free area for tissue culture production at a west coast facility, thus assuring a steady supply of own-rooted plants and the ability to ship to a much wider market area than was possible from Manitoba production. The 'Discovery' cultivar remains the major Asiatic elm in northern zones at this time.



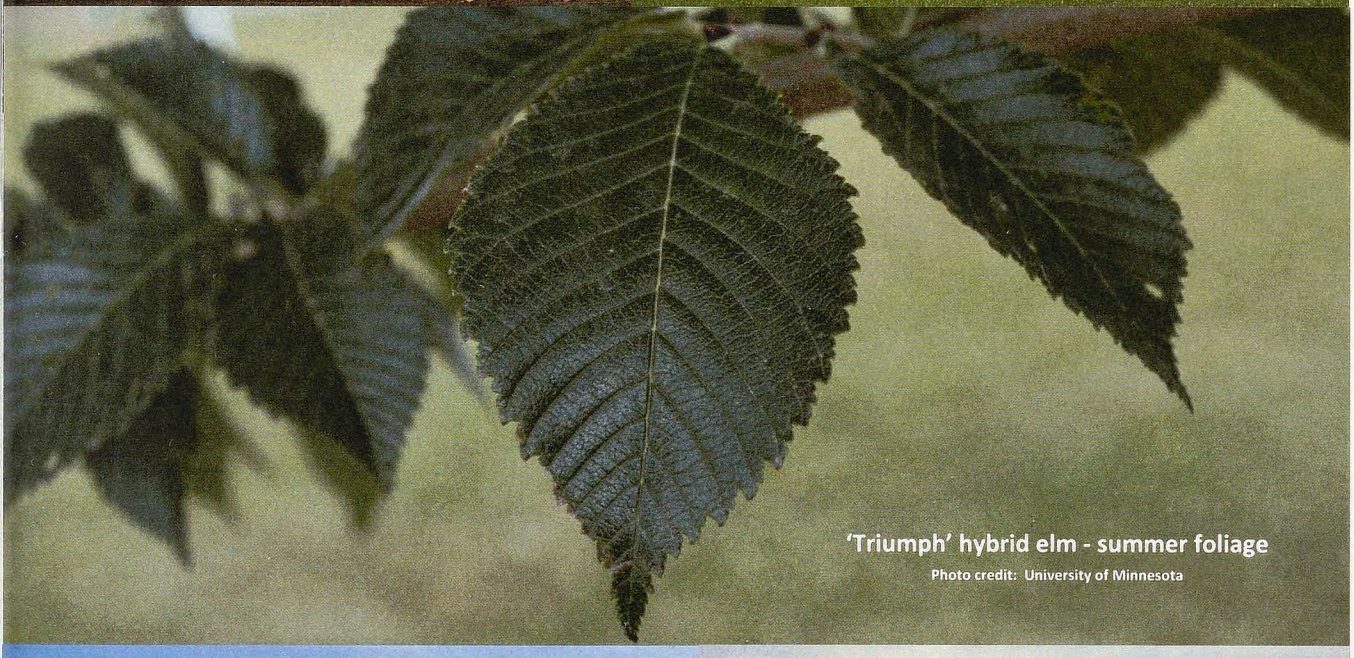
'Triumph' hybrid elm - fall colour

Photo credit: J. Frank Schmidt Nursery



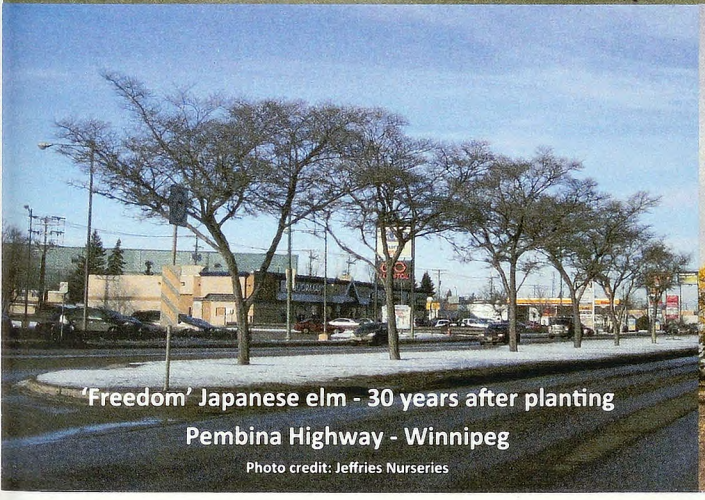
'Discovery' Japanese elm

Photo credit: Jeffries Nurseries



'Triumph' hybrid elm - summer foliage

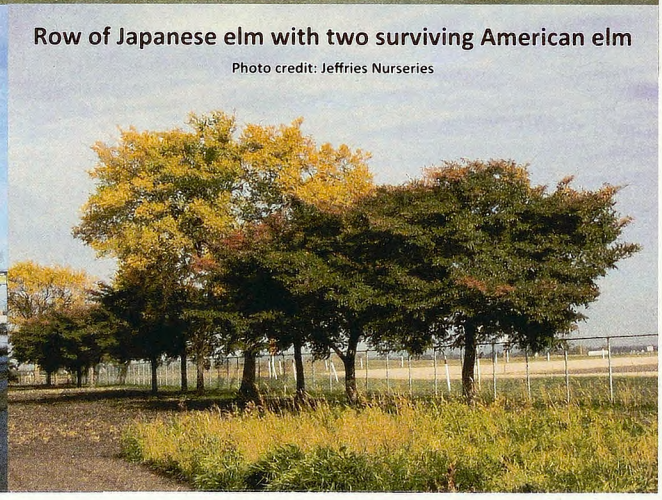
Photo credit: University of Minnesota



'Freedom' Japanese elm - 30 years after planting

Pembina Highway - Winnipeg

Photo credit: Jeffries Nurseries



Row of Japanese elm with two surviving American elm

Photo credit: Jeffries Nurseries

There are several deciduous tree species that are considered of minor interest at the present time, but may become more valuable in the future. In some cases, these trees are new to the prairies, with germplasm recently entering the region for the first time.

Acer triflorum - THREE-FLOWERED MAPLE

The three-flowered maple, is a species of maple native to hills of northeastern China and Korea. Limited testing in southern Manitoba has shown some promise for this unique tree.

Catalpa ovata - CHINESE CATALPA

Chinese catalpa is the most winter hardy species in the genus and can survive in microclimates in southern Manitoba. Northern catalpa (*Catalpa speciosa*) is best used in zone 5.

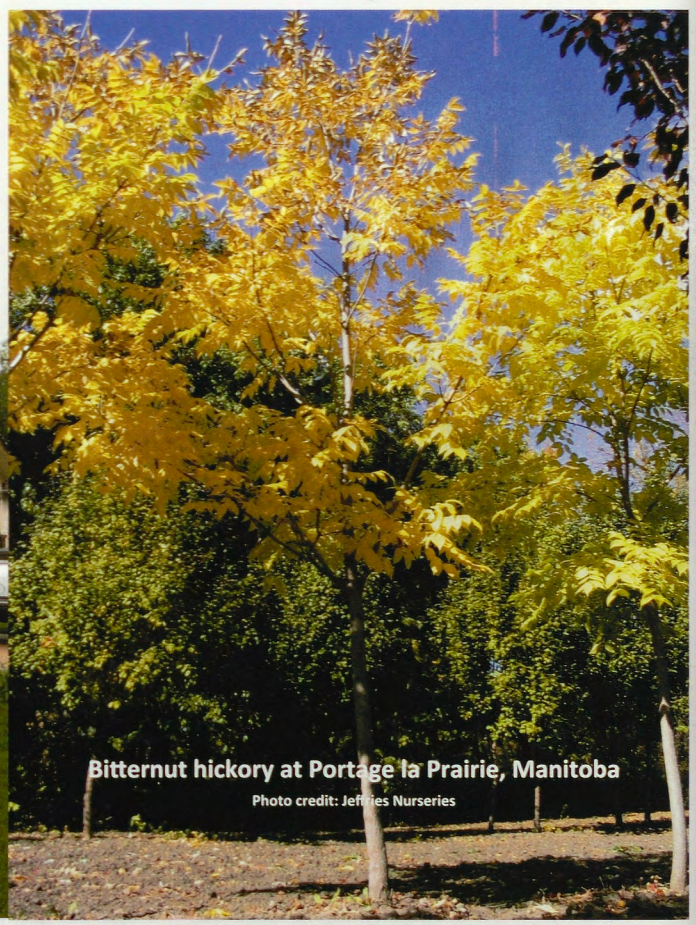
Carya cordiformis - BITTERNUT HICKORY

Native stands of bitternut hickory can be found as far north as Itasca state park in north-central Minnesota. It is a slow-growing hardwood tree that has performed well in limited trials in southern Manitoba.

