United States Department of Agriculture
Natural Resources Conservation Service

2006 ANNUAL TECHNICAL REPORT

Manhattan Plant Materials Center

Serving Kansas, Nebraska, northern Oklahoma, and northeastern Colorado

Notices

The Manhattan Plant Materials Center (PMC) Annual Technical Report is a report to the plant materials discipline and cooperating agencies. This is a preliminary report of results from various studies conducted by the PMC Center staff. Conclusions may change with continued investigations or upon further analysis. Written authorization must be obtained from the authors before publishing data from these reports. Contact the PMC Manager for more information, at 3800 South 20th Street, Manhattan, KS 66502, or (785)-539-8761. Refer to our website at http://Plant-Materials.nrcs.usda.gov/ for additional information about our program.

This report uses currently accepted scientific names as they appear in the PLANTS (Plant List of Accepted Nomenclature, Taxonomy, & Symbols) database where practical. PLANTS is maintained by the National Plant Data Collection Center. See their website at http://plants.usda.gov/. The Flora of the Great Plains, University Press of Kansas is the authority regarding the usage of common names.

Mention of trade and company names does not imply any guarantee, warranty, or endorsement by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and does not imply its approval to the exclusion of other products that are also suitable.

Abbreviations of state names used in the text are according to The Gregg Reference Manual Fifth Edition. W.A. Sarin, McGraw-Hill Book Company 1977, with the exception of tables with space limitations where two letter postal designations are used.

On the cover: UL – Biological Science Technicians (BST) Jerry Longren and Don Garwood harvesting seed increase field of Echinacea; UR – compass plant; ML – spring color around PMC laboratory and greenhouse; MR – Jerry Longren, BST, innovating specialized harvesting equipment for PMC use; LL – Don Garwood, BST, rototilling foundation seed increase fields; LR –seed production on False indigo. Photography by John M. Row, PMC Specialist

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UNITED STATES DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

MANHATTAN PLANT MATERIALS CENTER

2006 ANNUAL TECHNICAL REPORT

Plant Materials Center Advisory Committee

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Stephen K. Chick, State Conservationist, Nebraska
Darrel Dominick, State Conservationist, Oklahoma
Allen Green, State Conservationist, Colorado
Jeff Burwell, State Resource Conservationist, Colorado
Jimmy G. Ford, Acting State Resource Conservationist, Oklahoma
James J. Krueger, State Resource Conservationist, Kansas
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Robert T. Escheman

Central Region Plant Materials Specialist

Joel L. Douglas

Plant Materials Specialists

Mark A. Janzen, KS, NE, OK
Patrick Davey, CO

Plant Materials Center Personnel

Richard L. Wynia, Manager
John M. Row, PMC Specialist
Robert Alan Shadow, Soil Conservationist
Donald R. Garwood, Biological Science Technician
Jerry D. Longren, Biological Science Technician
Erma J. Leuthold, Clerk-Typist (PPT)

Seasonal Positions-Biological Science Aid (Plants)

Adam D. Knepper
Joyce R. Meyer
Lindsey J. Richardson
Shane M. Rohde

Earth Team Volunteer

Dr. Wayne Geyer, Forester

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FOREWORD AND ACKNOWLEDGEMENTS

The Manhattan Plant Materials Center (PMC) is a federally owned and operated facility under the administration of the Kansas State Office of the Natural Resources Conservation Service (NRCS). Conservation plant research underway at the PMC is directed by a PMC Long-Range Plan with guidance from a State Conservationist's Plant Materials Advisory Committee with representation from Kansas, Nebraska, Oklahoma, and Colorado. The PMC maintains cooperative agreements for plant testing and development with the Agricultural Experiment Stations (Kansas State University (KSU), University of Nebraska-Lincoln, and Oklahoma State University), Kansas Biological Survey, U. S. Department of Interior (USDI)-Fish & Wildlife Service, U. S. Department of Agriculture (USDA)-Agricultural Research Service, U. S. Army Fort Riley Military Reservation, U. S. Army Corps of Engineers, and Kansas Department of Wildlife and Parks.

The PMC was established in 1936 as a Soil Conservation Service nursery. It is located on a 169-acre irrigated farm in the Kansas River Valley, 10 miles west and south of Manhattan, Kansas. Initial and advanced evaluations of new plant materials, seed increase plantings of promising accessions, and foundation seed increases of released plant materials are located at this site. Field evaluation plantings are located off-Center at federal and state cooperator sites. Field plantings are located in the PMC's service area on conservation district cooperator sites.

The Center acknowledges the efforts of the following individuals who have contributed to the Center's accomplishments. Bobby Brown, Research Assistant, KSU Entomology Department, insect identification; Dr. Walter Fick, Agronomy Department, KSU; Dr. Wayne Geyer, Horticulture, Forestry and Recreation, KSU; Vernon Schaffer, Agronomy Department. It also recognizes the assistance of Mary Shaffer, Public Affairs Specialist, NRCS, Salina, Kansas. Assistance provided by these individuals is greatly appreciated.

INTRODUCTION

The purpose of the Manhattan PMC technical report is to inform the NRCS plant materials discipline, its cooperators, and others interested in plant materials work of progress and new developments.

Mission: The Mission of the NRCS Plant Materials Program

To develop and transfer plant materials and plant technology for the conservation of natural resources. In working with a broad range of plant species, including grasses, forbs, trees, and shrubs, the program seeks to address priority needs of field offices and land managers in both public and private sectors. Emphasis is focused on using native plants as a healthy way to solve conservation problems and protect ecosystems.

Objectives: The objectives of plant materials activities are to select and develop special and improved plants, and to determine reliable techniques for successfully establishing and maintaining plants for conservation uses. These uses include controlling soil erosion and improving soil on all lands. Finding suitable plants for stabilizing critical high-yielding sediment sources, including sand dunes, stream banks, and shorelines; windbreaks and shelterbelts; toxic or problem soils; improving forage quantity and quality for pasture and rangelands; wildlife food and cover; beautification; and recreation areas are of particular importance. Culturally significant plants, threatened and endangered species, and invasive species are also areas of concern.

Long-range Priorities: Each of the states served by the PMC has identified its plant material problems, needs, and priorities in its respective current state's long-range plant materials program. PMC activities are directed toward meeting the needs and priorities as set forth in the long-range plans of the four states.

The major priority items identified are:

1. Suitable plants and improved methods of establishment on critical areas for stabilization and erosion control; critical areas include saline and alkali areas, surface mine areas, stream bank and shoreline protection, road cuts and fills, blowout areas, etc.

2. Selected varieties of grasses and legumes for use in range seeding, interseeding, and pasture planting; including the development of techniques for production, re-establishment, and maintenance

3. Woody selections with superiority in hardiness and resistance to drought, heat, disease, and insects for use in field and farmstead windbreaks

4. Shrub species to supplement or replace those most commonly used for the shrub row in multiple-row windbreaks, for interplanting with trees in single-row windbreaks, and for specific needs in recreational developments

5. Shrubs, browse, and herbaceous plants to provide improved cover and food for upland game birds, waterfowl, and other wildlife species

6. Studies leading to improvements in cultural practices to improve plant establishment, maintenance, pest control, yield, harvest, and seed processing technology

Service Area: The PMC primarily serves Nebraska, Kansas, northern Oklahoma, and northeastern Colorado. The service area consists of an area with much diversity and is covered by five regions designated as:

Western Great Plains Range and Irrigated
Central Great Plains Winter Wheat and Range
Southwestern Prairies Cotton and Forage
Central Feed Grains and Livestock
East and Central Farming and Forest

Service Area Description: This area, in general, was originally native grass prairie. It is dissected by a number of major streams. Areas of timber follow the stream courses and extend to the slopes in the east where sufficient precipitation supports a mixed hardwood forest. Elevations range from 700 to 5000 feet. Annual precipitation rates vary from 42 inches in parts of Oklahoma and southeast Kansas to 12.7 inches at the other extreme in northeastern Colorado. Distribution of the rainfall is typical of a warm-season grassland climate with 75 percent of the total falling from April to September. Temperatures fluctuate widely and can be accompanied by high winds and long periods without effective precipitation. Soils vary widely from the clay pans of southeast Kansas and northeast Oklahoma to the loess-derived silt loams of the high plains and the sandhill region of northern Nebraska.

Location: The PMC is located in the Kansas River Valley, 10 miles west and south of Manhattan, Kansas, at an elevation of 1030 feet, longitude 96°37' and latitude 39°37'.

Facilities: The facility includes 169 acres of land, 10 buildings, 2 greenhouses, a lathhouse with walk-in cooler, and 4 irrigation wells. Portions of the land holdings are used by Kansas State University Agricultural Experiment Station under provisions of an annual working agreement.

Climate and Soils: The soils found on the PMC are Belvue silt loam (formerly Haynie very fine sandy loam), Eudora silt loam, Bourbonais-Bismarckgrove complex, Stonehouse-Eudora complex (formerly Carr-Sarpy complex), and Fluvents (formerly Sarpy loamy fine sand). The PMC is in Major Land Resource Area 76. Average annual precipitation is 34.8 inches. The average frost-free period is 178 days. Prevailing surface winds are southerly in the summer months and northerly in the winter months.

OUTREACH

Outreach activities consist of providing assistance to Native American Indian tribes of the Central Great Plains. The Manhattan PMC provides assistance in the collection and propagation of culturally significant plants. Such efforts result in the establishment of plant propagation nurseries, educational and ceremonial displays. Ethnobotanical information and plant descriptions may also be provided. In 2006 technical assistance was provide to the AiKiRuti healing garden in Winnebago, Nebraska. PMC staff provided switchgrass bundles and assistance with construction of a switchgrass arbor at Haskell Indian Nations University campus. See Technology Transfer, Page 6, for further information regarding outreach activities in 2006.

COOPERATIVE EFFORTS

The Manhattan PMC is involved in many collaborative efforts with cooperating universities, USDA-ARS, seedsmen, and nurserymen. The PMC, at a minimum provides seed for research and quite often technical assistance is provided. On-site studies include land for the study and in some cases labor and other PMC resources are provided. The following list is not comprehensive but captures many of the cooperative efforts the PMC was involved with in 2006.

