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SPECIES-SITE ADAPTATION STUDY OF WOODY PLANTS FOR NORTH DAKOTA

NDSU Agricultural Experiment Station Department of Plant Sciences

PROJECT ND06203 (REVISION)

OBJECTIVES

1. To systematically evaluate species, named cultivars and new selections (accessions) of trees and shrubs for cold hardiness and drought tolerance, establishment and survival, growth rate, vigor and potential for shelter belt, urban forestry and landscape use under varying climatic and edaphic conditions;
2. To provide evaluation data in order to make valid woody plant recommendations based on regional adaptation zones in North Dakota and;
3. To obtain performance and adaptation information on a broad range of woody plant taxa for future writing of a woody plant reference book for the Northern Plains regions.

JUSTIFICATION

Trees and shrubs have an important functional and aesthetic impact on our environment. From the early days of statehood to the present, North Dakota citizens have been aware of the need for adapted woody plant species capable of surviving cold harsh winters and droughty summers of our state (9). Extreme temperature fluctuations, drought and drying winds, a short growing season and a wide range of soil conditions in the Great Plains present some of the most challenging requirements for plant culture in the world (13, 33). Consequently, plants must be cold tolerant and adaptable to North Dakota conditions. In northern climates, winter injury is often the major factor limiting plant survival (28). Unwary buyers spend large sums of money on insufficiently winter-hardy trees and shrubs,

particularly new cultivars not adequately evaluated in the North Central United States.

Climatic and edaphic conditions vary throughout the state. For example, the fertile but heavy clay soils of the Red River Valley are atypical of the soil types found in the rest of the state. Rainfall, a critical factor for optimum plant growth, ranges from 21-inches per year in extreme southeastern North Dakota to 14 inches in the northwestern corner of the state.

The overplanting of a single species (monoculture) has been an ongoing problem, particularly in the Plains states, where the inventory of adapted woody species is very limited. Therefore, devastation of American elm by Dutch elm disease, white-barked birches by bronze birch borer and Siberian elm by 2,4-D and/or canker has a greater impact in this region.

According to Kielbaso (20), an urban forest population should consist of no more than 10% of a given genus, and no more than 5% of a given species. Based on a 1980 national survey study, Kielbaso and Kennedy (21) found that 75% of trees being planted on streets were represented by only seven species nationally, as few as four in the North Central region and up to 10 species in the West. Thus, there is a vital need to identify and utilize a more diverse population of woody plants to avoid future disasters of monoculture.

New adapted plant species need to be introduced from foreign or domestic sources and new cultivars need to be bred to selected from sources which are specifically adapted in the Northern Plains. The need to expand the diversity of plants in the central Great Plains landscape was the driving force behind the establishment of the Nebraska Statewide Arboretum Plant Development Program (7). The establishment and expansion of the Center for Development of Hardy Landscape Plants by Pellett (27) at the University of Minnesota and the Alaska Plant Materials Center (36) serve as additional examples to illustrate the importance of woody plant evaluation. The need for comprehensive evaluation of new shade and ornamental tree introductions for use in the North Central United States has long been recognized by horticulturists, landscape architects, urban foresters, utility companies and homeowners interested in high quality trees in the landscape environment (22). According to Gerhold (8), the lack of comparative information about tree performance under harsh city conditions makes it very difficult to choose th best species and cultivars for a specific site. Testing and evaluation of plant material at multiple sites across the various soil, moisture and temperature regimes of North Dakota is necessary to provide data for making plant

recommendations to nurserymen, park personnel, foresters, arborists and the general public.