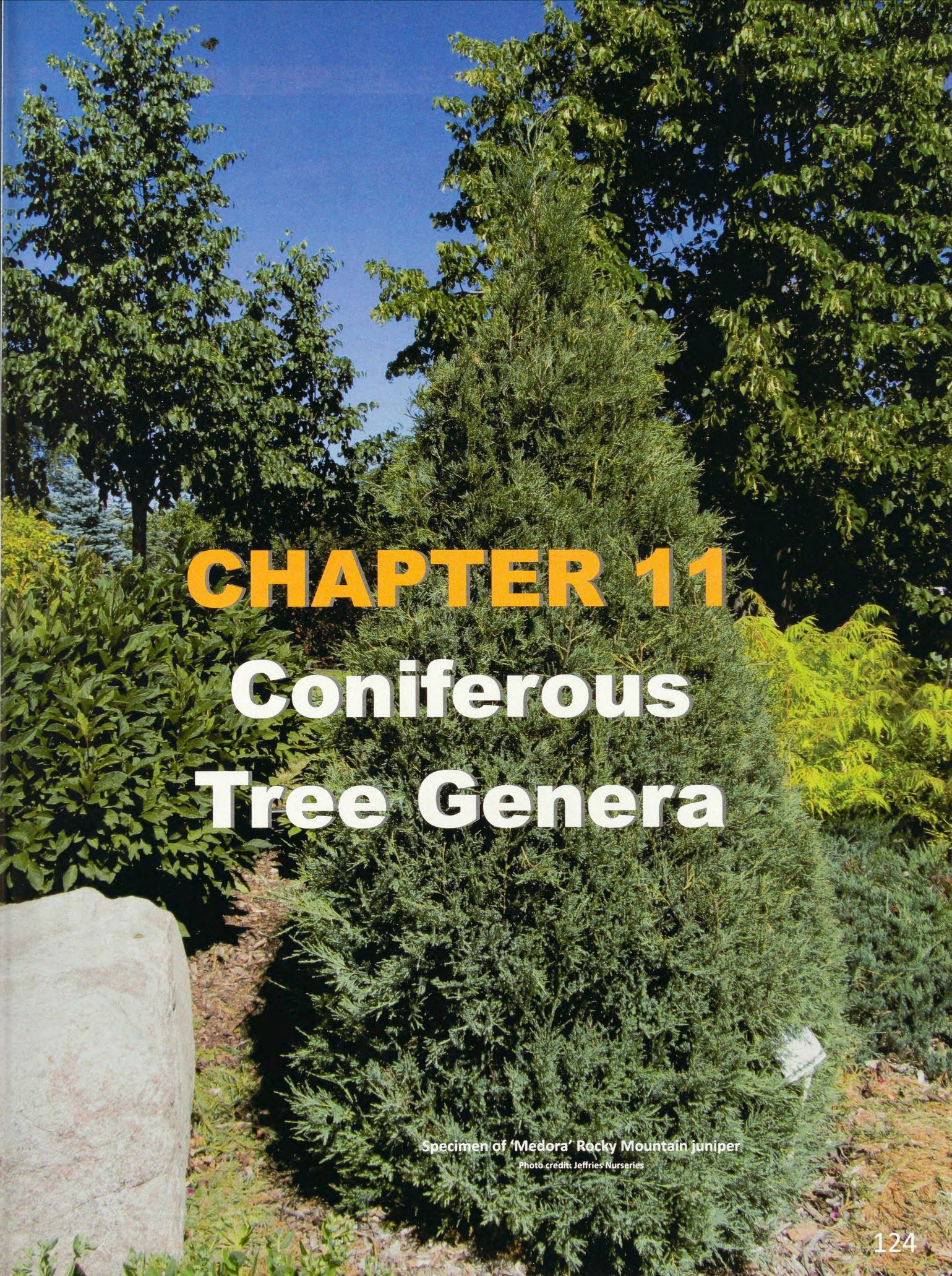
Ginkgo biloba - GINGKO

Gingko grows reliably as a street tree in the twin cities of Minneapolis-St. Paul, Minnesota. However, recent attempts to establish cultivars: 'Autumn Gold', 'Saratoga' and 'The President' in zone 3 field trials have failed.

Chinese catalpa in Morden, Manitoba
Photo credit: Jeffries Nurseries



Bitternut hickory at Portage la Prairie, Manitoba
Photo credit: Jeffries Nurseries



CHAPTER 11
Coniferous Tree Genera

Specimen of 'Medora' Rocky Mountain juniper

Photo credit: Jeffries Nurseries

Conifers play an important role in northern landscapes. With the exception of the deciduous larch (*Larix*), we rely on the evergreen conifers to give us the exterior greenery over long periods of winter conditions. Although the boreal forest has a number of evergreen species that are reliably hardy in prairie zones, it is the introduced species including Colorado spruce (*Picea pungens*), the 'Black Hills' strain of native white spruce (*Picea glauca*) and Scots pine (*Pinus sylvestris*) that with pyramidal forms of our native white cedar (*Thuja occidentalis*) have become the backbone of our evergreen plant choices.

Boreal forest areas are generally characterized by moist, acidic soils which becomes a limiting factor in using more of the hardy native conifers in prairie regions with dry, alkaline soils. The native evergreens are not lacking in hardiness as white pine (*Pinus strobus*) is found in zones 2 and 3 in eastern Manitoba; the red pine (*Pinus resinosa*) occurs in the sandy soils of Black Island in Lake Winnipeg (zone 2); and the black spruce, balsam fir, jack pine and limber pine are found in zone 1. However, it is uncommon to find a healthy tree of any of these species in the alkaline areas of the midwest and prairies. Another factor that limits the use of some native conifer species is their preference for extremely moist planting sites as is the case for native larch (*Larix laracina*) and black spruce (*Picea mariana*).

DECIDUOUS CONIFERS

Tamarack or larch (*Larix laracina*), has a widespread distribution from central Manitoba outlier stands across the northern forest zone from the southeast to the northwest. While the tamarack is a long-lived native tree, the introduced Siberian larch (*Larix siberica*) usually has much wider landscape use in the prairie region due to its drought tolerance and adaptation to mineral soils. Larch could have wider landscape application in locations that allow for large trees, such as municipal parks.

Native tamarack in Manitoba
Photo credit: University of Manitoba

Siberian larch in the landscape
Photo credit: University of Manitoba

EVERGREEN CONIFERS

Two species of tree-form of juniper range into the U.S. Midwest, but none are found as native trees in prairie Canada. Rocky mountain juniper (*Juniperus scopulorum*) from western North Dakota sources has yielded the 'Medora' cultivar. 'Medora' has proven to be the most reliable, deer-resistant evergreen in a pyramidal form that can be grown in zones 2 and 3. It is clearly a full zone more winter hardy than other older upright cultivars. The new 'Sky High' juniper introduction from Bailey Nurseries has not been fully tested in the prairies, but it may have equal hardiness to 'Medora' based on its North Dakota origin.

The eastern red juniper (*Juniperus virginiana*) has not proven to be a long-lived tree in zones 2 and 3. The 'Taylor' cultivar has been trialed for more than 15 years in southern Manitoba, but has suffered serious winter burn on two occasions, rendering the plants unsaleable.

'Medora' Rocky Mountain juniper in the landscape
Photo credit: Jeffries Nurseries

'Sky High' Rocky Mountain juniper
Photo credit: Bailey Nurseries

True firs (*Abies* spp.) are seldom used in the prairie landscape. The native Balsam fir (*Abies balsamea*) prefers acidic, organic soils and higher moisture; conditions that are seldom found together in most of the prairie region. Probably the species could see wider use with soil modification, such as the addition of acidic peat moss. Alpine fir (*Abies lasiocarpa*) from the high altitudes of the western Rocky mountains has done well in zone 2 landscapes at the University of Saskatchewan.

The silver or concolor fir (*Abies concolor*) has been represented by a specimen at the Morden Research Centre for over 75 years. It has shown some winter browning and is a species more suited to zone 4 and 5. The Siberian fir (*Abies siberica*) is an introduced Asian tree that has grown well in landscapes in southern Manitoba, but is rarely planted. Spring frosts can sometime damage the new growth of Siberian fir.

Two main spruce species form the dominant percentage of evergreen cover in our northern boreal forest. They are among the hardiest of evergreen trees and are adapted to quite different sites. The native black spruce (*Picea mariana*) is typically found growing in wetter locations, including poorly drained lowlands. Abundant across the central and northern regions of the prairie provinces, it is rarely found growing anywhere other than a forest setting. The native white spruce (*Picea glauca*) is a common forest tree on well-drained sites in the boreal forest. With its strong growth rate and adaptation to agricultural areas it has proven more suited to prairie landscape use than any other native evergreen.

