

Breeding, Selection and Evaluation and Propagation in the NDSU Woody Plant Improvement Program

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INTRODUCTION

Woody plant evaluations at North Dakota State University began in 1954. In 1971, Dr. Dale E. Herman initiated the Woody Plant Improvement Program (WPIP). Woody plant introductions begin in 1986 with the collaborative release of Meadowlark forsythia (*Forsythia* 'Meadowlark') with South Dakota State University, Arnold Arboretum, and North Carolina-Regional Plant Introduction Station. To date, this program has released 58 woody plant selection into the ornamental nursery trade.

Diversity is important and there is a great need for adapted, winter hardy, pest resistant woody plants suitable for use in the northern U.S.A. and prairie Canada. Many of the current commercially available nursery cultivars are not suitable for USDA cold climatic Zones 3 and 4, lower annual moisture availability, and higher soil pH levels.

There is also a need to increase plant diversity in response to disease and insect pest issues and loss of adapted genera and species (*Betula* spp., *Fraxinus* spp., *Picea* spp. and *Ulmus americana*).

The WPIP has two primary goals:

- 1) Evaluate unreleased or released cultivars from the nursery trade to determine usability in the United States Northern Great Plains
- 2) Increase diversity through selecting and/or breeding new woody plants suitable for the U.S.A. Northern Great Plains.

The NDSU WPIP program woody plant selections are ideal for urban climate conditions. Urban soils are typically compacted, dry, and have a high pH (>7.5). North Dakota is considered to be the eighth driest state with respect to annual precipitation in

the United States. North Dakota (ND) soils are typically alkaline with a pH >8.0.

The WPIP has nine research evaluation sites in North Dakota (Fig. 1.) There are three primary research evaluation sites:

- 1) NDSU Horticulture Research Farm (HRF) and Dale E. Herman Research Arboretum (DEHRA) (Absaraka, North Dakota, USA; Lat:46.9859, Long: -97.3549)
- 2) Research plots (Fargo, North Dakota),
- 3) NDSU Langdon Research Extension Center (Langdon, North Dakota; Lat: 48.7631, Long: -98.3713).

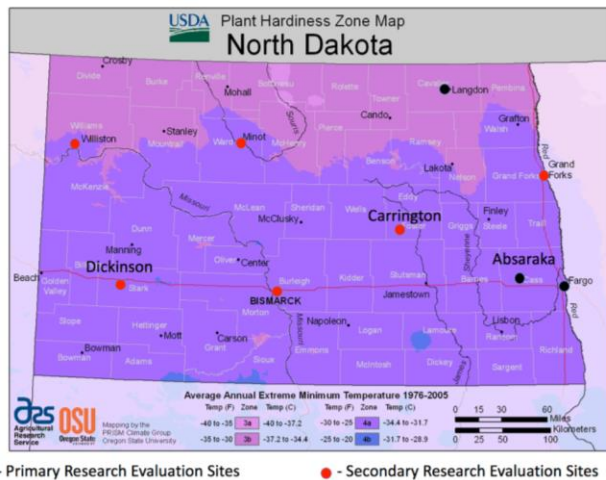


Figure 1. Evaluation site locations in ND for the NDSU Woody Plant Improvement Program.

The other secondary sites include Williston, Grand Forks, Dickinson, and Bismarck, ND. The first two primary sites are located in a USDA plant hardiness Zone 4a while the NDSU Langdon REC is classified as a hardiness Zone 3b. This past winter (2018-2019) was the coldest on record for the last 25 years. Most of ND reached winter average temperature lows that were less than -34 °C. The NDSU HRF and DEHRA has a low of -38 °C putting this location into a USDA hardiness Zone of 3b. the Langdon REC was classified with dropping into a USDA hardiness Zone of 2b.

EVALUATIONS AT NDSU WPIP

The NDSU WPIP has evaluated 200+ genera and 3,000+ species and cultivars of trees and shrubs. Over 9500+ accessions obtained, evaluated since planting began in 1974. The largest and most diverse woody ornamental plant collection in North Dakota and the Northern Great Plains is located at the NDSU HRF and DEHRA with a total of 80 acres (~32 ha). The NDSU WPIP program focuses on obtaining germplasm materials based on the Köppen-Geiger climate classification which places North Dakota in a *Dfb* with a warm-summer humid continental climate; coldest month averaging below 0 °C, at least 4 months averaging above 10 °C, and no significant precipitation difference between seasons. This *Dfb* classification allows for matching other locations with the same *Dfb* classification around the world to focus on suitable sources of germplasm.

The NDSU WPIP is involved with several woody plant evaluations including cultivar comparison with several industry co-operators and private breeders. It is also the northern site for hybrid maple evaluations (*Acer palmatum* × *A. pseudosieboldianum*).

For plant evaluation, selections and breeding, germplasm is collected from three different methods including:

- 1) Foreign and domestic seed sources (growing out seedling populations and selection individuals with superior attributes),
- 2) Plant breeding (tradition breeding including F2 populations to observe segregation of traits including hybridizing with both intra and interspecific hybridization),
- 3) In vitro tissue culture utilizing somaclonal variations, embryo rescue and mutagenesis.