New cultivars of woody plants are continually being developed through breeding efforts and/or selection by nurserymen, plant breeders and amateur horticulturists. Laking (24) states, that long-term observation of species in many different locations will eventually determine their real value for landscape purposes. In studies by Kozel, trees of Sycamore Maple (*Acer pseudoplatanus L.)* performed well for the first five years but growth and survival problems occurred in subsequent years (23). *Plataus x acerifolia* (Ait) Willd. 'Bloodgood' was rated highly in shade tree evaluation tests at Wooster, Ohio, but some years later was injured badly during severe winters (6). *Pyrus calleryana* Decne. cultivars have become exremely popular boulevard and specimen trees in United States hardiness zones 5 through 7. However, over time, certain cultivars are proving highly fireblight susceptible and the cultivar 'Bradford' tends to produce a trunk structure that is very prone to splitting after 15-20 years of age (6). In North Dakota, hundreds of miles of shelterbelts have been planted to *Populus x euroamericana* Moench. 'Robusta' and related cultivars. Unfortunately drought conditions predispose this hybrid to winter dieback and then canker diseases further devastate them. *Populus x jackii* 'Northwest' has also been utilized heavily in Plains shelterbelts, but evaluation over time has shown that this cultivar often defoliates prematurely in the summer due to attack by poplar rust, *Melampsora* spp. Chapman (1) states that tolerance or resistance to insect attack should be a major consideration in woody plant improvement and planting decisions. These examples serve to illustrate that unlike annual crops such as cereal grains, which can be evaluated in a relatively short time, woody plant materials need long term testing to determine their ultimate value.

Many species and cultivars have not been tested across the state or in sufficient numbers to make valid comparisons or recommendations. Establishment of experimentally replicated test sites provide valuable information on performance of selected woody plants over a wide range of growing conditions in the state. This data, along with observations from other research locations, provide a basis for making recommendations of woody plant material for use in the state. In addition, published literature with specific application to woody plant recommendations for the United States Northern Plains is very limited. The book, "Trees and Shrubs for the Northern Plains" by Hoag (19) is very outdated and there is a dire need for a new woody plant manual or book. A major goal of the woody plant improvement research projects at NDSU is to obtain sufficient data and evaluation information so that a new reference book can be written.

PREVIOUS WORK AND PRESENT OUTLOOK

In his book, *Trees and Shrubs for Northern Gardens,* Snyder (32) states that plants differ greatly in their hardiness, or ability to grow and thrive in a given area. In areas where cold hardiness is a prime concern, seed origin (provenance), in relation to latitude is a major factor in determining the adaptability of a species to a given site (5, 13, 28, 31, 33). Trees grown from a more southerly seed source will usually be less winter hardy than those grown from a more northern source. This emphasizes the importance of evaluating plants for hardiness in the area in which they are to be grown.

In 1954, a project was begun by the USDA-ARS to evaluate plants on a regional basis. Ames, Iowa was designated as the Regional Plant Introduction Station. NDSU has cooperated with this NC-7 Regional Project on a continuous basis. The program has been successful in testing woody plants for regional adaptability (35). Plant material from this program is being planted and evaluated annually at the Horticulture Research Farm near Absaraka, ND and the Carrington Research/Extension Center. At least 40% of the accessiona supplied for evaluation through the NC-7 program has proven to be insufficiently winter hardy in North Dakota.

Tree improvement research at the Denbigh Experimental Forest (34) focused on programs to develop adapted species for Northern Great Plains shelterbelts. Work with Green Ash (*Fraxinus pennsylvaica* Marsh.), Scotch Pine (*Pinus sylvestris* L.), and Ponderosa Pin (*P. Ponderosa* Dougl. Ex P. Laws. & C. Laws), has received the most emphasis. Early forestry research dealt with shelterbelt establishment, survival, renovation and weed control studies. Currently, Dr. Zongming Cheng, NDSU horticulturist, is conducting biotechnology research which focuese on improvement of woody species adapted to the Northern Plains regions. His goal is to genetically engineer tree species with resistance to 2,4-D, insects and diseases.

The acquirement of the Horticulture Research Farm near Absaraka, ND in 1974 provided an arboretum site to study hardiness and performance of a large number of species and cultivars (25). Information obtained from initial screening of plants in the NDSU Research Arboretum enables research personnel to select promising plants for inclusion in this multiple site research project which began in North Dakota in 1987 (2, 3, 4). Morton (26) points out the importance of arboreta and the value they play in identifying new, or under-utilized plant species for commercial production and public use.