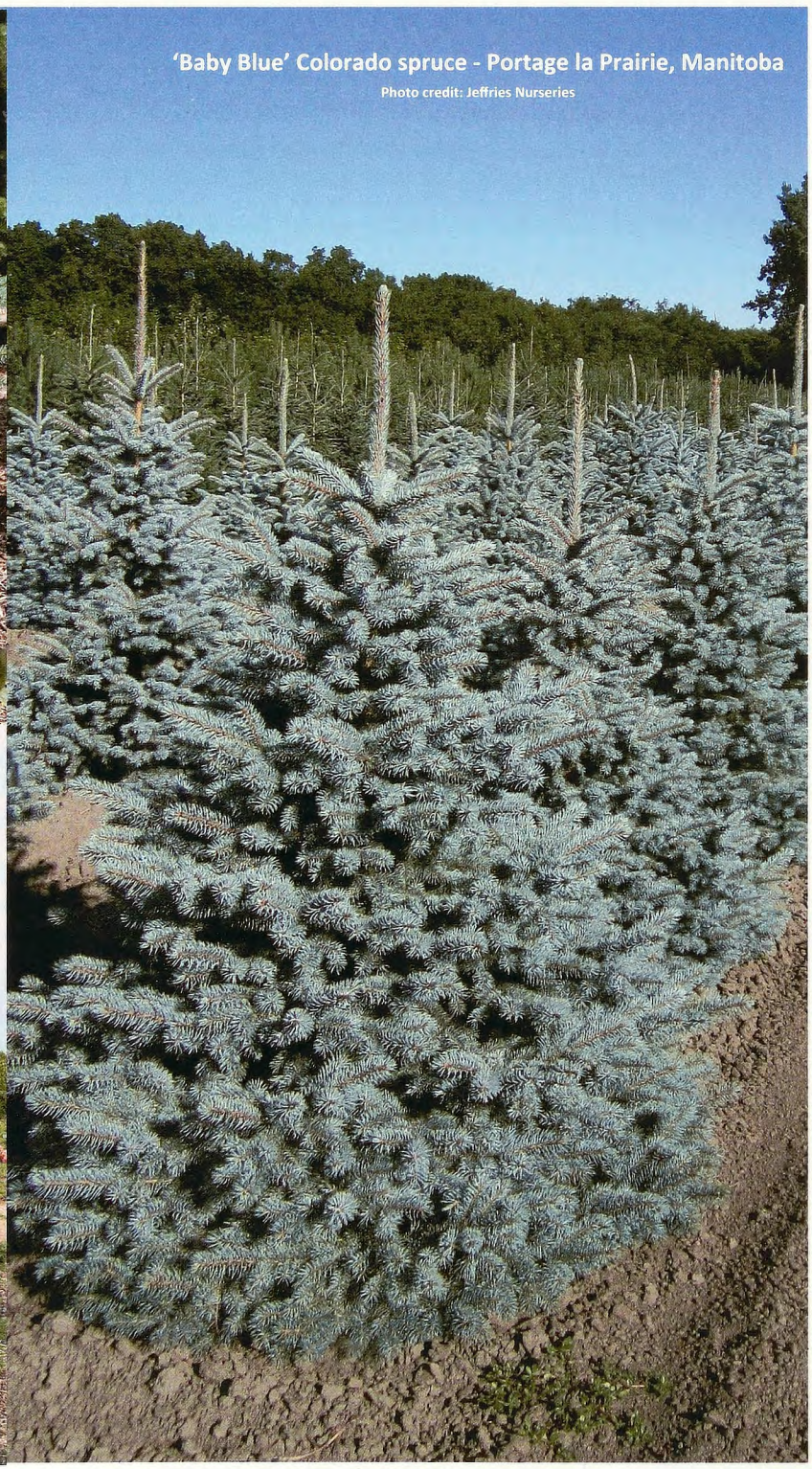
Among introduced species, the Colorado spruce (*Picea pungens*) along with the 'Black Hills' strain of white spruce have dominated spruce plantings in the prairie region. In general, 'Black Hills' white spruce (*Picea glauca* var. *densata*) has been favoured in the landscape industry for its denser branching compared to local seed sources. The genetic purity of the 'Black Hills' strain is open to question after many years of seed reproduction. We have seen considerable plant variation in this seed strain, but overall it has rarely suffered any damage from frost or winter in zones 2 and 3.

The Colorado spruce originates from the southwestern United States in the Rocky Mountains from Colorado to Utah to New Mexico and Wyoming. Colorado spruce comes in both green and blue-needled forms. Seed strains native to the 'Kaibab' and 'San Juan' forests have consistently shown winter browning as young trees following severe prairie winters. In contrast, the strains of Colorado spruce now grown in North Dakota and prairie regions, have unusual tolerance to winter conditions. Progress in Colorado spruce seed strains with blue coloured needles has been dramatic in the past 25 years and most of these strains are from seed harvested from the fine select clones such as 'Hoopsii'. The 'Everblue' strain from Everblue Nursery of Calgary, Alberta consistently produces a uniform seed strain with close to 100% blue phase. The Jeffries' 'Select' strain also has a high proportion of silver blue individuals. The 'Baby Blue' strain from Ontario, has yielded close to 100% silver blue seedlings. With such consistently high quality seedlings, the need for grafting of named cultivars has been in decline.

Nevertheless, some Colorado spruce cultivars should be mentioned. The first, named 'Hoopsii', originated in Europe and is extremely cold hardy with outstanding silver blue needles. As a young tree it may require some careful training to form a straight trunk and full crown, but as it develops into a mature specimen it is among the best of the blue spruce. It should be noted that seeds of 'Hoopsii' spruce produce a very high quality seedling strain. A second even more important prairie cultivar is 'Globosa', the globe blue spruce, which can be grown as a globe-shaped, own-rooted form or as a top-grafted crown on a 1 meter (3') interstem. Globe blue spruce will develop the regular crown of a spruce if allowed to develop a central leader. In our experience, this cultivar grows at 50-60% of the rate of a seedling Colorado spruce. The Columnar Colorado spruce, 'Fastigiata', is more popular in zones 4-5 than in zones 2-3. It struggles after extreme winter weather and is prone to needle loss and browning. With some improvement in winter hardiness this columnar form would have a place in northern zones.

Other introduced spruce species include Norway spruce (*Picea abies*) and Meyers spruce (*Picea meyeri*). Norway spruce is a large growing spruce with large cones and drooping secondary branches. It is little grown in recent years, although dwarf cultivars developed from this species including 'Little Gem', 'Ohlendorfii' and 'Nidiformis' are sold in small quantities. Meyers spruce is an introduced species from China that has been recommended as an alternative to Colorado spruce. With bluish needles and tolerance to a wider range of soils, it has been successfully cultivated in North Dakota.

'Globosa' Colorado spruce top-graft
Photo credit: Bailey Nurseries



'Baby Blue' Colorado spruce - Portage la Prairie, Manitoba
Photo credit: Jeffries Nurseries

'Black Hills' white spruce
Photo credit: Bailey Nurseries

The genus *Pinus* has both native and introduced large tree representatives in the prairie landscape. Pines are unique among conifers since their needles are grouped in bundles called fascicles with 2, 3 and 5-needled forms. Many of the pines also produce attractive scaly bark that has definite winter value. There are six pine species that are native to the prairies and northern plains. Many of these are used extensively in the forest industry and some have been tested to a limited extent as landscape trees.

Jack pine (*Pinus banksiana*) and its related western species Lodgepole pine (*Pinus contorta*), are common native plants on sandy growing sites. The eastern Jack pine does poorly in prairie landscapes, but the western Lodgepole pine has been extensively grown for use in northern Alberta landscapes where the climate and soils are more favorable.

Lodgepole pine (*Pinus contorta*) is native to central and western Alberta as well as a unique, refuge population in Cypress Hills provincial park that borders with Saskatchewan. This dark-green, 2-needled pine is a useful shelterbelt species. Lodgepole pine is quite popular as a native evergreen in Alberta landscapes, but has limited use in other northern areas.

Limber pine (*Pinus flexilis*) is a most interesting, soft-textured, 5-needled conifer found in foothills of the Rocky mountains as well as an isolated population in the North Dakota Badlands. This tree has rarely been grown in nurseries, but its native range suggests it should be somewhat tolerant of prairie conditions. It deserves wider trials and past testing at Morden showed perfect hardiness for the western strain.

Ponderosa pine (*Pinus ponderosa*) is a large-statured, 3-needled conifer native to western North Dakota and the Black Hills of South Dakota. It has been a popular tree in yard shelterbelts particularly in South and North Dakota. Its growth can be rapid and the form straight and full. The only limitation is the occasional winter browning in severe prairie winters.