Cooperator	**Affiliation**	**Research Interest**
Dr. Mike Casler	USDA-ARS-Dairy Forage Res. Cen.-Univ. of Wisconsin	Adaptation zones of switchgrass populations
Shauna Dendy	Kansas State Univ.	Rust in warm-season grasses
Phil Fay	Kansas State Univ.	Greenhouse studies of grasses
Dr. Steven Fransen	Washington State Univ.-Prosser	Warm-season grass trials; grass-legume mixtures
Dr. Karen Garrett	Kansas State Univ.	Diseases of warm-season grasses
Dr. Wayne Geyer	Kansas State Univ.	Evaluation of green ash
Dr. Lawrence Hagen	USDA-ARS-Wind Erosion Res. Unit	Wind erosion effects
Ari Jumpponen	Kansas State Univ.	Warm-season grass endophytes
Steve Masterson	USDA-ARS-Univ. of Nebraska-Lincoln	Biochemistry of seed germination and seedling development in switchgrass
Dr. Rob Mitchell	USDA-ARS-Univ. of Nebraska-Lincoln	Interseeding legumes in grass swards
Dr. Joe Moyer	Kansas State Univ.	Warm-season grasses
Dr. Tim Springer	USDA-ARS-Southern Plains Res. Sta.	Tannin levels in roundhead lespedeza
Dr. Tim Springer	USDA-ARS-Southern Plains Res. Sta.	Big bluestem comparison trials
April Stahnke	South Dakota State Univ.	Native perennial sunflowers
Dr. Charles Taliaferro	Okla State Univ.	Upland switchgrass biomass
Dr. Kenneth Vogel	USDA-ARS-Univ. of Nebraska-Lincoln	Warm-season grasses
Becky White	Carson Engineering Center	Warm-season grasses - mine tailings
Gail Wilson	Kansas State Univ.	Warm-season grass C3-C4 evaluations

TECHNOLOGY TRANSFER

The dissemination of information resulting from plant materials work is in the form of presentations, tours, and printed materials. Printed materials include newsletters, release brochures, technical notes, planting guides, conservation plant fact sheets, national news articles, reports, etc. The following publications and events occurred in 2006. Author's given name reduced to initials following first appearance in this section of the annual technical report. Any deviation from this scheme indicates that the author's given name is not known.

Year 2006 publications and events.

Abstracts: Published in conference proceedings.

Propagation and establishment of Mead's milkweed. John M. Row and Richard L. Wynia. Ecology, evolution, and conservation of a rare prairie plant: Mead's milkweed (*Asclepias meadii*). Kansas Biological Survey and Univ. of Kansas Field Station and Ecological Reserves, Lawrence, Kans. Nov. 2006. 8p.

Viability of native forbs seed stored under two storage environments: Results following 26 years of storage. John M. Row and Richard L. Wynia. Abstracts, 20th North American Prairie Conference. Kearney, Nebr. Jul. 2006. 75p.

Brochures: Brochures produced by the plant materials program or co-authored with other units of government.

Planting Guide for Five Native Forbs Released for Conservation Use. Manhattan Plant Materials Center. Manhattan, Kans. Jan. 2006. Robert Alan Shadow. 2p.

Conference Room: The PMC conference room is utilized by federal, state, and local conservation agencies for meetings and training activities. Over 60 people used the facility this year for the following activities:

Kansas Section, Society for Range Management
Kansas Water Office

Host: The PMC was host to the Regional Collegiate Soil Judging Contest, October 2-4, 2006.

Misc. Publications: Articles published in various organization's publications that do not fit in another category.

New Porthole Device Eases Inspection and Cleaning of Combines. *In:* Plant Solutions. Feb. 2006. R. A. Shadow and Jerry D. Longren. 2p.

Switchgrass Isn't Just for Growing Anymore. *In:* Plant Solutions. May 2006. J. Row and John Englert. 2p.

Newsletters: The Manhattan PMC publishes a quarterly newsletter that is distributed in the service area to all field locations. The newsletter has been published and distributed since 1994.

Plants for the Heartland. Jan. 2006. R. A. Shadow, R. L. Wynia, and J. M. Row. 4p.

Plants for the Heartland. Apr. 2006. J. M. Row and R. L. Wynia. 4p.

Plants for the Heartland. July 2006. J. M. Row, R. A. Shadow, and R. L. Wynia. 4p.

Plants for the Heartland. Oct. 2006. M. A. Janzen, J. M. Row, and R. L. Wynia. 4p.

Plant Fact Sheets: Plant Fact Sheets are produced for the PLANTS Database that benefit the Plant Materials Program and NRCS programs.

American Sloughgrass (*Beckmannia syzigachne*) Plant Fact Sheet. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. March 2006. R. L. Wynia. 2p.

Roundhead Lespedeza (*Lespedeza capitata*) Plant Fact Sheet. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. August 2006. R. L. Wynia and R. A. Shadow. 2p.

Smooth Oxeye (*Heliopsis helianthoides*) Plant Fact Sheet. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. 2006. R. A. Shadow. 2p.

Plant Guides: Plant Guides are produced for the PLANTS Database that benefit the Plant Materials Program and NRCS programs.

American Sloughgrass (*Beckmannia syzigachne*) Plant Guide. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. June 2006. R. L. Wynia. 4p.

Bluejoint Reedgrass (*Calamagrostis canadensis*) Plant Guide. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. March 2006. R. L. Wynia. 4p.

Prairie Sandreed (*Calamovilfa longifolia*) Plant Guide. PLANTS Database. USDA NRCS National Plant Data Center, Baton Rouge, LA. June 2006. Wayne Duckwitz and R. L. Wynia. 3p.

Posters: Posters are produced and/or presented by the PMC at various functions.

Viability of native forbs seed stored under two storage environments: Results following up to 26 years of storage. 20th North American Prairie Conference, July 26, 2006. Kearney, Nebr. J. M. Row.

Presentations: Presentations are made by PMC staff to update various groups about plant materials program activities and facilitate technology transfer.

Plant Materials Issues. Kansas NRCS Area Specialist's Meeting, Feb. 2, 2006. State Office, Salina, Kans. M. A. Janzen.

Plant Materials Information Program. Kansas NRCS Area 1, Feb. 9, 2006. Hays, Kans. M. A. Janzen.

Red River Prairie Cordgrass Production Experiences and Storage, Feb. 21, 2006. Omaha, Nebr. Nancy Jensen and R. L. Wynia.

Native American Plant Materials Program. To Bridge a Gap Conference, Mar. 2, 2006. Okmulgee, Okla. M. A. Janzen.

Plant Materials Program to Nine Tribal Chiefs. Inter-Tribal Plant Materials Program. June 21, 2006. Miami, Okla. M. A. Janzen.

Plant Materials Program/Seeding Specifications. Bermuda grass Field Day. Jul. 6, 2006. Independence, Kans. M. A. Janzen.

15th Annual ITAM Workshop. Aug. 7, 2006. Kansas State Univ. Union, Manhattan, Kans. R. L. Wynia and R. A. Shadow.

2006 ITAM Workshop. Aug. 7, 2006. Fort Riley Military Reservation, Fort Riley, Kans. R. L. Wynia and R. A. Shadow.

PM Program to Eight Native American Tribes. Tribal Environmental Group Plant Materials Meeting, Aug. 24, 2006. Miami, Okla. M. A. Janzen.

Update of Plant Materials Activities and Long-Range Plan Review. Nebraska Plant Materials Committee Meeting, Aug. 31, 2006. State Office, Lincoln, Nebr. M. A. Janzen.

Update of Center Activities. Nebraska Plant Materials Committee Meeting, Aug. 31, 2006. State Office, Lincoln, Nebr. R. L. Wynia.

State Conservationist's Plant Materials Advisory Committee Update. Fort Riley Military Reservation, Fort Riley, Kans. Sep. 12, 2006. R. L. Wynia and M. A. Janzen.

Propagation and establishment of Mead's milkweed at the Manhattan Plant Materials Center. Nov. 27, 2006. Univ. of Kansas, Lawrence, Kans. J. M. Row.

Reports: Annual and technical reports produced by PMC staff documenting plant materials activities for a given period of time.

2005 Annual Technical Report Manhattan Plant Materials Center, Manhattan, Kans. 108p.

2005 Progress Report of Activities Manhattan Plant Materials Center, Manhattan, Kans. 4p.

Training Sessions: The PMC staff puts on training sessions or takes part in training sessions to train staff, cooperators, and the general public about various aspects of the plant materials program.

Hazard Communications Standards. Kansas NRCS Area 3 DC Meeting. Feb. 8, 2006. Hutchinson Community College. R. L. Wynia. Trainees: 45

Plant Materials Program Overview. New Employee Training. Apr. 4, 2006. Broken Bow, Nebr. M. A. Janzen. Trainees: 40

Area 4 Kansas NRCS Soil Conservation Training Session, Manhattan PMC. May 3, 2006. R. L. Wynia and M. A. Janzen. Trainees: 15

Orientation for Biological Science Aids, Manhattan PMC. May 15, 2006. J. M. Row. Trainees: 4

Kansas NRCS Student Trainee Orientation Meeting. Manhattan PMC. June 6, 2006. R. L. Wynia and Cleveland Watts. Trainees: 16

Seed Quality. Bismarck PMC, Bismarck, N. Dak. Aug. 3, 2006. R. A. Shadow. Trainees: 25

NRCS Boot Camp. Aug. 24, 2006. Lied Center, Nebraska City, Nebr. R. L. Wynia. Trainees: 36

Poisonous Plants Power Point Presentation. Manhattan PMC. Sep. 11, 2006. J. M. Row. Trainees: 5

Tours: The PMC staff welcomes visitors and readily conducts tours. During calendar year 2006, more than 90 people visited the Center, of which 50 toured the Center. The following groups are representative of the yearly interest in the Manhattan Plant Materials Program:

Good Sam RV Club Tour
Haskell Indian Nations University Interns
Kansas NRCS Employees
Kansas NRCS Student Trainees

PLANT MATERIALS DEVELOPMENT FLOW CHART

Assembly	Initial Evaluations	Initial Seed/ Plant Increase	Advanced Evaluations	Field Evaluation Plantings	Seed/Plant Increase	Field Plantings	Release
FORBS AND LEGUMES							
		Asclepias tuberosa (SI)			*Chamaecrista fasciculata*		*Chamaecrista fasciculata* (F)
		Echinacea angustifolia					
		Liatris punctata				*Liatris punctata*	
		Silphium laciniatum (S)					
GRASSES AND GRASS-LIKE PLANTS							
Redfieldia flexuosa	*Panicum virgatum*		*Panicum virgatum*				
Scirpus sp.		*Calamovilfa gigantea* (F)					
			Schizachyrium scoparium				
					Bouteloua gracilis		*Bouteloua Gracilis* (F)
TREES AND SHRUBS							
	Amorpha fruticosa	*Amorpha canescens* (S)			*Betula nigra*	*Betula nigra* (T)	
	Celtis occidentalis	*Ceanothus herbaceous*		*Celtis occidentalis* (S)			
		Cotoneaster lucida (F)	*Fraxinus pennsylvanica* (S)				
	Platycladus orientalis	*Prunus americana*		*Platycladus orientalis* (S)		*Prunus americana* (F)	
	Quercus macrocarpa	*Cephalanthus occidentalis*			*Prunus angustifolia*	*Prunus angustifolia*	*Prunus angustifolia* (F)
		Salix exigua (S)		*Ulmus pumila* (S)	*Ribes aureum* var *villosum*	*Ribes aureum* var *villosum* (F)	
				Ulmus parvifolia			

Release Type: F-Formal SI-Source Identified S-Selected T-Tested

SELECTION AND INITIAL INCREASE OF SUPERIOR PLANTS

Initial increase is the production of seed or other propagules of potentially useful plants selected on the basis of initial or advanced evaluation for further evaluation or research. The following accessions are currently in the status of initial seed or plant increase.