In 1974, Dr. Dale Herman established a major ash selection and evaluation program including 70 accessions representing six different species and many selections propagated asexually. Upon completion of this study, four superior Green Ash selections and one standard cultivar, 'Marshall's Seedless', were the first entries in this new cooperative testing project. From 1987-1994, 83 accession of woody plants have been planted for evaluation, including 75 accessions, 32 species and 16 hybrids of trees and 10 accessions, 3 genera, 2 species, and 4 hybrids of shrubs. Hundreds of other accessions have been planted in the NDSU Research Arboretum for preliminary screening (3, 14). Since there is a 5-10 year testing period, evaluations have been completed on a limited number of the accessions. A sampling of preliminary accomplishments as a result of this study include:

- The introduction of three Green Ash cultivars which are receiving widespread planting and acceptance throughout the North Central United States. They have proven to be well adapted in all seven North Dakota sites (11).
- Promoting the successful commercial production and planting of three additional ash species in the North Central United States, including *F. nigra* Marsh., *F. mandsurica* Rupr. And to a lesser degree, *F. americana* L. 'Autumn Blaze', the only winter hardy cultivar of White Ash to date in North Dakota (12, 29). This will enhance the diversity of ash species planted, and lessen Green ash monoculture problems.
- The introduction of *Pyrus ussuriensis* Maxim. 'MorDak' - Prairie Gem Flowering Pear. This winter hardy pear serves as a substitute in the Northern Plains for *Pyrus calleryana* Decne. cultivars which are popular in the midwest and east, but lack winter hardiness in hardiness zones 3 and 4. Prairie Gem is adapted to plains conditions except in very dry or high pH sites (11).
- The introduction of a winter hardy, highly ornamental selection of *Euonymus bungeana* Maxim. For the Northern Plains is planned in the near future.
- Interest in increasing in other states concerning the potential recommended planting of *Maackia amurensis* Rupr. And Maxim. (10, 28). Evaluation of this small Asian tree species in North Dakota has shown adequate winter hardiness, although its growth rate is very slow if planted in unfavorable droughty sites.
- Several linden species and cultivars are proving to be superior in adaption to North Dakota conditions than generally accepted for this genus in past decades. Iron chlorosis is rarely a problem in this genus and lindens perform well in heavy clay soils.
- Clonal hybrid NDSU selections of *Lonicera* with resistance to aphid witchesbroom appear promising in all

North Dakota evaluation sites.

- Several NDSU *Quercus, Aesculus* and *Acer* selections have excellent potential for introduction and future recommendation for the Northern Plains.
- The North Dakota Killdeer Moutain seed source of *Betula papyrifer* Marsh. Is proving to be a superior source for commercial production and adaptability to Northern Plains conditions. In addition, several hybrid *Betula* selections with superior qualities are being placed into the evaluation program. Tolerance or resistance to pests is an important factor being considered in our birch selection and evaluation program as well as with other genera. In collaboration with Dr. Zongming Cheng, micropropagation is being utilized to speed their entry into the evaluation program.
- It is very important to retain diversity in an evaluation program and not concentrate on only a few genera because our goal is to provide a broader range of taxa that can be recommended for planting in the Northern Plains. Additional selected genera in which promising accessions are under evaluation include *Alnus* (Alder), *Amelanchier* (Serviceberry), *Cornus (*Dogwood), *Phellodendron* (Corktree), *Pinus* (Pine), *Pseudotsuga* (Douglas-fir), *Populus* (Poplar), *Salix* (Willow), *Syringa* (Lilac), *Thuja* (Arborvitae), *Ulmus* (elm) and others.
- Evaluation reports have been compiled annually and distributed to all project cooperators, in-state and out-of-state woody plant specialists, wholesale and retail nursery personnel and other individuals. Community foresters, park and golf course managers and the general public are now utilizing recommended woody plant accessions as a result of this program.
- Selected publications from this evaluation program include nursery sources and recommended, borderline and non-adapted compilations of hundreds of woody plant taxa. Some publications (12, 13, 14, 29, 30) encompass a broad range of taxa, whereas others are restricted to the generic level, including *Malus* - Crabapples (17), *Juniperus* - Junipers (16, 18) and *Lonicera* - Honeysuckles (15).

Future efforts will continue to focus on selection and evaluation of neglected native as well as foreign woody plant germplasm for hardiness, pest resistance and adaptation. The inventory of recommended woody plants for the Northern Plains is being significantly expanded through the result of this research.