Red pine (*Pinus resinosa*) is native to eastern Manitoba, with a small, northern outlier stand on Black Island, in Lake Winnipeg, about 160 km (100 miles) north of Winnipeg. Red pine grows on sandy, well drained soil and prefers neutral to acidic soil conditions. It is seldom found in alkaline soils although it deserves wider examination to see if natural variation exists for this characteristic.

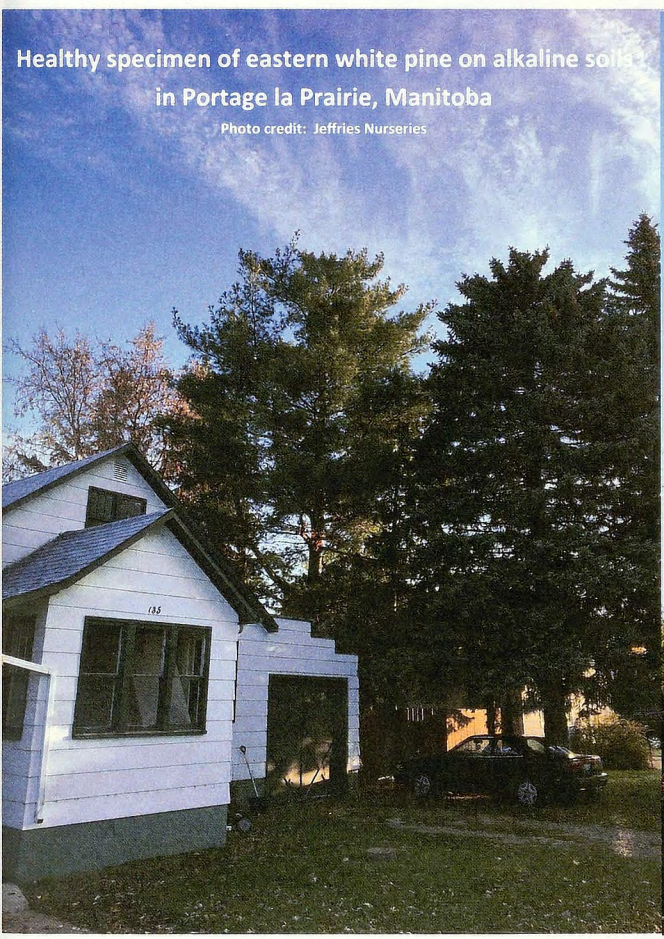
Eastern white pine (*Pinus strobus*) is a 5-needled conifer common to the southeastern region of Manitoba where remnants of the forests that supported early lumber trade can still be found. Its massive tree form would make it a great park tree, but its affinity for more acidic soils has limited its use in agricultural regions. Susceptibility to white pine blister rust has also limited the use of eastern white pine in wetter areas of the prairie provinces. A few specimens are seen in central Manitoba, but most are chlorotic.

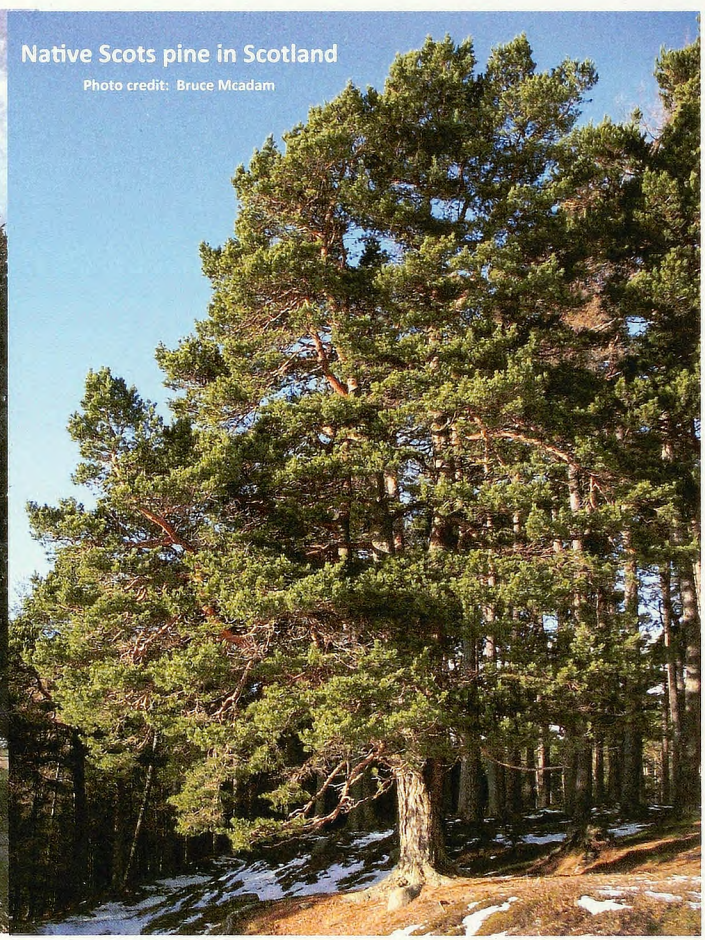
Several pine species have been introduced to the prairies and northern plains from other continents. Finding reliable seed sources and strains of introduced conifers was a continuous problem for early shelterbelt and tree nurseries and this included the pine group.

Scots pine (*Pinus sylvestris*) from Europe has become a very important species based on reliable strains from Russia and northern Finland. It is probably our most widely used tree form pine and can be pruned up into an attractive crown form. The exfoliating, orange-brown bark is a distinctive feature of Scots pine, particularly in the winter months. The trunk damage from sapsuckers has been a cause of concern, but the tree has shown remarkable resilience to overcome this pest.

Swiss stone pine (*Pinus cembra*) is a rare yet choice member of the pine genus that has been grown fairly widely. Its soft, 5-needled foliage make it a full bodied tree which is slower growing and compact. Swiss stone pine is often damaged by deer browsing, but as the tree becomes mature and lower branches are removed this could be manageable.

Mugo pine (*Pinus mugo*) is capable of becoming a small tree, but the more popular dwarf forms are often heavily sheared to maintain a compact form. Several dwarf forms (e.g. 'Pumilio') and the upright variety *uncinata*, have been successfully grown in the prairie region.


Healthy specimen of eastern white pine on alkaline soils in Portage la Prairie, Manitoba
Photo credit: Jeffries Nurseries


Native Scots pine in Scotland
Photo credit: Bruce Mcadam

Eastern white cedar (*Thuja occidentalis*) is unique in that many important landscape trees and shrubs have been developed from this evergreen species. The native distribution of the species includes the eastern one third of southern Manitoba as far north as 250 miles north of Winnipeg. Eastern white cedar is valued for its dense evergreen foliage and tiny seed cones. On older trees that are headed up, the unique bark of this species comes into view with long peeling strips. Among the recommended prairie cultivars are broadly-pyramidal growers (e.g 'Techny') and narrow pyramidal types including the 'Skybound' cultivar. In terms of culture, the value of deep watering in the fall cannot be overstated. Cedar foliage has a high rate of water loss in the dry, windy prairie winter and water uptake prior to freeze -up is essential to prevent winter browning. Deer browsing of cedar can be a major problem on rural properties.

RECOMMENDED PRAIRIE CULTIVARS:

- ⇒ **'Brandon'** (H: 25' W: 5') - columnar form; subject to snow damage; zone 3
- ⇒ **'Dark Green'** - (H: 25' W: 10') - broad pyramidal form; dark-green colour; zone 2
- ⇒ **'Skybound'** (H: 25' W: 5') - outstanding columnar form; dense foliage; zone 2
- ⇒ **'Techny'** (H: 20' W: 10') - broad pyramidal form; zone 2

Eastern white cedar - young bark and foliage
Photo credit: University of Manitoba

Eastern white cedar - peeling mature bark
Photo credit: University of Manitoba

'Techny' eastern white cedar - sheared hedge

Photo credit: Bailey Nurseries Inc.