<table>
<tr><th>Accession No.</th><th>PI No.</th><th>Common Name</th><th>Species</th><th>Study No.</th></tr>
<tr><td>9049944</td><td>514675</td><td>lead plant</td><td><i>Amorpha canescens</i></td><td>20I023H</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: A polycross composed of accessions 9013351, Comanche Co., Kans.; 9013344, Washita Co., Okla.; 9013354, Stephens Co., Okla.; and 9017622, Saline Co., Kans.</td></tr>
<tr><td></td><td>421278</td><td>butterfly milkweed</td><td><i>Asclepias tuberosa</i></td><td>20I009S</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: Saunders Co., Nebr.</td></tr>
<tr><td>9034682</td><td></td><td>river birch</td><td><i>Betula nigra</i></td><td>20I010K</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: Houston Co., Minn.</td></tr>
<tr><td>9050018</td><td></td><td>big sandreed</td><td><i>Calamovilfa gigantea</i></td><td>20I032X</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: A polycross composed of accessions 9026760, Reno Co., Kans.; 9026777, Payne Co., Okla.; 9035891, Lipscomb Co., Tex.; 9042800, Garza Co., Tex.; 9042911, Winkler Co., Tex.; 9049764, Rice Co., Kans.; 9049765, Stafford Co., Kans.; 9049823, Stafford Co., Kans.; and 9049866, Comanche Co., Kans.</td></tr>
<tr><td>9049952</td><td>514676</td><td>New Jersey tea</td><td><i>Ceanothus herbaceous</i> var <i>pubscens</i></td><td>20I024H</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: A polycross composed of accessions 9013414, Osborne Co., Kans.; and PI-421286, Wabaunsee Co., Kans.</td></tr>
<tr><td>9050496</td><td></td><td>Common buttonbush</td><td><i>Cephalanthus occidentalis</i></td><td>20I043E</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: A polycross composed of accessions 9050287, Hodgeman Co., Kans.; 9050296, Miami Co., Kans.; 9050311, Douglas Co., Kans.; 9050323, Harvey Co., Kans.; 9050340, Cleveland Co., Okla.; 9050359, Harvey/Reno Co., Kans.; 9050360, Osage Co., Kans.; 9050371, Butler Co., Kans.; 9050375, Montgomery Co., Kans.; 9050389, Douglas Co., Kans.; 9050392, Johnston Co., Okla.; and 9050395, Logan Co., Okla.</td></tr>
<tr><td></td><td>325270</td><td></td><td><i>Cotoneaster lucidus</i></td><td>20I033K</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: USSR</td></tr>
<tr><td>9023353</td><td></td><td>black samson</td><td><i>Echinacea angustifolia</i></td><td>20I018S</td></tr>
<tr><td colspan="5">ORIGIN/SOURCE: A polycross composed of accessions PI-421340, Butler Co., Kans.; PI-421331, Logan Co., Okla.; PI-421362, Ellis Co., Kans.; PI-421307, Noble Co., Okla.</td></tr>
</table>

Selection and Initial Increase of Superior Plants (continued)

Accession No.	PI No.	Common Name	Species	Study No.
9049894		dotted gayfeather	*Liatris punctata*	20I022S
ORIGIN/SOURCE: A polycross composed of PI-421419, Woodson Co., Kans.; PI-421497, Lane Co., Kans.; and PI-421488, Rush Co., Kans.				
9049945	514677	American plum	*Prunus americana*	20I028J
ORIGIN/SOURCE: A polycross composed of accessions 9013483, Gove Co., Kans.; 9013498, Valley Co., Nebr.; 9013500, Valley Co., Nebr.; 9013515, Harlan Co., Nebr.; and 9013544, Kingman Co., Kans.				
9049970		Chickasaw plum	*Prunus angustifolia*	20I029J
ORIGIN/SOURCE: A polycross composed of accessions 9013486, Gove Co., Kans.; 9013519, Kingfisher Co., Okla.; 9013524, Roger Mills Co., Okla.; 9013527, Woods Co., Okla.; 9013528, Woods Co., Okla.; 9013543, Gray Co., Kans.; 9013547, Garfield Co., Okla.; and 9013548, Kingfisher Co., Okla.				
9050270		buffalo currant	*Ribes aureum* var *villosum*	20I036X
ORIGIN/SOURCE: A polycross composed of accessions 9049770, Morris Co., Kans.; 9049773, Ellis Co., Kans.; 9049806, Holt Co., Nebr.; 9049810, Sheridan Co., Nebr.; and 9049884, Loup Co., Nebr.				
9050135		sandbar willow	*Salix exigua*	20I040E
ORIGIN/SOURCE: Brown Co., Kans.				
9050148		sandbar willow	*Salix exigua*	20I040E
ORIGIN/SOURCE: Sarpy Co., Nebr.				
	421557	compass plant	*Silphium laciniatum*	20I020H
ORIGIN/SOURCE: Okmulgee Co., Okla.				

SEED AND PLANT PRODUCTION

Cultivar	Genus/Species	Common Name	Origin	Class	Acres
HERBACEOUS					
Forbs					
Riley Germplasm	*Chamaecrista fasciculata*	showy partridge pea	Riley Co., Kans.	G2	0
Kaneb	*Dalea purpurea*	purple prairie clover	Riley Co., Kans.	FND	0.56
Reno Germplasm	*Desmanthus illinoensis*	Illinois bundleflower	Reno Co., Kans.	G2	0
9023353	*Echinacea angustifolia*	black sampson		SFP	0.17
Prairie Gold	*Helianthus maximiliani*	Maximilian sunflower	Kans.	FND	0.35
Midas	*Heliopsis helianthoides* var *scabra*	false sunflower	Kans.	FND	0.12
Kanoka	*Lespedeza capitata*	round-head lespedeza	Kans., Okla.	FND	0.28
9049894	*Liatris punctata*	dotted gayfeather	Kans.	G2	0.19
Eureka	*Liatris pycnostachya*	thickspike gay-feather	Kans.	FND	0.07
Sunglow	*Ratibida pinnata*	grayhead prairie coneflower	unknown	FND	0.24
Nekan	*Salvia azurea* var *grandiflora*	pitcher sage	Kans.	FND	0.23
421557	*Silphium laciniatum*	compass plant	Okmulgee, Co., Okla.	G2	0.02
Grasses					
Kaw	*Andropogon gerardii*	big bluestem	Riley Co., Kans.	FND	1.0
Garden	*Andropogon hallii*	sand bluestem	Garden Co., Nebr.	SFP	0.57
El Reno	*Bouteloua curtipendula*	sideoats grama	Canadian Co., Okla.	FND	0.84
9050485	*Bouteloua gracilis*	blue grama		SFP	1.37
Pronghorn	*Calamovilfa longifolia*	prairie sandreed	Nebr.	FND	0.75
9050018	*Calamovilfa gigantea*	giant sandreed	Kans., Okla., Tex.	SFP	0.85
Bend	*Eragrostis trichodes*	sand lovegrass	Kans., Okla.	FND	0.24
Blackwell	*Panicum virgatum*	switchgrass	Blackwell, Okla.	FND	1.23
Kanlow	*Panicum virgatum*	switchgrass	Wetumka, Okla.	FND	0.72
Barton	*Pascopyrum smithii*	western wheatgrass	Barton Co., Kans.	FND	1.0
Southwind	*Phragmites australis*	common reed	Kans., Okla.	FND	0.8
Aldous	*Schizachyrium scoparium*	little bluestem	Kansas Flinthills	FND	2.4
Cimarron	*Schizachyrium scoparium*	little bluestem	Kans., Okla.	FND	1.57
Cheyenne	*Sorghastrum nutans*	yellow Indian grass	Fort Supply, Okla.	SFP	0.35
Osage	*Sorghastrum nutans*	yellow Indian grass	Kans., Okla.	FND	1.0
Atkins Germplasm	*Spartina pectinata*	prairie cordgrass	Washington Co., Nebr.	G2	0.83
Pete	*Tripsacum dactyloides*	eastern gamagrass	Kans., Okla.	FND	1.0
WOODY					
9049944	*Amorpha canescens*	lead plant	Kans., Okla.	G2	0.07
9034682	*Betula nigra*	river birch	Houston Co., Minn.	G2	0.15
9049952	*Ceanothus herbaceous* var *pubscens*	New Jersey tea	Kans.	G2	0.11
325270	*Cotoneaster lucidus*		USSR	FND	0.05
Pink Lady	*Euonymus bungeanum*	winterberry	China	FND	0.03
9049945	*Prunus americana*	American plum	Kans., Nebr.	FND	0.05
9049970	*Prunus angustifolia*	Chickasaw plum	Kans., Okla.	FND	0.12
Lippert	*Quercus macrocarpa*	bur oak	Stillwater, Okla.	FND	0.02
Konza	*Rhus aromatica* var *serotina*	aromatic sumac	Kans.	FND	0.09
9050270	*Ribes aureum* var *villosum*	buffalo currant	Kans., Nebr.	FND	0.05
9050135	*Salix exigua*	sandbar willow	Brown Co., Kans.	G2	0.09
9050148	*Salix exigua*	sandbar willow	Sarpy Co., Nebr.	G2	0.11
9004450	*Juglans microcarpa*	little walnut	Beckham Co. & Washita Co., Okla.	SFP	0.1

DISTRIBUTION OF PLANT MATERIALS IN 2006

The following table shows the distribution of plant materials from the Manhattan PMC. A total of 45 seed and plant orders were shipped to 14 states and 3 plant materials centers during the calendar year 2006. Over two thousand and ten pounds of seed, 439 rhizomes, and 70 plants were shipped to conservation districts, universities, federal and state agencies, and private entities. These materials were used in field trials, research, seed or plant increase and demonstration plantings and for educational purposes.

Herbaceous Plant Materials

		Seed Orders			Plant Orders		
State	Use	Number	Number of Packets	Bulk Pounds	Number	Number of Rhizomes	Number of Plants
Kansas	CD				2	427	
	CI	4		1,006.8			
	RC&D	1		87.7			
	RES	1		0.4			
Subtotal		6		1,094.9	2	427	
Nebraska	CI	2	1	45.0			
	FA	2	1	4.1			
	OR	2		8.1			
Subtotal		6	2	57.2			
Colorado	CI	2		34.2			
Missouri	CI	1		39.6			
Oklahoma	RES	2		2.8			
Texas	CI	3		401.8			
	Demo	1	12	0.1	1	12	
	PMC	1		1.3			
	RES	1		7.4			
Subtotal		11	12	487.2	1	12	
Other States	CD	1		19.2			
	CI	3		263.5			
	Demo	2		4.4			
	PMC	1		13.4			
	RES	5	2	39.3			
Subtotal		12	2	339.8			
Total		35	16	1,979.1	3	439	

Legend: CD=Conservation Districts CI=Commercial Increase FA=Federal Agencies GPP=Germ plasm Preservation OR=Outreach PMC=Plant Materials Centers RC&D=Resource Conservation & Development RES=Research at public and private institutions

Woody Plant Materials

		Seed Orders		Plant Orders		
State	Use	Seed Orders	Bulk Pounds	Number	Number of Cuttings	Number of Plants
Kansas	CD			1		70
	RC&D	1	2.5			
	RES	1	0.9			
Subtotal		2	3.4	1		70
Missouri	RES	1	3.5			
Montana	CI	1	13.0			
Oklahoma	RC&D	1	11.0			
Texas	Demo	1	0.5			
Subtotal		4	28.0			
Total		6	31.4	1		70