PROCEDURE

This project is rather unique because it places research studies into various sectors of the state in cooperation with

four NDSU research centers and three urban forestry sites. It is the only project to specifically determine adaptation of woody plants for landscape, shelter belt, park and community forestry needs in an experimental, replicated plot format. The following agencies will be involved:

-NDSU, Department of Plant Sciences

-NDSU, Department of Plant Pathology

-NDSU Agricultural Research Centers at Carrington, Dickinson, Langdon and Minot

-Urban forestry programs at Bismarck, Fargo and Grand Forks, North Dakota

-North Dakota Forest Service (Towner State Nursery)

-North Dakota Association of Soil Conservation Districts (Lincoln-Oakes Nurseries)

NDSU horticulturists have the following responsibilities:

1. Recommend plant material;
2. Propagate and/or supply plant materials;
3. Distribute and plant test materials;
4. Maintain plot maps, monitor establishment and coordinate replacement plantings;
5. Coordinate maintenance and
6. Compile data, analyze and publish results of evaluations.

Long-term commitment of land and resources has been made by NDSU Research Centers. Responsibilities of these cooperators include:

1. Provide site, equipment, and labor assistance, and
2. Establish and maintain test material.

The urban forestry programs will:

1. Provide site, equipment, and labor assistance to plant and maintain test materials;
2. Provide monetary assistance in purchasing plant materials, and
3. Identify and document relocated test materials.

The Towner State Nursery and Lincoln-Oakes Nurseries will cooperate by:

1. Recommending plant material, and
2. Propagating and/or supplying lining-out stock.

Depending on plant availability, plot configuration will consist of either a randomized block design or a randomized complete block design to provide statistically valid information for comparison of seedling and cultivar accessions. Such selections or cultivars will bake up the treatments in each replication for comparison purposes. The number of replications per plant site will vary according to the type of plant material; i.e., clonal vs. Seed propagated. All material will be hand-planted. A soil auger will be used to facilitate planting when larger stock is involved.

Data will be collected annually and will include planting date, establishment and survival, vigor, height, crown width, hardiness, pest susceptibility, soil adaptability (as related to moisture, pH and iron chlorosis) and landscape characteristics. Weather and climatic data will be correlated with establishment and overall woody plant performance.

Urban forestry sites will receive sufficient test materials to plant approximately 0.1 acre annually. Because these sites include a management plan with probable crop rotation after a 5-year minimum test period, a standard spacing of 15' between x 10' within rows will be used.

Approximately one acre will be allocated annually for test materials at research center sites. A management plan with crop rotation after a 10-year minimum test period will be utilized. It may be necessary in certain instances to reduce the test period 1-3 years depending on accession, it growth rate, or other factors. A standard spacing of 20' between x 15' within rows for trees and x 10' for shrubs will be used.

Efforts will be made to maintain consistent cultural practices at all locations. Irrigation will be employed for initial establishment. Clean cultivation will be utilized. Standard mulching practices will be implemented.

Test material may be obtained from a variety of sources including agencies that produce trees, university research programs, arboreta and botanical gardens, commercial nursery sources and seedling or clonal research selections.

Probable Duration Five years

Financial Support (Annual)

Personnel

Dr. Dale E. Herman, Project Leader
Larry J. Chaput, Project Coordinator

Planting Site Cooperators

NDSU Agricultural Experiment Stations:
Carrington Research/Extension Center
Dickinson Research/Extension Center
Langdon Research Center
North Central Research Center, Minot
North Dakota Urban Forestry Department
Paul Blumhardt (City Forester) Bismarck Forestry Dept.
John Wesolowski (City Forester) Fargo Forestry Dept.
John Staley (City Forester) Grand Forks Forestry Dept.

Other Cooperators

Roy Lafromboise (Nursery Manager), North Dakota Forest Service, Towner State Nursery, Towner, ND
Greg Morgenson (Nursery Manager), North Dakota Association of Soil Conservation Districts, Lincoln-Oakes

Nurseries, Bismarck, ND
Dr. Zongming Cheng, Department of Plant Sciences, NDSU (Micropropagation)
Mr. James Walla, Department of Plant Pathology, NDSU

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