'Skybound' eastern white cedar - patio privacy screen

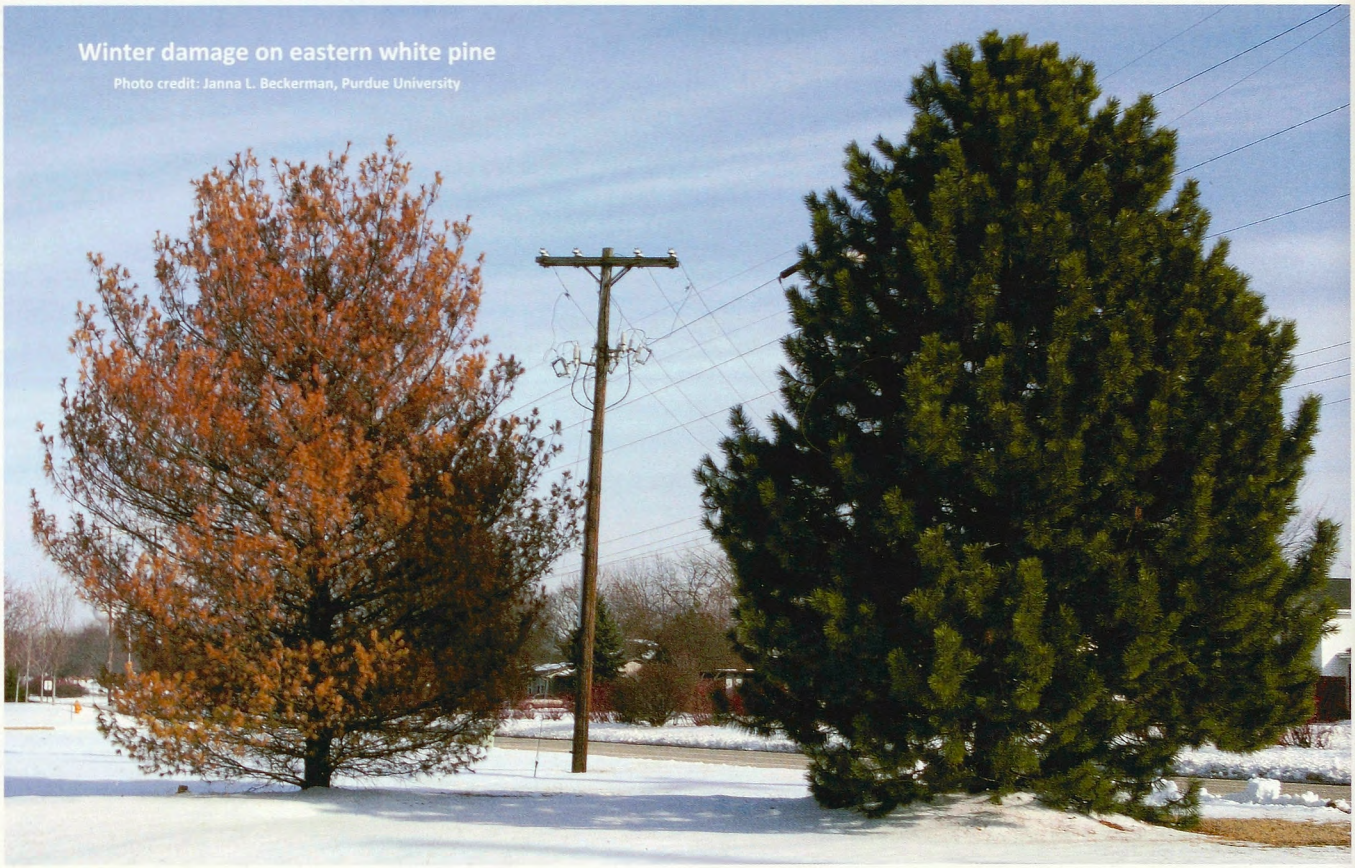
Photo credit: Jeffries Nurseries

Few evergreens are native to the prairie ecozone where precipitation is limited and dry, cold winters test the strength of any plant that chooses to retain its foliage. Most of our native evergreens are confined to the eastern or western boundaries of the prairie region or in the boreal forest of the Canadian shield where soils are more acidic and summers are cooler. When we choose to plant evergreens in the southern parts of the prairie provinces, some special care is required to successfully overwinter these trees.

Evergreens should receive abundant moisture in fall before the soil freezes up. Remember that evergreens lose water from their foliage throughout the winter, but are unable to take up replacement moisture from the frozen soil below. Hence there is value in deep fall watering in an attempt to fully hydrate the tree prior to the onset of winter.

In communities prone to dry, desiccating winter winds, it may be prudent to construct simple windbreaks beside the tree that deflect wind. Rather than wrapping an evergreen to protect it from winter sun and drying winds, install a burlap wall on either side of the plant. It is important to ensure adequate air circulation around the tree, so the burlap should not touch the foliage.

Planting location is also important when seeking to successfully overwinter evergreen trees. Choosing a sheltered, partially shaded area (e.g. east side of building) that receives ample, lasting snow cover will make a major difference in the longterm survival of evergreen trees.



Winter damage on eastern white pine

Photo credit: Janna L. Beckerman, Purdue University

CHAPTER 12
Tree Diversity for the Future

Fall foliage of 'Regal Celebration' Freeman maple
Photo credit: Jeffries Nurseries

The past has taught us that we need to diversify our tree plantings and avoid the risk of disease and insects to a tree monoculture. While there is a limited selection of trees to draw from in zones 2 to 4, we can extend our limited choices with some good planning. The tree species which produce larger seeds such as walnuts, butternut and buckeyes can be used in wide boulevards and parks where their fruit is acceptable. The same rule might apply to heavy seed and fruit producers such as some maples and some flowering crabapples. The remaining tree species which have no major limitations should make up the standard choices for street and residential use.

The diversity formula proposed by the late Dr. Frank Santamour in which he suggested a maximum use of 10% of a species, 20% of a genus and 30% of a family is still an important rule to observe in tree diversity. More recently, Dr. John Ball of South Dakota State University has proposed a simpler tree planting formula where no more than 5% of the tree plantings in a community should come from a single genus. Using Minnesota as an example, the graph below shows that more than 50% of community trees are ash, maple or spruce. In order to meet Ball's proposal, a list of at least 20 suitable tree genera is needed for the prairie region. This is a tall order, but may be possible with intelligent community planning.

DNR COMMUNITY TREE SURVEY

Top Ten Genera in Minnesota

Based on rapid assessments for every Minnesota community (boulevard, ROW and front-yard trees) in 2010