Three plant improvement methods utilized are: Selections by landscape observation, mass selection (seed source and seed lot variation), and breeding (both traditional and mutagenic).

GENERA OF PRIMARY BREEDING FOCUS

The NDSU WPIP is focusing on breeding four primary genera: *Acer*, *Magnolia*, *Sambucus*, and *Ulmus*. The primary goal of all of the breeding work is on increased hardiness and secondarily on aesthetic improvements. With the large germplasm collection located at the NDSU HRF and DEHRA, there are many accessions that have shown outstanding hardiness and make excellent parents for improvement through breeding efforts. These include Spring Welcome® magnolia (*Magnolia × loebneri* 'Ruth'), Fall Grandeur™ red maple (*Acer rubrum* 'Minnkota'), *Sambucus nigra* 'TS14019' (prostrate form), and Northern Empress® Japanese elm (*Ulmus davidiana* var. *japonica* 'Burgundy Glow').

Magnolia breeding objectives focus on flower tepal color, introducing any color from *M. acuminata* hybrids coupled the hardy Spring Welcome® selection (white flower color). Maple (*Acer* spp.) breeding objectives are utilizing known hardy and environmental tolerant selections to develop a better adapted Freeman maple (*A. × freemanii*). The current selections, such as

Autumn Blaze, do not have consistent performance with respect to pH tolerance and hardiness. Utilizing a red maple selection that is known to be pH tolerant and have outstanding hardiness would be better suited for a Freeman maple hybrid selection.

Elm breeding objectives focus on crossing Northern Empress® Japanese elm (outstanding burgundy fall color and other attributes) with Hallelujah lacebark elm (*Ulmus parvifolia* 'Hallelujah') which has outstanding ornamental bark.

Ornamental breeding research at NDSU includes developing freeze test procedures for earlier hardiness screening, traditional breeding efforts (making interspecific crosses with cold hardy species and hybrids), developing molecular markers for breeding selection and propagation protocols (micropropagation, grafting and vegetative cuttings). Freeze tests and molecular markers will assist in reducing time, efforts and costs with selection of desirable progeny. Measuring electrical conductivity of damaged cells from organs such as vegetative buds, flower buds and stem tissue, allows to screen for winter hardiness. Recently, research has been conducted on establishing a micropropagation protocol for Northern Empress® Japanese elm to reduce basal callus and increase axillary shoot proliferation utilizing nutrient salt formulation screening and use of anti-auxin compound p-chlorophenoxyisobutyric acid (PCIB).

RECENT INTRODUCTIONS

Some outstanding recent selections that have come out of the NDSU WPIP include:

Summer Flare™ Japanese tree lilac (*Syringa reticulata* 'SumDak'), Northern Empress® Japanese elm, (*Ulmus davidiana* var. *japonica* 'Burgundy Glow'), Cinnamon Curly® dwarf Korean birch (*Betula costata* 'CinDak'), Lavaburst® Ohio buckeye

(*Aesculus glabra* 'LavaDak'), Emerald Flare® birch (*Betula tianshanica* 'EmerDak'), and Fireflare Orange® Mollis azalea (*Rhododendron × kosteranum* 'FireDak'). Several future selections include: *Cercidiphyllum japonicum* (Japanese katsuratree) and *Acer truncatum × A. platanoides* hybrids (Figs. 2 - 6).

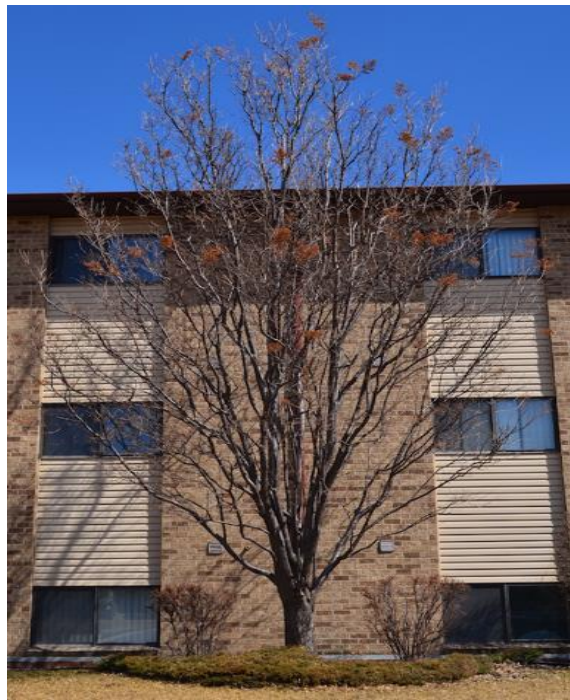


Figure 2. Summer Flare™ Japanese tree lilac (*Syringa reticulata* 'SumDak')



Figure 3. Northern Empress® Japanese elm, (*Ulmus davidiana* var. *japonica* 'Burgundy Glow')



Figure 4. Cinnamon Curls® dwarf Korean birch (*Betula costata* ‘CinDak’)



Figure 5. Lavaburst® Ohio buckeye (*Aesculus glabra* ‘LavaDak’)



Figure 6. Fireflare Orange® Mollis azalea (*Rhododendron* × *kosteranum* ‘FireDak’)