YEAR 2006 CLIMATOLOGICAL DATA FOR MANHATTAN, KANSAS

2006 Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg Max	55.2	48.6	57.7	75.5	79.4	91.0	95.9	91.2	79.0	67.5	59.4	51.1	71.0
Avg Min	30.5	22.1	35.5	50.7	54.8	65.1	71.7	67.9	53.3	43.5	32.8	29.0	46.4
Avg Mean	42.8	35.4	46.6	63.2	67.1	78.0	83.8	79.5	66.2	55.5	46.1	40.1	58.7
High	70	84	80	92	98	100	108	109	95	97	84	63	
Low	20	0	22	32	41	50	56	51	41	23	19	8	
Min† < 10	0	2	0	0	0	0	0	0	0	0	1	1	4
Min† < 32	16	24	10	0	0	0	0	0	0	8	13	18	89
Max† > 90	0	0	0	3	6	15	23	16	2	2	0	0	67
Precip	0.50	0.01	2.93	3.46	2.85	1.44	4.10	10.91	1.99	1.95	0.11	1.57	31.82
PMC‡	-	-	2.68	2.88	2.19	1.71	3.41	9.79	2.06	2.38	0.04	-	-
Precip†	4	5	11	9	11	12	10	14	9	7	4	6	102
Snow	1.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Heat DD*	687	830	549	143	96	0	0	0	45	345	585	748	4027
Cool DD*	0	0	4	79	162	391	583	451	80	50	0	0	1798

Normal Values (1971-2000)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg Max	39.5	46.8	57.5	67.9	77.5	87.1	92.5	90.8	82.1	70.7	54.5	42.9	67.5
Avg Min	16.1	21.5	31.4	42.2	52.5	62.3	67.3	65.1	55.5	43.2	30.2	19.9	42.3
Avg Mean	27.8	34.2	44.5	55.1	65.0	74.7	79.9	78.0	68.8	57.0	42.4	31.4	54.9
Precip	0.86	1.00	2.59	3.07	5.08	5.23	4.10	3.27	3.67	2.77	2.10	1.06	34.8
Snow	4.8	4.9	3.4	0.9	0.1	0	0	0	0	0.2	1	3.7	18.8
Heat DD*	1153	864	637	315	106	7	0	4	48	265	679	1042	5120
Cool DD*	0	0	0	17	106	298	461	405	163	15	0	0	1465

Departure From Normal

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Avg Max	15.7	1.8	0.2	7.6	1.9	3.9	3.4	0.4	-3.1	-3.2	4.9	8.2	3.5
Avg Min	14.4	0.6	4.1	8.5	2.3	2.8	4.4	2.8	-2.2	0.3	2.6	9.1	4.1
Avg Mean	15.0	1.2	2.1	8.1	2.1	3.3	3.9	1.5	-2.6	-1.5	3.7	8.7	3.8
Precip	-0.36	-0.99	0.34	0.39	-2.23	-3.79	0	7.64	-1.68	-0.82	-1.99	0.51	-2.98
Snow	-3.6	-3.9	-3.4	-0.9	-0.1	0.0	0.0	0.0	0.0	-0.2	-1.0	-3.7	-16.8
Heat DD*	-466	-35	-88	-172	-11	-7	0	-4	-4	80	-94	-294	-1094
Cool DD*	0	0	4	62	56	93	122	46	-84	35	0	0	333

*Daily values were computed from mean temperatures. Each degree that a day's mean is below (or above) 65°F is counted for one heating (or cooling) degree day. † Number of days. ‡ Gauge in operation March 2 to November 28.

Official Recording Station, Manhattan, KS

CLIMATIC SUMMARY 2006

Temperature Extremes: 0ºF Mid-February; 109ºF in August

First Killing Frost: October 13th

Last Killing Frost: May 2nd

Number of Frost Free Days: 163

Temperature: The record high temperature of 70ºF on January 7 set the tone for the month with an average temperature of 42.8ºF. It was the warmest January on record. Despite record warmth on the 28th, the February average temperature fell in the middle of the range only 0.9 degrees warmer than average. Highs on the 28th were balanced by extremely cold temperatures during the middle of the month. March was slightly warmer than normal, mostly due to warmer than normal low temperatures; however, no records were set. The warmer than normal trend continued in April, with a new record high of 92 degrees on the 14th was part of the heat wave that left April almost 8 degrees warmer than normal. May was slightly cooler than normal. A record low of 28ºF was set on May 2nd. This was the last of the extremely cold weather. The daily average high ran several degrees above normal. While there were several readings in the 90's, the century mark was not broken. June was the 20th warmest on record; however no new daily records were set. July was a study in contrasting temperatures with highs above 100º being replaced by highs in the 80's. However, despite the warm temperatures, no new record highs were set. A new record for a warm low was set on the 18th, when the temperature only dropped to 85º F. The trend continued in August with temperatures in the 100's in the beginning of the month and ending the month in the 70's. The month was slightly warmer than normal, though no records were set. September was cooler than normal. Despite the cold weather, no freezing temperatures were observed and no records were set. Despite a warm beginning, including a new record high on the first, October was cooler than normal. The first frost of the season occurred on October 13th, only two days earlier than normal. November was a wild month. Warm conditions through mid-month gave way to winter. Tornadoes in the vicinity, including Fort Riley and Keats gave way to temperatures in the teens with winds in excess of 30 mph and snow with true winter conditions arriving on the 27th. December was warmer than normal but no records were set.

Precipitation: Dry conditions prevailed in January with measurable precipitation on only 4 days. February was the 2nd driest, continuing the dry trend. The year was the 7th driest start since 1890. March was slightly wetter than normal. A lingering storm system starting on the 18th brought most of the moisture, but the heaviest single day event came on the 31st, when severe weather rolled through the area. April was wetter than normal, thanks to a wet start and a wet end of the month. The benefit was limited by the spotty distribution. May was much drier than normal, making the period March through May the driest since 1890. Despite having 16 days with precipitation, June ranked as the 8th driest on record. This was a sharp contrast to last June, which ranked as one of the 10th wettest on record. Not surprisingly, the dry weather was accompanied by warm temperatures. Rainfall was exactly normal for July, but the warmer than normal conditions resulted in high demand and an increase in drought stress in the area. August was the 3rd wettest on record. September was drier than normal with mostly light rains. Despite 10 days with rain, October was below normal for precipitation. Storms on October 26-27 brought welcome relief to the dry month which ended 0.82 inches drier than normal. The first snow fell on the 16th of November but melted on contact. December was wetter than normal, despite a dry start to the month. The month ended on a wintry note, as snow fell throughout the day on the 31st leaving 2.5 inches of snow on the ground to start the New Year.

STUDIES

Studies are planned and developed by the Plant Materials Center staff to solve high-priority problems identified in the Center's Long-Range Program. All PMC studies are listed as part of the National Plant Materials Program projects. Twenty studies were active in on-site and off-site (OS) trials in 2006 (Table 1.1). Details of active studies can be found on the subsequent pages.

Table 1.1. Status of studies conducted by PMC staff.

Study No.	Study Name	Location	Status	Start Date	End Date	Project No.
20A107T	Seed storage study.	KSPMC	Active	1973	2020	RN 1.1
20A126L	Adaptation trials of superior grasses and forbs selected for advanced testing.	KSPMC	Active	1992	2050	NA 1.1
20A127K	Evaluation of PMK-1 and other *Fraxinus pennsylvanica* germ plasm for resistance to ash borers.	KSPMC	Active	1997	2010	CP 4.1
20A215H	Rrps of little bluestem (*Schizachyrium scoparium*).	KSPMC	Active	1992	2008	RN 1.1
20C006G	Evaluation of perennial cool-season forage grasses.	OS KS	Inactive	1996	------	PH 1.1
20C007Ta	Propagation of Mead's milkweed (*Asclepias meadii*).	KSPMC	Active	1996	2010	NA 1.1
20C007Tb	Propagation of earleaf gerardia (*Agalinis auriculata*).	KSPMC	Inactive	1996	------	NA 1.1
20C008L	Evaluation of plant materials for use in soil bioengineering techniques.	KSPMC	Inactive	1998	------	WA 3.1
20I003L	Evaluation of miscellaneous grasses.	KSPMC	Active	1970	2020	NA 1.1
20I010K	Evaluation of miscellaneous trees and shrubs.	KSPMC	Active	1961	2050	CP 4.1
20I026K	Evaluation of hackberry (*Celtis* sp.).	KSPMC/ OS KS	Active	1979	2006	CP 4.1
20I031K	Evaluation of Oriental arborvitae (*Platycladus orientalis*).	KSPMC/ OS OK	Active	1979	2007	CP 4.1
20I037K	Evaluation of selected common hackberry (*C. occidentalis*).	KSPMC	Active	1988	2008	CP 4.1
20I038K	Bur oak seed source study.	KSPMC	Active	1991	2015	CP 4.1
20I039E	Evaluation of switchgrass (*P. virgatum*) germplasm for rhizomatous characteristics.	KSPMC	Active	1992	2010	CP 4.1
20I041K	Evaluation of Siberian elm (*Ulmus pumila*).	OS CO/NE	Active	1997	2020	CP 4.1
20I042E	Initial evaluation of indigobush (*Amorpha fruticosa*) for use in streambank stabilization, shoreline protection, and wetland restoration and enhancement.	KSPMC	Active	1997	2007	WQ 3.1
KSPMS-T-9902-OT	Assist Native American Tribes with the reestablishment of culturally significant plants.	OK, KS, NE	Active	1999	2020	- - -
KSPMS-T-0001-CR	Conservation field trial; reclamation of blue shale outcrop sites in Jewell County, Kansas.	OS KS	Active	2000	2010	ML 1.1
KSPMS-T-0201-CR	Plant species for revegetation of natural and man-induced saline areas.	OS KS	Active	2002	2006	CP 3.1
KSPMC-T-0501-RA	Longevity of native warm-season grass seed: storage viability vs. seedling vigor/stand establishment.	KSPMC/ OS KS	Active	2005	2008	RA 1.1
KSPMC-T-0502-RA	Laboratory evaluation of plant materials to determine seed analysis, germination, and propagation techniques.	KSPMC	Active	2004	2020	RA 1.1
KSPMC-P-0601-RA	Increasing seedling vigor and stand establishment of big sandreed (*Calamovilfa gigantea*).	KSPMC	Active	2006		RA 1.1

A. Advanced Evaluations

1. Study No. 20A107T - Seed storage study.

Introduction: Long-term storage facilities can provide a source of valuable seed stocks without maintaining large numbers of plants for seed production. Bass (1980) underlined the importance of maintaining small samples of many kinds of seeds, indefinitely, for breeding purposes. Seeds stored in unheated buildings are, however, subject to wide fluctuations in temperature and humidity in eastern Kansas, where the average annual humidity ranges from 51 to 81 percent and average annual temperatures range from -9° to 33°C (16° to 92°F). Such conditions are detrimental to the longevity of grass seeds in storage (Priestly *et al*. 1985).

In 1973, the USDA-SCS built a seed storage facility to preserve valuable seed stocks at the PMC, Manhattan, Kansas. This facility is rodent proof and is temperature and humidity controlled. Although the storage requirements for many plant species are known, there is little information available documenting the benefits of a controlled versus an uncontrolled environment for storing native plant seeds in eastern Kansas. Harrington's (1959) rule of thumb is that the percent relative humidity (RH) + temperature in degrees Fahrenheit should not exceed 100 for safe seed storage. Rincker and Maguire (1979) and Rincker (1981) found that even after 14 years germination was greater than 80 percent for several grasses stored at 5°F (-15°C) and 60 percent RH (Ackigoz and Knowles 1983).