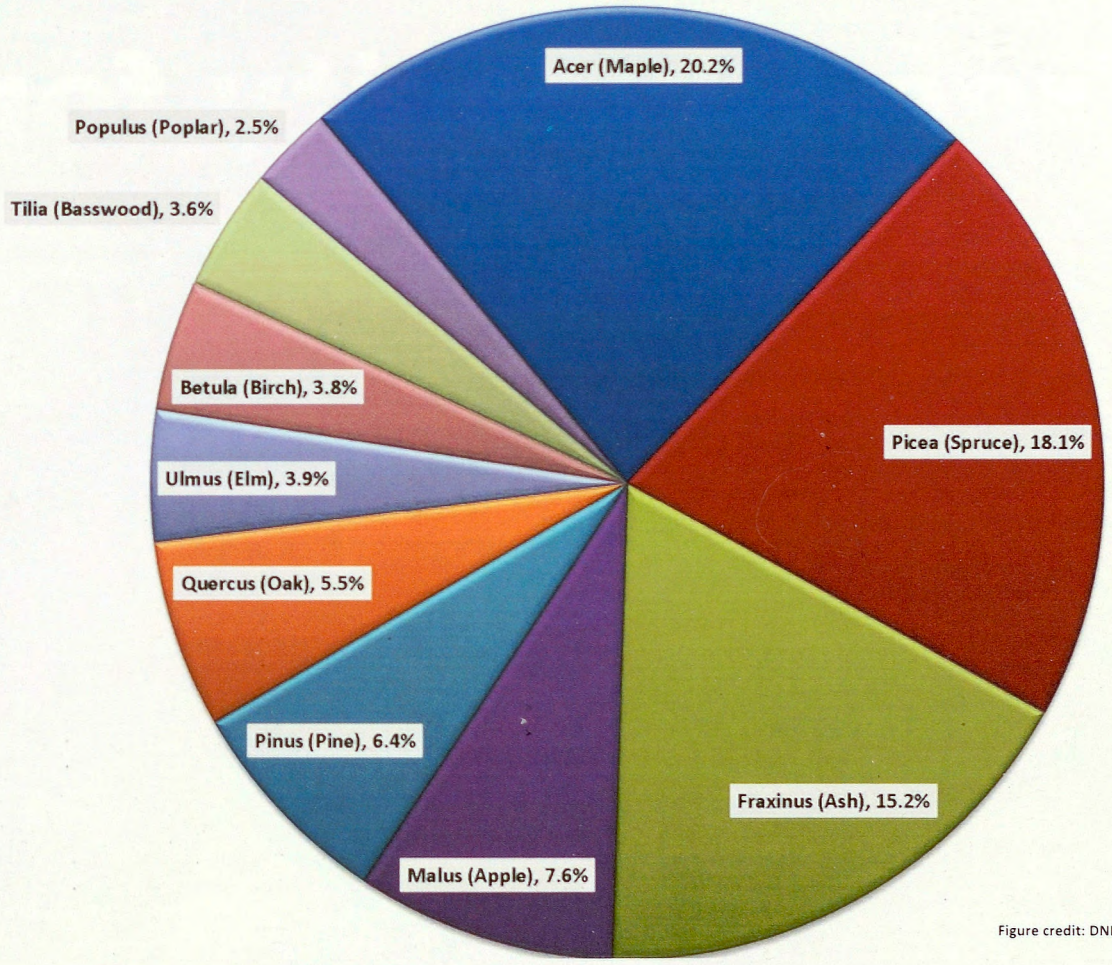


Figure credit: DNR Minnesota

SMALLER STATURE TREES

Flowering crabapples are one of the most important small flowering trees in northern zones. Adding to their flowering appeal is a range of outstanding foliage colours in green and copper to dark purple leaves. Some cultivars with tiny berry size fruit, especially when tenaciously attached to the fruit stem as in 'Starlite', have a place for provision of winter food for birds. However, there remains a strong interest in non fruit-bearing cultivars of which the Canadian-developed 'Spring Snow' leads the North American market. The future will see a major push to develop many more fruitless flowering crabapples. These new female-sterile cultivars will remove the concerns associated with large fruit and trees that have to be sprayed to control pests that could be harboured and spread to high value apple orchards. The development of non fruiting trees will also remove any concern about invasiveness of these plants. The move to have many more improved cultivars with fire blight and apple scab resistance is well within reach and the 'Starlite' and 'Gladiator' cultivars are a marked improvement. We need to respond to homeowners who want to do less spraying and yet expect clean, healthy foliage.

The genus *Prunus* offers many opportunities for new flowering trees. 'Muckle' plum is an example of an interspecific hybrid (*Prunus nigra* x *Prunus tenella*) with outstanding floral display but limited vigor. Can its ploidy be increased for enhanced growth? 'Ming' Amur cherry is thought to be a cross between *Prunus maackii* and *Prunus fruticosa*. It may offer the improved resistance to frost cracking often sought in Amur cherry cultivars grown in areas with wet autumn conditions. Can other similar interspecific hybrids be developed from within this genus to unlock new combinations of ornamental characteristics?

Japanese tree lilac (*Syringa reticulata*) cultivars have become one of the most popular flowering tree for northern zones. They combine abundant summer flowering with clean, attractive foliage. However there are disease limitations attributed to verticillium or anthracnose that cause dead branches and stem damage making some nursery-grown trees unsaleable. This is a problem on which breeders need to continue to work. It would also be valuable to have a range of flower colours but this may be difficult to develop by conventional breeding.

Scab-resistant foliage of 'Starlite' flowering crabapple

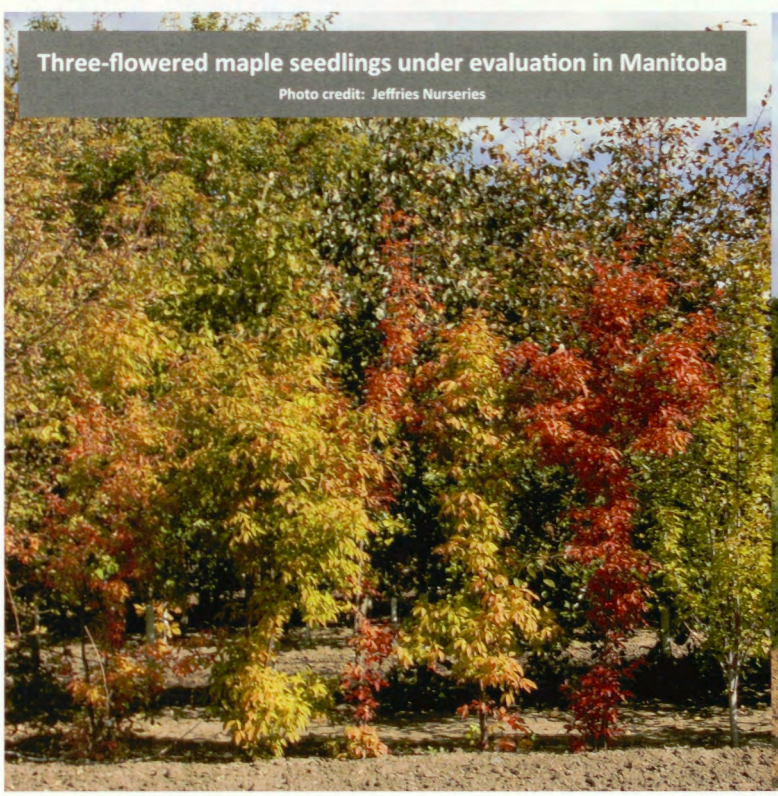
Photo credit: Jeffries Nurseries

LARGER STATURE TREES

The maple genus holds great potential for the future. Recent introductions 'Regal Celebration' Freeman maple and 'Prairie Rouge' red maple are the first promising cultivars that combine alkali-tolerance and northern zone hardiness. No doubt, future breeding work will lead to faster growing cultivars than these preliminary introductions. While there are concerns about the overuse of Freeman maples in some parts of the United States, the species would presently constitute less than 1-2% of tree use in zones 2 and 3.

The hard wood maples, including sugar maple can also become staple trees in zone 3 plantings. Hardier cultivars of Norway maple would enable this species to see wider use in the prairie region. We have seen some early maturing selections of Norway maple in the NDSU arboretum which may hold promise for future development. The three-flowered maple (*Acer triflorum*) is another species that appears to be adapted to zone 3. Finally, are there Japanese maple hybrids that can have a future as featured trees in northern gardens?

While progress has been made in developing columnar birch cultivars (e.g. 'Parkland Pillar') which are suitable for smaller lot size as well as accent and screening, there is a limited choice in other genera for northern zones. The future should see trees from other large-statured genera bred for columnar form, including oak and hackberry. Breeding for form can involve interspecific hybridization between hardy native species and uniquely-shaped exotic species. Alternatively, mass evaluation of native-sourced seedlings can reveal occasional outliers that can be multiplied as clone cultivars.



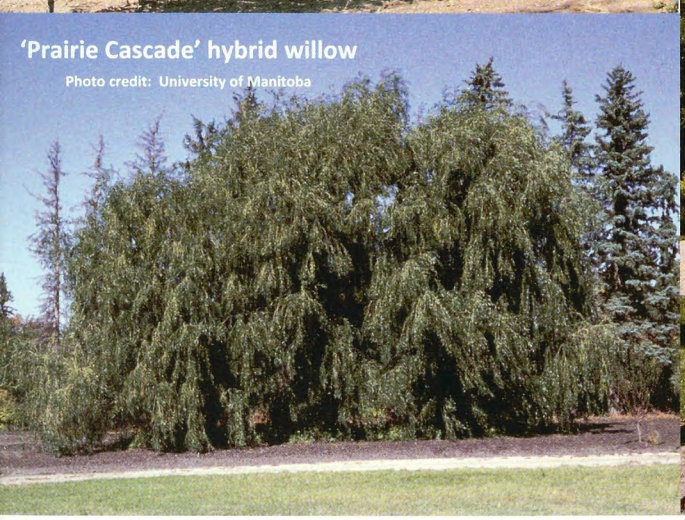
Three-flowered maple seedlings under evaluation in Manitoba
Photo credit: Jeffries Nurseries

'Parkland Pillar' Asian white birch
Photo credit: Jeffries Nurseries

The willows are widely used for their weeping crown form and shelterbelt applications. While the 'Prairie Cascade' weeping willow, developed at Morden, has become very popular in northern U.S. landscapes, it is only considered reliable in zones 3 and 4. The introduced 'Lace' willow from China is perhaps a half zone more hardy but lacks the golden stem colour of 'Prairie Cascade'. There is a wide variation in hardy willows particularly for parks and green spaces. Most of the existing tree-form willows are of very large spreading crown form which limits the usefulness of this genus in most residential areas.

Poplars have been greatly improved for disease resistance and narrow upright form. 'Sundancer' ranks among the better semi-columnar, seedless introductions. However, we still lack a hardy poplar that can match the striking columnar form of the black poplar cultivar 'Lombardy'. With the occurrence of bronze leaf disease in the columnar aspen group, there is a breeding opportunity to develop a range of disease resistance. The 'Guardian' aspen is a start, but there is more genetic improvement needed by future breeders. Ideally the narrow, columnar form of Swedish aspen can be combined with iron-clad resistance to bronze leaf disease.

'Sundancer' hybrid poplar shelterbelt
Photo credit: PFRA



'Prairie Cascade' hybrid willow
Photo credit: University of Manitoba

'Guardian' columnar aspen
Photo credit: Jeffries Nurseries

While some progress has been made in Birch breeding in terms of ascending forms, there are still significant pest limitations such as bronze birch borer and leaf miner. These limitations contribute to a relatively short life span for most hardy birch cultivars in the prairie landscape. Birch might be a genus for future breeders to apply genetic engineering principles to improve stress tolerance and tree longevity by integrating genes for pest resistance.