This study was set up initially to compare the viability and longevity of warm-season and cool-season grasses when the seed storage facility was newly constructed in 1973. Forbs and legumes were added to the study in 1979.

Objective: Evaluate how controlled temperature and humidity and uncontrolled (warehouse) conditions affect native plant seeds.

Procedure: Seeds of 21 plant species were assembled. Eighteen of the species were native, consisting of five forbs, two legumes, 11 warm season grasses, and one cool season grass. Three introduced cool season grasses were also included in the study.

Seed storage facilities consisted of a seed storage building with controlled environment and an uninsulated building (hereafter referred to as the warehouse) without a controlled environment. The warehouse was wood frame on a concrete slab with clapboard siding. The warehouse was subject to wide fluctuations in temperature and humidity. The seed storage building was of all metal construction and insulated throughout. The storage room itself was sealed to exclude outside air and humidity.

Temperature and humidity in the seed storage building were controlled by a UNA-DYN (Model A30T) two tower, desiccant bed dehumidifier and a standard air conditioning unit. Temperature controls were set to maintain 18.3°C (65°F) summer, 12.8°C (55°F) fall-spring, and –1.1° to 7.2°C (30° to 45°F) in the winter. Relative humidity was maintained between 10 to 20 percent. A hygro-thermograph was used to monitor temperature and humidity. Each seed lot was divided into two portions and placed in burlap and/or cotton duck bags for storage. One sack of each lot was placed in the warehouse in a steel drum to prevent rodent damage. Pest strips containing 2-2 dichlorovynyl dimethyl phosphate (Vapona) (20% active ingredient) were placed in each barrel for insect control. The second sack of each seed lot was placed on shelves inside the seed storage building. The initial purity and germination test and subsequent germination tests were conducted in accordance with the Association of Official Seed Analysts Rules for Seed Testing (Anonymous 1978). Samples (100 g) of all lots were taken annually thereafter and sent to the Kansas State Board of Agriculture Seed Laboratory through 1993 for standard germination tests. Kansas Crop Improvement Association conducted germination tests from 1994 to the present. Seed lots were removed from the study when germination test results for that lot dropped below 10 percent of the original test.

No testing was conducted for years 17 and 19 [therefore no data (ND)] in the grasses since year-to-year changes were slight in most cases. No testing was conducted in years 11 and 13 for the forbs. Later on, it was decided that it was not a good idea to skip a year of testing in case viability for a particular lot was declining, so testing was resumed on an annual basis. Testing was discontinued for the uncontrolled storage environment entries after 13 years for warm-season grasses, 7 years for cool season grasses, and after 6 years for most forbs. Testing was discontinued for cool-season grasses in a controlled storage environment following 27 years of study. Refer to Tables 1.2A and 1.2B for cool-season grass germination test results.

Potential Products: Information Technology

Progress or Status:

Warm-Season Grasses

Most of the warm-season chaffy grasses declined in germination this year. The viability of ‘Kaw’ big bluestem (*Andropogon gerardii* Vitman) dropped to its lowest point in 33 years of testing, down 20 percentage points from the previous year. While that is quite a drop it is too early to tell if that is the beginning of a trend or just an anomaly. ‘Garden’ sand bluestem (*Andropogon hallii* Hack.) dropped 8 percentage points to 49%, however, its lowest point 7 years ago was 37% viability. The viability of ‘Osage’ Indian grass [*Sorghastrum nutans* (L.) Nash] declined only one percentage point and still exceeds that of the original germination test. ‘Aldous’ little bluestem (*Schizachyrium scoparium* Michx.) was the only warm-season chaffy grass to rebound this year. A germination of 67% was the same as 2 years ago and 11 years ago. Among the non-chaffy warm-season grasses, the viability of ‘El Reno side-oats grama (*Bouteloua curtipendula* Michx.) and buffalograss [*Buchloë dactyloides* (Nutt.) Engelm.], each increased by 2 percentage points over last year’s test. The smooth seeded switchgrasses continue to maintain viability at acceptable levels. ‘Kanlow’ switchgrass (*Panicum virgatum* L.) a lowland-type of switchgrass, rebounded 15 percentage points over last year at 64% germination, which was just below the original test of 66%, 33 years ago. The viability of ‘Blackwell’ (*P. virgatum* L.) an upland-type of switchgrass remained steady with last year’s test and was 4 points higher than the original test. ‘Bend’ sand lovegrass [*Eragrostis trichodes* (Nutt.) Wood] showed the best improvement of any of the non-chaffy grass entries with a 16 point increase over last year. ‘Pete’ eastern gamagrass [*Tripsacum dactyloides* (L.) L.] declined by 1 percentage point from last year but maintains a relatively steady level of viability that has been maintained over the last 5 years. Refer to Tables 1.1A and 1.1B for germination test results of warm-season grasses for the past 33 years.

Forbs

Three entries remain in the controlled storage environment test following 27 years of storage. One legume, ‘Kaneb’ purple prairie clover (*Dalea purpurea* Vent.), and two genera of the Asteraceae family, ‘Prairie Gold’ Maximilian sunflower (*Helianthus maximiliani* Schrad.) and ‘Midas’ false-sunflower [*Heliopsis helianthoides* (L.) Sweet var. *scabra* (Dun.) Fern.] continue to show viability (Tables 1.3A and 1.3B). ‘Kanoka’ round-head lespedeza (*Lespedeza capitata* Michx.), which was added to the study in 1980, continues to be viable following 21 years of storage in a controlled storage environment. Prairie Gold continued to rebound with an additional 5 point increase in germination from 2 years ago. The germination level for Midas has leveled out at 5 percent and will be dropped from the study. Both legumes, Kaneb purple prairie clover and round-head lespedeza declined from last year.

Interpreting the Results

If the data were plotted out, there are peaks, valleys, and plateaus associated with the data. The question that is often asked is, “how could this be”? We tend to think of viable seed as starting at some point and declining from there over time. While this is true it is not necessarily a straight line or even a nice gentle curve. Smoothing the data might help but the year-to-year fluctuations in the data are bothersome. How can you go from 37% viability for Garden sand bluestem in one year and 57% seven years later? Consider the variables that enter into play. It is impossible to uniformly mix the seed, especially that of a chaffy grass species. Next on the list is sampling. While uniform sampling is attempted, it remains a variable since it is random from year-to-year. At this point one has a sample that gets sent in to a seed laboratory (hopefully the same lab as the previous year) for a germination test. A random portion of the sample is separated out and used for the test. Additional variables include any fluctuations in incubator settings from year-to-year, location (micro-climate) in the incubator year-to-year, and interpreting the results.

Literature Cited:

Ackigoz, E. and R.P. Knowles. 1983. Long-term storage of grass seeds. Can. J. Plant Sci. 63:669-674.

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Rincker, C.M. 1981. Long-term subfreezing storage of forage crop seeds. Crop Sci. 21:424-427.

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Table 1.1A Germination test results for selected warm-season grasses over a period of years under controlled and uncontrolled storage environments.

Species	Entry	Storage	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Andropogon gerardii	Kaw	Cont.	63	74	82	73	65	73	87	77	81	78	74	66	78	80	69	88	57
		Uncont.	63	77	68	77	65	62	42	29	13	1	TE						
Andropogon hallii	Garden	Cont.	74	80	77	79	81	81	86	70	87	78	81	78	85	71	70	88	79
		Uncont.	74	76	75	74	76	73	68	24	33	30	13	4	1	TE			
Bouteloua curtipendula	El Reno	Cont.	22	66	76	69	73	73	72	70	69	74	76	71	64	71	78	86	73
		Uncont.	22	72	74	79	74	68	66	64	45	31	24	5	TE				
Buchloe dactyloides	PMT-1181	Cont.	73	72	72	73	70	74	60	70	44	57	71	57	61	76	74	45	67
		Uncont.	73	60	71	76	81	67	62	66	43	50	42	48	18	4	TE		
Eragrostis trichodes	Bend	Cont.	77	82	68	78	76	73	72	76	73	71	83	60	61	67	67	63	ND
		Uncont.	77	78	72	57	51	20	9	22	0	TE							
Panicum virgatum	Blackwell	Cont.	85	90	89	92	92	92	95	91	94	95	94	93	93	91	92	98	95
		Uncont.	85	91	91	90	92	81	84	81	80	71	62	43	25	10	TE		
Panicum virgatum	Kanlow	Cont.	66	70	70	72	74	68	67	73	72	70	77	74	61	65	67	68	65
		Uncont.	66	74	65	71	64	54	45	37	31	16	13	2	TE				
Schizachyrium scoparium	Aldous	Cont.	70	78	76	70	73	66	78	69	64	72	68	59	74	60	64	81	60
		Uncont.	70	71	76	67	63	54	44	36	22	12	6	4	6	TE			
Sorghastrum nutans	Osage	Cont.	75	64	78	75	71	74	84	72	79	69	76	63	74	59	67	88	70
		Uncont.	75	68	83	70	48	44	30	5	7	0	TE						
Spartina pectinata	PMK-1800	Cont.	67	75	68	60	48	55	54	56	24	11	51	46	64	45	48	38	24
		Uncont.	67	63	34	0	TE												
Tripsacum dactyloides	Pete	Cont.	10	41	27	43	24	39	31	46	41	36	47	31	43	37	32	58	28
		Uncont.	10	50	40	46	35	40	17	26	24	4	TE						

Table 1.2A Germination test results for selected cool-season grasses over a period of years under controlled and uncontrolled storage environments.

Species	Entry	Storage	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Thinopyrum ponticum	Jose	Cont.	89	91	94	98	94	95	93	92	91	85	80	89	78	73	50	61	36
		Uncont.	89	94	95	92	83	60	9	2	TE								
Bromus inermis	Elsberry	Cont.	ND	ND	ND	54	49	37	17	9	12	2							
		Uncont.	ND	ND	ND	54	21	8	3	TE									
Pascopyrum smithii	Barton	Cont.	10	46	59	75	81	84	79	75	55	64	49	72	65	55	75	52	84
		Uncont.	10	51	70	79	52	32	7	2	TE								
Phalaris arundinacea	Ioreed	Cont.	82	92	87	77	83	88	81	81	73	70	80	75	67	68	70	77	56
		Uncont.	82	88	77	70	52	16	1	TE									

Table 1.1B Germination test results for selected warm-season grasses over a period of years under the controlled storage environment.

Species	Entry	0	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Andropogon gerardii	Kaw	63	ND	77	ND	60	68	61	70	40	45	40	52	39	41	30	36	47	27
Andropogon hallii	Garden	74	ND	88	ND	73	82	75	76	74	71	37	71	56	65	47	48	57	49
Bouteloua curtipendula	El Reno	22	ND	88	ND	75	79	69	67	70	68	74	66	64	69	62	68	60	62
Buchloe dactyloides	PMT-1181	73	ND	75	ND	61	69	75	72	45	67	67	60	72	71	66	49	57	59
Eragrostis trichodes	Bend	77	50	ND	70	55	ND	64	66	48	53	30	50	51	28	33	26	42	
Panicum virgatum	Blackwell	85	ND	96	ND	93	93	90	90	96	88	85	87	93	92	91	91	89	89
Panicum virgatum	Kanlow	66	ND	77	ND	73	59	63	69	66	79	57	64	63	71	58	66	49	64
Schizachyrium scoparium	Aldous	70	ND	65	ND	66	ND	67	68	61	76	62	72	64	70	61	67	63	67
Sorghastrum nutans	Osage	74	ND	78	ND	71	93	85	78	60	75	83	81	78	89	77	72	79	78
Spartina pectinata	PMK-1800	67	ND	17	ND	9	16	3	1	TE									
Tripsacum dactyloides	Pete	10	ND	47	ND	53	50	46	47	43	45	43	44	42	35	42	38	39	38

Table 1.2B Germination test results for selected cool-season grasses over a period of years under controlled storage environment.

Species	Entry	Storage	0	17	18	19	20	21	22	23	24	25	26	27	28
Thinopyrum ponticum	Jose	Cont.	89	ND	36	ND	14	7	7	TE					
Pascopyrum smithii	Barton	Cont.	10	ND	75	ND	67	18	18	14	9	4	TE		
Phalaris arundinacea	Ioreed	Cont.	82	ND	42	ND	41	31	23	22	15	16	8	2	TE

Table 1.3A Germination test results for selected forbs over a period of years under controlled and uncontrolled storage environments.

Species	Entry	Storage	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dalea purpurea	Kaneb	Cont.	81	77	84	83	87	85	82	86	83	82	86	ND	86	ND	81	64	77
		Uncont.	81	83	83	77	79	82	75	59	39	20	18	TE					
Helianthus maximiliani	Prairie Gold	Cont.	66	70	67	68	81	72	77	65	69	71	61	ND	62	ND	38	39	62
		Uncont.	66	65	57	36	38	1	TE										
Heliopsis helianthoides	Midas	Cont.	78	74	68	68	65	61	69	33	49	54	54	ND	39	ND	31	36	56
		Uncont.	78	65	65	56	51	40	6	TE									
Lespedeza capitata	9026784	Cont.	83	89	86	94	85	ND	88	ND	80	91	92	89	84	97	68	72	43
		Uncont.	83	83	30	32	ND	ND	15	TE									
Liatris pycnostachya	Eureka	Cont.	56	44	17	13	15	24	ND	6	15	11	10	ND	13	ND	11	3	3
		Uncont.	56	30	2	TE													
Ratibida pinnata	Sunglow	Cont.	82	89	81	82	79	70	68	62	60	55	39	ND	24	ND	6	11	11
		Uncont.	82	93	76	24	8	2	TE										
Salvia azurea var *grandiflora*	Nekan	Cont.	30	33	37	26	29	33	26	21	22	19	11	ND	26	ND	23	4	21
		Uncont.	30	30	14	14	6	5	TE										

Table 1.3B Germination test results for selected forbs over a period of years under the controlled storage environment.

Species	Entry	0	17	18	19	20	21	22	23	24	25	26	27
Dalea purpurea	Kaneb	81	71	85	68	54	60	96	76	67	63	77	68
Helianthus maximiliani	Prairie Gold	66	43	17	79	19	20	11	40	17	20	25	30
Heliopsis helianthoides	Midas	78	26	22	34	11	10	30	25	8	6	6	5
Lespedeza capitata	Kanoka	83	79	69	59	70	64						
Liatris pycnostachya	Eureka	56	0	TE									
Ratibida pinnata	Sunglow	82	4	TE									
Salvia azurea var *grandiflora*	Nekan	30	9	7	4	3	TE						

Tables Legend: Cont. = controlled; Uncont. = uncontrolled; ND = no data; TE = testing ended

2. Study No. 20A126L - Adaptation trials of superior grasses and forbs selected for advanced testing.

Introduction: Part of the release process for a superior plant material selected for release is to test the plant's area of adaptation. The Manhattan PMC is often called upon by other PMCs and other entities for the purpose of testing superior plants that they have selected for release.

Objective: The purpose of this study is to provide a standard means by which superior plants will be evaluated for adaptation.

Procedure: The superior plant will be established in 6.1 m (20 ft) rows with a 2.1 m (6 ft) spacing (unless otherwise specified) between rows. A known cultivar will be planted adjacent to the superior plant as a standard of comparison (if available) in a 3X replicated planting. Plantings are irrigated as needed during the initial growing season to aid establishment.

Evaluation Factors: Factors for evaluation will include plant vigor, stand, seed production, and resistance to disease, drought, and cold.

Potential Products: Information technology and cultivar release.

Progress or status: The following warm-season grasses are currently under test at the Manhattan PMC: Upland-type switchgrass (*Panicum virgatum* L.) and prairie sandreed [*Calamovilfa longifolia* (Hook.) Schribn.] which is part of an inter-center strain trial. Forbs that are currently under test are a number of tick-trefoils: Dillenius' tick-trefoil [*Desmodium glabellum* (Michx.)], Illinois tick-trefoil (*Desmodium illinoense* Gray), and panicledleaf tick-trefoil [*Desmodium paniculatum* (L.) DC.]; Penstemons: Cobaea penstemon, (*Penstemon cobaea* Nutt.), narrow beardtongue (*Penstemon angustifolius* Nutt. ex Pursh), and large beardtongue (*Penstemon grandiflorus* Nutt.).

a. Adaptation zones of switchgrass populations: Switchgrass as a species is broadly adapted to most of the latitudinal range of the lower 48 states (25 to 49 degrees North Latitude). It is thought that most switchgrass populations have northern or southern limits beyond which they are relatively unadapted. The purpose of this study is to answer some basic questions about geographic adaptation of six switchgrass populations. The objective is to determine the relative importance of latitudinal vs. longitudinal adaptation zones of switchgrass populations collected from native prairie remnants. Six switchgrass populations with little or no plant breeding history from Wisconsin south to Blackwell, Oklahoma, will be included in the study. This trial is in cooperation with Dr. Mike Casler, USDA-ARS Dairy Research Center, University of Wisconsin. It consists of four cultivars: 'Blackwell', 'Cave-in-Rock', 'Pathfinder', and 'Sunburst', and two experimental lines. It was planted June 19, 2001, at Manhattan in field D-2. Plots 1.2- x 7.6-m (4- x 25-ft) with six replications, solid seeded in a Latin square design with 0.3 m (1 ft) drill spacing on a Belvue silt loam soil.

Seed was harvested from selected plots in 2006; however, the seed fill was so reduced that further seed harvest was suspended. Seed harvest will be attempted in subsequent years when the seed fill is determined to be of better quality and quantity.

b. Prairie sandreed: The plant materials specialist for Michigan requested that the Manhattan PMC participate in an inter-center strain trial to test the adaptation of a selection of prairie sandreed to our local climate. The Rose Lake PMC at East Lansing, Michigan, provided both plants and seed for the trial. Twelve plants of accession 9086408 were planted one foot apart in a rod row in Field B-3 at Manhattan. Refer to Study No. 20I003L, page 34, for further information on spaced plants. Hulled seed was planted in 0.3-m (10 foot) rod rows spaced 0.18-m apart with 3 replications on May 26, 2005, with a Kinkaid Plot Planter. 'Pronghorn' prairie sandreed was planted as a standard of comparison. A stand of 91.1% was recorded on August 18 for accession 9086408.

c. Desmodium Species: The plant materials specialist for Michigan requested that the Manhattan PMC participate in an inter-center strain trial to test the adaptation of three Desmodium selections to our local climate. The Rose Lake PMC at East Lansing, Michigan provided both plants and seed for the trial. The Manhattan PMC added two entries to the planting at Manhattan. One local collection and a collection from McPherson County, Kansas, were added to the trial that was established from seed. In all, five accessions were placed in the trial. Refer to Table 2.1, for a listing of the entries.

Table 2.1 Five Desmodium seed collections planted at Manhattan, Kans., June 7, 2005.

Accession	**Cultivar**	**Species**	**Common Name**
9005087	Marion	*Desmodium glabellum*	Dillenius' tick-trefoil
9013451	CNS	*Desmodium illinoense*	Illinois tick-trefoil
9050393	CNS	*Desmodium* sp.	tick-trefoil
9055415	Alcona	*Desmodium glabellum*	Dillenius' tick-trefoil
9055428	Grant	*Desmodium paniculatum*	panicledleaf tick-trefoil

Seed was planted in 3.05 m (10 ft) rod rows spaced 1.52 m (5 ft)apart with 3 replications on May 26, 2005, with a Kinkaid Plot Planter. Plants were set out June 7, 2005, in rod rows with an in-row spacing of 45.7 cm (18 in) apart. Poor stands were obtained from seed even though it was scarified. The dry weather is thought to have been a factor in the lack of success in establishing a stand. Stand improved, for all the established entries, which ranged from 13.4 to 31.5 percent, Table 2.2. The increase in stand was due to increased canopy except for accession 9050393 where 12 new seedlings were established. The new seedlings were from seed that did not germinate the previous year. Grazed by herbivores skewed some of the plant growth data.

Table 2.2 Desmodium seeding trial percent stand and number of plants per accession at Manhattan, Kans.

Accession	**No. New Seedlings**	**Percent Stand**	**No. of Plants Evaluated**	**Total No. of Plants**
9005087	0	29.2	7	11
9013451	0	0	0	0
9050393	12	31.5	4	8
9055415	0	13.4	3	5
9055428	0	19.9	7	10

The stand improved for all entries in the spaced plant nursery. Accession 9055428 performed best of the three entries, Table 2.3.

Table 2.3 Desmodium spaced plant growth data and percent stand at Manhattan, Kans.

Accession	**No. of Plants Surviving**	**Percent Stand**	**No. of Plants Blooming**	**Percent Bloom**	**Foliage Height***	**Plant Height***	**Plant Vigor**
9005087	8	80.0	0	0	58.2	58.2	3
9055415	6	60.0	2	33.3	62.5	62.5	3.5
9055428	7	67.6	4	57.0	67.6	81.0	1.5

*cm

d. Penstemon Species: Cobaea penstemon was a native forb of interest back in the 1970's when Accession 9004455 came into being with the pooling of seed collected from accessions PMK-1474 from Riley Co., Kansas and PMK-1983 from Osage Co., Oklahoma after a period of initial evaluation at Manhattan, Kansas. It is desirable to compare the performance of 9004455 with commercially available Cobaeas as well as other popular penstemon species. The accessions assembled, Table 2.4, for the trial were established as cone-tainer stock before planting them in a spaced plant nursery in field B-3 at the PMC. Enough plants were available to establish at least 2 replications of 5 plants each per accession, except for accession 9026604.

Table 2.4 Penstemon species planted at Manhattan, Kansas

Accession	Species	Common Name	Origin
9026604	*Penstemon angustifolius*	narrow beardtongue	Garden Co., Nebr.
9004455	*Penstemon cobaea*	Cobaea penstemon	Riley Co., Kans. and Osage Co., Okla.
9050493	*Penstemon cobaea*	Cobaea penstemon	Taney and Ozark Counties, Mo.
9050491	*Penstemon cobaea*	Cobaea penstemon	Ozark Co., Mo.
9082707	*Penstemon grandiflorus*	large beardtongue	Lyman Co., S. Dak., Emmons, Grant and Ransom Counties, N. Dak., Polk Co., Minn.