Elms were considered the premium shade and boulevard tree until the arrival of Dutch Elm Disease. This genus certainly needs to be revisited now that we have DED-resistant clones of American elm for northern zones. These survivors come from native stands in southern North Dakota ('Prairie Exhibition') and southeastern Minnesota ('St. Croix'). We have found 'Prairie Expedition' a difficult tree to produce acceptable grade out in nursery production both at the liner and caliper tree stage. The 'St. Croix' elm may well be lacking in hardiness for zone 3. There is clearly room for a DED-resistant selection with the form of 'Brandon'.

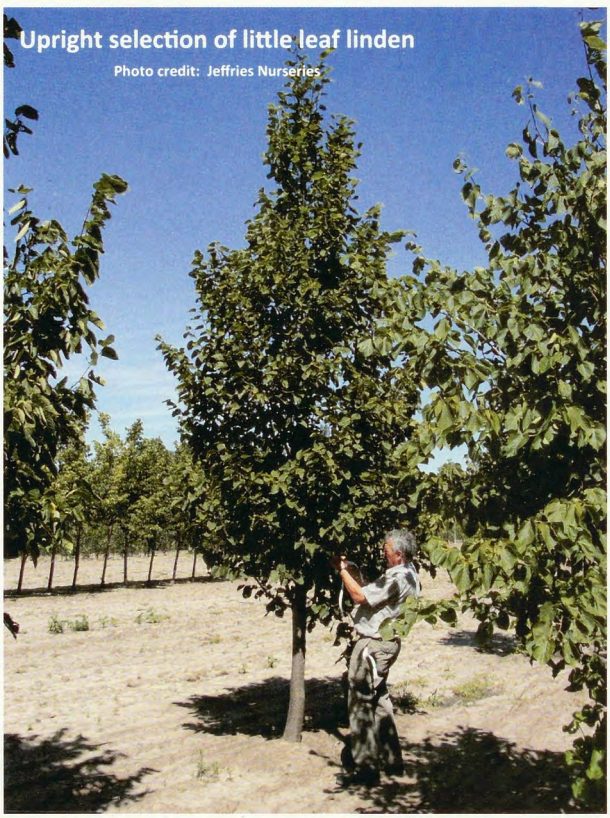
The crown structure of Japanese elm (*U. davidiana var. japonica*) sometimes leaves room for improvement, however the slower growth and smaller stature of the species is a plus for constricted landscapes. Some of the cultivars from other Asiatic elm species are faster growing and more adapted to southern zones. We have found 'Triumph' hardy in zone 3, but it is later maturing and may be damaged in a severe test winter. The more recent hybrid elm introductions of 'Commendation' and 'Danada Charm' have not been adequately tested in our trials. There is a future for better Asiatic elms that possess more hardiness than 'Triumph' while keeping the shorter crown height of the Asiatic cultivars.

'Danada Charm' hybrid elm
Photo credit: J Frank Schmidt Nurseries

Japanese elm selection
Photo credit: Jeffries Nurseries

The lindens, along with the maples, seem to be moving into dominant use with the decline of ash cultivars. Frank Skinner's enduring work with hybridization of the European *Tilia cordata* with the native *Tilia americana* has given us the 'Dropmore' cultivar which is the most popular linden for zones 2 and 3. The value of the *Tilia mongolica* species is seen in the popular 'Harvest Gold' cultivar, grown widely in the U.S. and Canada. Reported Japanese beetle resistance in Mongolian linden is a definite plus in southern and eastern parts of the Midwestern States. A special northern form of European linden is the 'Golden Cascade' cultivar, one of the most overlooked linden introductions. There is also potential in the cultivar 'Skinur', a hybrid between *Tilia mandshurica* and the native *Tilia americana* developed by Hugh Skinner. The large showy leaves are a highlight of this hybrid species.


'Skinur' hybrid linden
Photo credit: Jeffries Nurseries


Upright selection of little leaf linden
Photo credit: Jeffries Nurseries

Although the hackberry is native to southern Manitoba and has done well in boulevard plantings, it remains a much underutilized species and there are no clonal selections for zones 2 and 3. Seedlings of the species are quite variable in form and a superior clone would be a definite asset. Nurseries in the U.S. are now having good success with budding selections of hackberry.

The intercrossing of white oak (*Q. alba*), bicolor oak (*Q. bicolor*) and the native bur oak (*Q. macrocarpa*) will give future gains in oak breeding. The smaller-growing Mongolian oak (*Q. mongolica*) has been evaluated in Manitoba for several decades and although some have reported putative hybrids of this oak, the authenticity of the crosses is doubtful. There are, we believe, possibilities to hybridize this species with bur oak to give smaller-statured oaks with some orange-red fall foliage colour.

The columnar forms of Colorado spruce do well in zone 4 and but often suffer winter browning in zones 2 and 3, as do the southern 'Kaibab' and 'San Juan' strains of Colorado spruce. A columnar Colorado spruce with the hardiness of 'Hoopsii' would be a very reliable prairie evergreen for small spaces. The 'Medora' juniper is unsurpassed as a small, deer-resistant, columnar evergreen conifer. It will show slight discolouration following our severest winters in zone 3, but remains a full zone hardier than 'Wichita Blue' and any other named clones. The recently introduced 'Sky High' juniper from western North Dakota is now under evaluation in zone 3.

Conventional plant breeding has been slow in trees due to long life cycles, slowness to flower and the dioecious flowering habit of a number of genera. The use of new breeding procedures including gene editing could give gains in disease and insect breeding. Losses of birch to pests such as Bronze birch borer greatly limits the use of this genus. This and the related Emerald ash borer pest in ash would be good candidates for gene editing research. Strong gains have been made in tree propagation research using tissue culture and softwood cutting procedures. There are still some genera including oak, buckeye and ironwood where cultivars are underutilized due to propagation difficulties. Hopefully new developments in tissue culture and rooting of softwood cuttings will continue to aid in the success of hard-to-propagate tree species.

Developing tolerance to alkaline soil conditions through breeding or the use of special rootstocks has the potential to increase the use of several tree species. Our work has shown that the screening of Freeman and red maple seedlings can uncover increased tolerance for alkaline soils. The use of bur oak rootstock imparts chlorosis resistance to northern pin oak (*Quercus ellipsoidalis*) in soils as high as pH 8. A similar type of rootstock may be found for use in red oak (*Quercus rubra*) which has the same struggle with soil alkalinity. Issues with dry, alkaline soils are also found in evergreen trees; both white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) are suited to more acidic soils than is common throughout the prairie region. Perhaps an alkali-tolerant, compatible rootstock could allow both of these trees to be useful landscape and park trees in the prairie region. Alternatively, we may find provenances of these species that are more tolerant to prairie soil types. It is only by screening larger populations that this variation is revealed.

Red oak street tree in northwestern Minnesota

Photo credit: Jeffries Nurseries

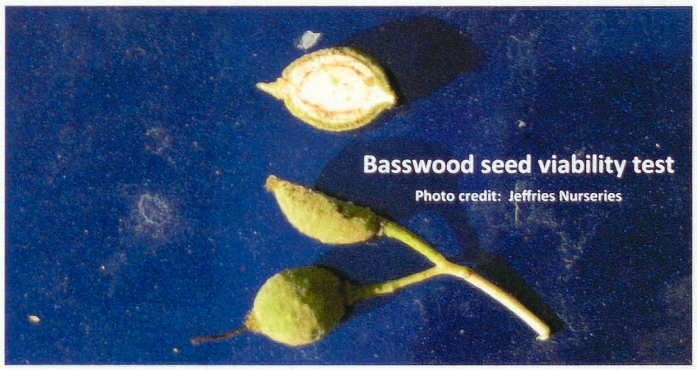
APPENDIX

Fall colour of 'Prairie Rouge' red maple

Photo credit: Jeffries Nurseries

DECIDUOUS FLOWERING TREES

	Vegetative Propagation Procedure	Seed Propagation Procedure
Malus - crabapple	'Dolgo' and 'Columbia' seedlings are widely compatible in budding	Fall sown or 100 day moist stratification at 4℃ to break dormancy
	'Ottawa #3' and 'Bud 9' clonal rootstock have been used for dwarf apple	
Prunus - plum, chokecherry	American plum seedlings are widely compatible for plums	Seedage treatment same as *Malus*
	'Mustang' clonal rootstock, is compatible with plums, apricots and peaches (Appropriate zones)	Tissue culture or softwood cuttings
	'Goldspur', 'Klondike', and 'Ming' Amur cherry are grown by softwood cuttings or tissue culture	N/A
Pyrus - pear	Ussurian pear (Harbin strain) has been widely used in Zones 1-7 as a rootstock for budding	Seedage treatment same as *Malus*
Sorbus - mountain ash	European mountain ash is widely compatible with all northern cultivars	Seedage treatment same as *Malus*
Syringa - tree lilac	Japanese tree lilac seedlings are compatible in budding named tree lilac cultivars	September 1st fall sown or 60 days warm treatment at 20˚C followed by 120 days at 4℃ stratification
	Softwood cuttings are often used as a secondary propagation method	