The plots were successfully established with occasional watering during the initial year, 2005. Excellent stands were reported in 2006. Accession 9004455, faired well among the Cobaea entries. It was similar in plant growth and produced more flowering than the other 2 entries, Table 2.5.

Table 2.5 Penstemon spaced plant growth data and percent stand at Manhattan, Kans.

Plant Symbol	Accession	No. of Plants Surviving	Percent Stand	No. of Plants Blooming	Percent Bloom	Foliage Height*	Plant Height*
PEAN	9026604	5	100	5	100	30.2	30.2
PECO	9004455	10	100	7	70	38.5	46.4
PECO	9050491	10	100	6	60	36.9	47.2
PECO	9050493	24	96	15	62.5	36.7	48.2
PEGR	9082707	25	100	16	64	43.5	75.5

*cm

3. Study No. 20A127K - Evaluation of PMK-1 green ash for resistance to ash borers.

Introduction: Green ash (*Fraxinus pennsylvanica* Marsh.) was widely planted in the Northern Plains as a windbreak and landscape tree. Larval damage by the lilac (ash) borer, *Podosesia syringue*, and banded ash clearwing, *Podosesia aureocincta*, have severely reduced the use of green ash especially in the more southern portion of the tree's range. Larvae bore into the young tree trunk near the soil line, weakening the seedling so that they may break off in the wind. Tree borers are among the most difficult insect pests to control because the insects feed within the tree. Thus, pesticides are generally ineffective in controlling ash borers. Keeping trees healthy and growing vigorously helps to reduce or prevent borer attack.

Problem: The Manhattan PMC has germ plasm of green ash that has been tested as PMK-1 for several years. PMK-1 has not been formally tested to determine if it has ash borer resistance or if there are management methods in ash establishment that might limit or lessen ash borer damage to trees.

Objective: To test PMK-1 for borer resistance.

Procedure: Seeds of PMK-1 were pretreated and then stratified 60 days warm stratification at 20ºC followed by a 60 day prechill at 4ºC. At the end of pretreatment the seeds were placed on blotters in germination boxes and allowed to germinate in a plant growth chamber at 20º-30ºC (night/day). The seedlings were transplanted to 656-ml (40 in^3) "deep pot cells", later batches were transplanted to 164-ml (4 in^3) Ray Leach "Cone-tainers"^{TM}, and additional stratified seeds were direct seeded into cone-tainers. On September 27, 2001, 2-0 deep pot stock and cone-tainer stock were transplanted to 6 plots at the Kansas Crop Improvement Association (KCIA) headquarters in Manhattan, Kansas. The KCIA site was chosen because of a history with borer problems on green ash. The 2 tree plots consisted of 1 deep potted plant and 1 cone-tainer plant (designated A and B respectively) spaced 50 to 60 cm (19.7 to 23.6 in) apart on a Wymore silty clay loam soil. Six 2 tree plots at the Center were divided into 2 areas. One area was a compacted, rocky, old roadbed (critical area site designated CA) and the other site was the typical Belvue silt loam soil on the Center. All plantings were caged to reduce browse damage by herbivores.

Potential Products: Cultivar Release

Progress or Status: One tree was attacked by a lilac borer in the PMC CA plots. No borer activity was detected at the KCIA site. The only other borer activity was noted in the bur oak assembly at the PMC where green ash was planted as replacement trees.

Literature Cited:

Association of Official Seed Analysts. 1999. Rules for Testing Seeds. 126 p.

Young, J.A. and C.G. Young. 1992. Seeds of Woody Plants in North America. Dioscorides Press. Portland, Oreg. 407 p.

4. Study 20A215H - Evaluation of little bluestem.

Introduction: Little bluestem (*Schizachyrium scoparium* Michx.) is a native, warm-season, perennial bunchgrass with a deep, fibrous root system. It is widely distributed over much of North America extending from Quebec, Canada, and Maine west to Alberta, Canada, and Idaho, and southward to Arizona and Florida. It occurs with other tall-grass prairie species such as big bluestem, Indian grass, and switchgrass, in the Plains where moisture conditions are favorable. In the drier mixed-grass prairie, it is associated with blue grama, side-oats grama, green needlegrass, western wheatgrass, prairie sandreed, and needle-and-thread. It possesses moderate drought and shade tolerance. It also tolerates a wide range of soils with adequate soil moisture.

Problem: There is a need for an adapted cultivar of little bluestem for range seeding, critical area planting, recreational area development, and other conservation uses in western Kansas and Nebraska.

Objective: To utilize recurrent selection techniques to improve 421554, (PMK-1840) germ plasm and select a superior little bluestem cultivar for the Kansas/Nebraska Service Area.

Procedure: Flats of little bluestem were planted in the greenhouse in spring 1992. Seedlings were selected at the two-to-three leaf stage and transplanted to cone-tainers for continued development in the greenhouse. Seedlings were selected based on performance and root morphology. Criteria such as speed of germination, coleoptile length, and subcoleoptile internode root production were used to select seedlings in the greenhouse screening. Plants were transplanted to a 2- x 2-m (7- x 7-ft) spaced plant field nursery approximately six weeks later.

Evaluation Factors: Plants will be evaluated for vigor, forage production, flowering date, disease resistance, seed production, and seed size. A grid-type evaluation system will be used to make selections of plants for inclusion in a polycross nursery. Evaluations will be conducted for two to three years with 10 to 20 percent of the nursery plants selected. Seed from the selected plant polycross will be tested against standard varieties or used to begin another cycle of recurrent phenotypic selection.

Potential Products: Cultivar Release

Progress or Status: Seed was collected from plots this year.

5. Study No. KSPMC-P-0601-RA - Increasing seedling vigor and stand establishment of big sandreed [*Calamovilfa gigantea* (Nutt.)].

Introduction: Big sandreed [*Calamovilfa gigantea* (Nutt.)] is a tall, native, robust, rhizomatous, warm-season perennial grass. It is found growing on sandy hills, dunes, and along stream margins in southern Kansas, Oklahoma, from Texas to Arizona, and from Kansas to Utah.

Problem: The genus Calamovilfa in general has weak seedling vigor and trouble with stand establishment. To ensure a varieties success in the commercial market place it must have a certain level of seedling vigor and ability to form a productive stand in a reasonable length of time. Commercial seed producers will not tolerate or produce a cultivar with substandard vigor and slow establishment.

Objective: Improve stand establishment of big sandreed by selecting plants with improved seed production qualities.

Procedure: A bulk seed sample was first divided into three fractions based on weight (Heavy, Heavy 2X, and Heaviest) using a South Dakota Seed Blower, to determine which weight fraction had the best germination. An unsorted sample was kept as a control. Approximately one pound of seed was then blown on the South Dakota Seed Blower at full air strength on a full length column for one minute. To provide adequate separation, only 50 to 100 ml of seed was blown at a time. The light sample trapped at the top of the column was collected, labeled, and set aside. The heavier seed from the bottom of the column was also collected. A uniform sample was pulled from this material and labeled as the “Heavy” fraction. The rest of the heavy seed was run through the blower again at full air strength on a full length column for one minute. The seed from the top of the column was labeled and set aside. A uniform sample was pulled from the bottom of the column and labeled as the “Heavy 2X” fraction since it had been blown twice. The remaining seed from the bottom of the column was run through the Dakota Seed Blower again at full air power and full length column for one minute, but yielded little separation. The column was then shortened by removing the middle section, and the remaining seed was blown at full air power for one minute in the short column. A uniform sample of the seed remaining in the bottom of the blower was collected and labeled as the “Heaviest” fraction. Seed weights for each fraction, Unsorted, Heavy, Heavy 2X, and Heaviest were obtained on an analytical balance using 10 replications of 100 seeds.

Evaluating Factors: Seed size and speed of germination will be evaluated after every cycle of selection to assess improvements.

Potential Product: Technology Transfer and Cultivar Release

Progress or Status: The Unsorted sample had an average seed weight of .5091 g per 100 seeds. The Heavy fraction averaged .7005 g per 100 seed, and the Heavy 2X yielded .7508 g per 100 seeds. The Heaviest fraction tipped the scales at .8366 g per 100 seeds, Table 5.1.

Germination tests were conducted on each fraction. Eight replications of 100 seeds were used for each weight fraction, and were subjected to two treatments: cold stratification and no stratification. The cold stratification treatment consisted of placing the seeds on moistened germination paper in a germination box, and storing them at 4^{o}C for 2 weeks before putting them in a germination chamber for one week at 24^{o}C. The treatment receiving no stratification consisted of placing the seeds on moistened germination paper in a germination box, and placing them in the germinator at 24^{o}C for one week. Since rapid establishment is one of the primary goals of this study, the germination tests were stopped after one week.

Table 5.1 Seed weight results for Unsorted, Heavy, Heavy 2X, and Heaviest seed fractions of big sandreed.

	Seed Weight (g)			
Rep	**Unsorted**	**Heavy**	**Heavy 2X**	**Heaviest**
1	0.52	0.6939	0.7432	0.8437
2	0.5067	0.7178	0.7426	0.8313
3	0.5112	0.7052	0.7516	0.8436
4	0.5006	0.6833	0.7503	0.8382
5	0.5047	0.7198	0.7386	0.8478
6	0.5103	0.6942	0.7465	0.8329
7	0.5305	0.7057	0.748	0.8337
8	0.4987	0.7012	0.772	0.8311
9	0.5075	0.6894	0.7563	0.8177
10	0.5009	0.6947	0.7592	0.8456
Average	**0.50911**	**0.70052**	**0.75083**	**0.83656**

Data from this series of tests showed the unstratified, Heavy 2X seed to have the best germination. It yielded 43.875% compared to the unsorted, unstratified sample which was 29.125%. The Heavy 2X fraction showed the highest overall germination for the study, and was shown to be significantly different than the other fractions (*P* = .0000). The unstratified treatment also proved to be significantly different than the stratified treatment (*P* = .0112). It is interesting to note that germination results for the Heaviest sample, 19.375%, fell below that of the Unsorted, 24.125%, Table 5.2. The seed showed a drastic drop in germination between the Heavy 2X and the "Heaviest" sample. Since the "Heaviest" seed makes up a portion of the Heavy 2X sample, it is reasonable to assume that the Heavy 2X germination could be further increased by separating "Heaviest" fraction from it.

Table 5.2 Germination test results for Unsorted, Heavy, Heavy 2X, and Heaviest seed fractions of big sandreed under cold stratified and unstratified conditions.

Rep	**Unsorted Seed Unstratified**	**Unsorted Seed Cold Stratified**	**Heavy Seed Unstratified**	**Heavy Seed Cold Stratified**	**Heavy 2X Unstratified**	**Heavy 2X Cold Stratified**	**Heaviest Seed Unstratified**	**Heaviest Cold Stratified**
1	29	29	21	32	46	40	17	15
2	30	32	35	43	48	30	15	17
3	16	20	32	24	47	37	22	13
4	25	27	40	32	44	32	27	14
5	28	27	34	14	54	37	21	16
6	19	33	42	24	39	30	14	6
7	23	35	33	26	33	36	14	13
8	23	30	38	26	40	36	25	17
% Germ	**24.125**	**29.125**	**34.375**	**27.625**	**43.875**	**34.75**	**19.375**	**13.875**

Two more separations were done on bulk samples to compare the percent of the Heavy 2X seed in the bulk sample. The first run yielded 51.15 g of Heavy 2X seed in a 383.80 gram sample. This ended up being 11.7% of the total seed in the sample. The second run yielded 41.28 g of Heavy 2X in a 382.69 gram sample. This gave 10.7% of the total sample as being Heavy 2X seed. Preliminary test appear to show that the Heavy 2X fraction roughly makes up 10% of seed in a bulk sample.