Basswood seed viability test
Photo credit: Jeffries Nurseries

Fruit of Japanese tree lilac
Photo credit: University of Manitoba

DECIDUOUS SHADE TREES

	Vegetative Propagation Procedure	Seed Propagation Procedure
Acer - maple		
Boxelder maple	Boxelder maple seedlings compatible for all boxelder maple cultivars.	Fall sown or 100 days moist stratification at 4℃.
Silver/Freeman maple	Silver maple seedlings compatible for silver maple cultivars. Most silver and Freeman maples are propagated from softwood cuttings.	Seed collected in early summer and sown immediately
Sugar maple	Northern sugar maple seedlings are compatible for 'Unity' and 'Inferno'. Some propagators have recommended budding on 2 year planted rootstock.	Seedage treatment same as boxelder maple
Amur/Tatarian maple	Amur maple and Tatarian maple cultivars are propagated by softwood cuttings.	Seedage treatment same as boxelder maple
Aesculus - buckeye	Grafting on Ohio buckeye or European horsechesnut is used for increasing buckeye cultivars	Seedage treatment same as boxelder maple
Alnus - alder	'Prairie Horizon' is propagated successfully by softwood cuttings	N/A
Betula - birch	Paper birch or European birch seedlings have been used for budding Cutleaf weeping birch Tissue culture has largely replaced budding for increase of newer cultivars	Shallow spring-sown seed; shows no dormancy
Celtis - hackberry	Common hackberry has been used for budding cultivars but success rate is low	Seedage treatments same as boxelder maple
Crataegus - hawthorn	*C. armoldiana* seedlings have been recommended as a hardy rootstock for budding 'Toba' and 'Snowbird'	Summer-sow *Crataegus* seed as it has a double dormancy
Fraxinus - ash	Green ash seedlings widely compatible for budding of all ash cultivars	Seedage treatment same as boxelder maple

DECIDUOUS SHADE TREES

	Vegetative Propagation Procedure	Seed Propagation Procedure
Juglans - walnut	Black walnut and butternut are only grown from seed.	Seedage treatment same as boxelder maple
Maackia	Budding on seedling Amur rootstock is used but a lack of northern cultivars has held back trials.	Seedage treatment same as boxelder maple
Populus - poplar	Trembling aspen is predominately seedling grown. Columnar aspens are now mostly tissue cultured.	Seedage same as birch
	The many hybrid cottonwood cultivars (*P. deltoides, P. nigra*) remain largely propagated from hardwood cuttings.	N/A
Quercus - oak	Bur and swamp white oak seedlings are reported to be compatible rootstock for most oak cultivars.	Seedage treatment same as boxelder maple
Salix - willow	Willow cultivars are propagated by hardwood cuttings.	N/A
Tilia - linden	Budding on seedling *Tilia cordata* rootstock	Seed collected in early fall and sown immediately
Ulmus - elm	American elm cultivars are often own-root from softwood cuttings or tissue culture.	Seed of American, Japanese and Siberian elm ripen in June and germinate immediately
	Hybrid elm cultivars are budded on *Ulmus pumila* seedlings.	

CONIFEROUS TREES

Abies - fir	N/A	Most conifers are now grown from seed under greenhouse conditions in plug trays. Stratification is not usually a requirement.
Juniperus - juniper	Softwood or hardwood cuttings	
Larix - larch	N/A	
Picea - spruce	Graft on white spruce seedling rootstock	
Pinus - pine	N/A	
Thuja - cedar	Softwood or hardwood cuttings	

Dave Adamson of Adamson Nurseries with rooted cutting of 'Goldspur' Amur cherry

Photo credit: Jeffries Nurseries

Cultures of 'Dakota Pinnacle' Asian white birch at Agri-forest Biotechnologies

Photo credit: Jeffries Nurseries

Purple summer foliage
'Prairie Splendor' Norway maple
'Gladiator' / 'Indigo Spire' rosybloom
'Schubert' / 'Spur Schubert' chokecherry

Silver summer foliage
Russian olive
Silky white willow

Blue foliage
Rocky mountain juniper
'Baby Blue' / 'Hoopsi' Colorado spruce

Orange-red fall foliage
'Inferno' sugar maple
Ohio buckeye
'Princess Kay' plum

Red fall foliage
Amur maple
Red maple
'Regal Celebration' Freeman maple
'Autumn Splendor' hybrid buckeye
Pagoda dogwood
'Shooting Star' northern pin oak

Purple fall foliage
'Royal Crown' Amur maple
'Nobility' white ash
'Purple Spire' rosybloom crabapple

Golden fall foliage
Green / Black / Hybrid ash
Ironwood
Amur cherry
American linden
'Golden Cascade' linden
'Harvest Gold' linden
Siberian larch
Tamarack

Pink flowers
'Toba' hawthorn
Rosybloom crabapple
'Muckle' plum

Yellow flowers
'Prairie Splendor' Norway maple
'Autumn Splendor' hybrid buckeye
'Green Spire' common caragana
Russian olive
American / Little leaf linden

Red flowers
'Prairie Rouge' Red maple
'Regal Celebration' Freeman Maple

White flowers
'Snowbird' hawthorn
'Spring Snow' / 'Starlite' crabapple
'Princess Kay' plum
Amur cherry
'Schubert' / 'Spur Schubert' chokecherry
Ussurian pear
Russian / Showy mountain ash
Japanese tree lilac

Fragrant flowers
Russian olive
Japanese tree lilac
American linden


Fall foliage of 'Autumn Splendor' buckeye
Photo credit: University of Minnesota

Red fruit

'Hot Wings' Tatarian maple
Siberian / Rosybloom crabapple
European / Showy mountain ash

Blue fruit

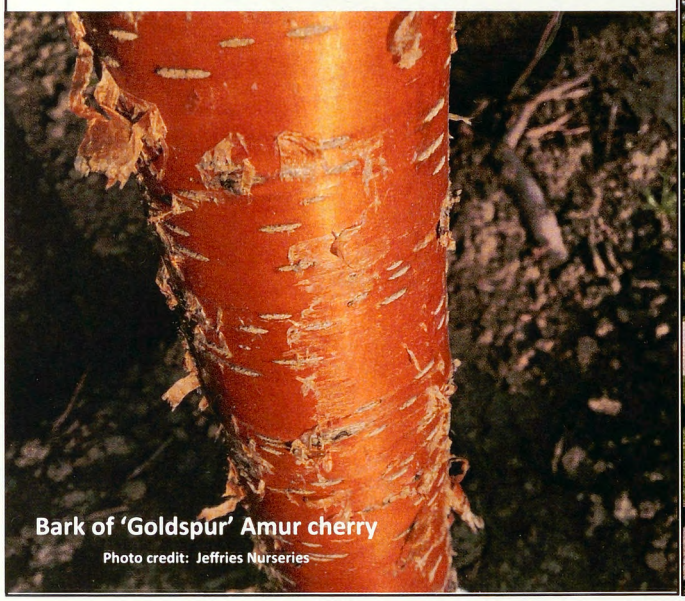
Pagoda dogwood
Amur corktree

Black fruit

Amur cherry
Common chokecherry

Unusual bark

Paper / River birch
Asian white birch
Cutleaf weeping birch
Hackberry
Ironwood
Amur maackia
Amur corktree
Amur cherry
Bur oak
'Admiration' hybrid oak
'Harvest Gold' linden
Scots pine
Eastern white cedar



Bark of 'Goldspur' Amur cherry
Photo credit: Jeffries Nurseries

Weeping form

Cutleaf weeping birch
'Royal Beauty' rosybloom
'Lace' weeping willow
'Prairie Cascade' Hybrid Willow
'Golden Cascade' Little leaf Linden

Columnar form

'Parkland Pillar' Asian white birch
'Green Spire' common caragana
'Emerald Spire' rosybloom crabapple
'Indigo Spire' rosybloom crabapple
'Purple Spire' rosybloom crabapple
'Green Wall' flowering crabapple
Swedish columnar aspen
'Guardian' columnar aspen

'Guardian' columnar aspen
Photo credit: Jeffries Nurseries

The following publications have been referenced in the development of this book:

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Front cover photo: **Fall colour on an advanced selection of sugar maple growing in Portage la Prairie, Manitoba**

Back cover photo: **Residential street lined with mature specimens of American elm in Winnipeg, Manitoba**

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