B. Cultural Evaluations and Special Studies

1. Study No. 20C006G - Evaluation of perennial cool-season forage grasses.

Introduction: Little information is available regarding the establishment, persistence, and management of adapted cool-season perennial grasses for use in MLRAs 72, 77, and 78. The use of adapted cool-season grasses can provide a livestock producer an option for lengthening the green grazing period. This study is being conducted in cooperation with Kansas State University's Agronomy Department.

Problem: The need exists to evaluate the adaptability and performance of cool-season perennial grass forage species for potential use in grazing strategies.

Objective: Evaluate various native and introduced cool-season perennial grasses for site adaptation and performance.

Procedure: Eleven different varieties of cool-season grasses (Table 1.1) were seeded in a randomized complete block design at three sites in Kansas: Clark, Phillips, and Wallace counties. Plots 1.5- x 6-m (5- x 20-ft), consisting of five rows spaced 0.3 m (1 ft) apart, were planted with a Kincaid Plot Planter. Each cultivar was replicated 4X.

Table 1.1 Cool-season grass varieties in trials at three Kansas locations.

Cultivar	Common Name	Species
'Hycrest'	crested wheatgrass	*Agropyron cristatum*
CNS	smooth bromegrass	*Bromus inermis*
'Jose'	tall wheatgrass	*Thinopyrum ponticum*
'Rush'	intermediate wheatgrass	*Elytrigia intermedia*
'Reliant'	intermediate wheatgrass	*Elytrigia intermedia*
'Slate'	intermediate wheatgrass	*Elytrigia intermedia*
'Barton'	western wheatgrass	*Pascopyrum smithii*
'Mankota'	Russian wild rye	*Psathyrostachys juncea*
'Bozoisky-Select'	Russian wild rye	*Psathyrostachys juncea*
'Manska'	pubescent intermediate wheatgrass	*Thinopyrum intermedium*
'Luna'	pubescent wheatgrass	*Thinopyrum intermedium*

CNS=Cultivar Not Stated

Potential Products: Technology Transfer and Revision of FOTG

Evaluation Factors: All varieties will be evaluated for establishment, persistence, forage quantity, and quality.

Progress or Status: A site visit was conducted at the Wallace County plots. A broadcast seeding of an annual medic species was conducted in the fall of 2006 over half of the plot.

2. Study No. 20C007Ta - Propagation of Mead's milkweed.

Introduction: Mead's milkweed (*Asclepias meadii* Torr. *ex* Gray) is a federally-listed, threatened species. The Plant Materials Program Strategic Plan has identified the recovery of threatened species as an emerging regional and national resource need. This study was initiated in 1996 at the request of the Kansas Biological Survey, Lawrence, Kansas. Seeds were collected that year on the Rockefeller Native Prairie (RNP) near Lawrence. Germination studies were conducted on the few seeds that were available for collection. The initial seedlings obtained from the germination studies were transplanted to cone-tainers in 1997 and grown out in the greenhouse-lathhouse-complex; the first field planting that year was to a buffalo grass-tall grass (BG-TG) mixed prairie. In 1998 plantings were made in two additional field scenarios: Red Group and Yellow Group on the "Salac Prairie" on the PMC, and Blue Group and White

Group monoculture plantings on a tilled site on the PMC. The Blue Group plants were lifted and transplanted in a row 2.74 m (5.8 ft) from the White Group. The prairie plantings were made in open areas of the existing sod where maintenance consists of an annual spring burn. The monoculture plants receive some weed control and tillage of adjacent areas. The Salac Prairie evolved from a grass-forb seeding mixture study involving various species native to the central Great Plains Region. Established in 1973, it has been allowed to persist as a prairie since the time when that study was completed. The (BG-TG) mixed prairie evolved from a buffalo grass cultivar trial established in 1992. Grasses and forbs native to the local area began to invade the plots as the study ended. The prairie is currently dominated by Indian grass [*Sorghastrum nutans* (L.) Nash], Illinois bundleflower (*Desmanthus illinoensis* (Michx.) MacM. ex B.L. Robins. & Fern.] and round-head lespedeza (*Lespedeza capitata* Michx.).

Problem: The need exists to learn more about propagation requirements and establishment techniques. The information will lend itself to recovery efforts for the species.

Objectives: Collect enough seed from identified native populations to establish a maintenance population. The maintenance population will be used to conduct further research on germination requirements, seed storage, and cultural techniques. Monitor the established prairie and monoculture plantings throughout the growing season and collect growth measurements and reproductive data. Collect additional seeds from the RNP near Lawrence, Kansas. Obtain or collect seeds from other plant populations in eastern Kansas to compare performance with the Rockefeller collections.

Procedure: A protocol was developed based on previous findings in this study to test additional seeds collected in 2003 on the RNP by Galen Pittman and the Goetz property by Jackie Goetz. Refer to the 2004 Annual Technical Report for details about the procedures that were used. In 2004, germination trials were conducted using stratified seed and various planting media and containers, Schedule 1-GT 2 and Schedule 2-GT 2. Containers used in the study were 50- x-150-mm peat pellets; 4 in^3 and 10 in^3 Ray Leach Single Cell cone-tainers containing PRO-MIX 'BX' growing medium or commercial topsoil, and 15 in^3 plant bands containing PRO-MIX 'BX'. Plants produced in Germination Trial 2 (GT-2) were carried over in 2006 to determine ability to maintain the plants in the containers for an extended period.

Schedule 1-GT 2. Containers with growing medium.

Start Date	Date Out	Patch	Weeks Stratification	No. Seeds	Medium/ Container
Feb 5	Apr 1	PMC	6-8	36	PRO-MIX 'BX' in plant bands
Feb 5	Apr 1	PMC	6-8	35	PRO-MIX 'BX' in cone-tainers
Feb 5	Apr 1	PMC	6-8	35	Commercial top soil in cone-tainers

Schedule 2-GT 2. Peat pellets and Cone-tainers.

Peat pellets.

Start Date	Date Out	Patch	Weeks Stratification	Seeds Per Rep	No. Reps.	No. Seeds
Feb 4	Mar 17	PMC	6	32	2	64

Cone-tainers

Start Date	Date Out	Patch	Weeks Stratification	Seeds Per Rep	No. Reps.	No. Seeds
Feb 4	Mar 17	PMC	6	22	2	44

Progress or Status: Established Field Plantings. The Yellow Group and Red Group plants rebounded after a poor showing last year due to freeze damage. Stands improved for both groups, the BG-TG mixed prairie was the only group to maintain its established stand of 100 percent, Table 2.1.

Table 2.1 Spring recovery and percent stand of established plants by group.

Group	Established Plants	Spring Recovery	Established Stand %	Current Stand %	Change From Previous Year %
Yellow	7	5	85.7	71.4	+28.5
Red	16	11	87.5	68.8	+25
White[1]	11	6	91.7	54.5	0
BG-TG	7	7	100.0	100	0
Prairie[2] (all)	30	23	86.7	76.7	+20

Monoculture[1]; Prairie[2] - Yellow, Red, BG-TG Groups;

Plants flowered in the Red, White, Blue, and BG-TG Groups this year. In all, five plants flowered, producing over 130 flowers; however, no follicles were produced. This was a first for Red Group with one plant flowering. Refer to Tables 2.2 to 2.4 for flower data for the BG-TG, White, and Blue groups.

Table 2.2 Summary of BG-TG mixed prairie flowering events.

	May 5		May 31
Plant No.	No. of Umbels	Buds/Umbel	Flowers/Umbel
2	1	15	PB
4	4	14,?,?,?	10, 17, 21, 5

PB=Past Bloom

Table 2.3 Summary of White Group monoculture flowering events.

	May 5		May 31
Plant No.	No. of Umbels	Buds/Umbel	Flowers/Umbel
8	1	9	PB
11	1	11	11

Table 2.4 Summary of Blue Group monoculture flowering events.

	May 5		May 31	
Plant No.	No. of Umbels	Buds/ Umbel	Flowers/ Umbel	Flowers Open
7	1	19	17	17 PB
10	1	17	18	18 PB

Salac Prairie plants remained in a juvenile growth habit in their ninth growing season (Tables 2.5 and 2.6). They have yet to develop the type of stems and leaves capable of supporting an inflorescence, with one exception. A single plant produced an umbel with 8 buds. However, stem caliper has increased for many plants that did not flower. Plants in the BG-TG mixed prairie, in their tenth growing season, produced stems and leaves

Table 2.5 Summary of plant growth (length, width, caliper) means for the Red Group "Salac Prairie" nine year old plants.

Date	5/5	5/31	5/31
			Range
No. of Plants	9	11	---
No. of Stems	13	13	---
Plant Length (cm)	---	26.0	5-35.8
No. of stems sampled	---	13	---
Leaf Width (mm)	---	4.2	2-21
No. sampled	---	13	---
Leaf Length (mm)	---	42.6	25-73
No. sampled	---	13	---
Stem Caliper (mm)	---	1.3	1-3
No. sampled	---	13	---

Table 2.6 Summary of plant growth (length, width, caliper) means for the Yellow Group "Salac Prairie" nine year old plants.

Date	5/5	5/31	5/31
			Range
No. of Plants	5	5	---
No. of Stems	5	5	---
Plant Length (cm)	---	28.8	24.7-34.6
No. of stems sampled	---	5	---
Leaf Width (mm)	---	2.6	2-4
No. sampled	---	5	
Leaf Length (mm)	---	35.2	22-44
No. sampled	---	5	---
Stem Caliper (mm)	---	1.1	1-1.5
No. sampled	---	5	---

capable of supporting reproductive structures (Table 2.7). BG-TG plants were superior to plants in the other groups for the four plant characteristics measured. BG-TG plants averaged 7.5 cm greater plant length, leaf length by 3 mm, leaf width by 5 mm, and stem diameter by 0.3 mm, over than the top competitor. Maintenance on the monoculture sites was reduced to mowing and burning three years after establishment. This maintenance was performed prior to emergence of the milkweeds in the early spring. Due to the rhizomatous nature of milkweeds, maintenance was reduced to prevent disturbance of offshoots arising from the mother plants. As the intensity of maintenance on the White Group and Blue Group monoculture sites was reduced the dynamics of the sites changed. The monoculture sites were in transition to an early successional (ES) plant community as annual grasses and forbs, as well as perennials, began to compete with monoculture plants. The dominant plant competition currently consists of Illinois bundleflower, round-head lespedeza, showy partridge pea [*Chamaecrista fasciculata* (Michx.) Greene], Canada goldenrod (*Solidago canadensis* L.*)*, little bluestem [*Schizachyrium scoparium* (Michx.) Nash], and sand dropseed [*Sporobolus cryptandrus* (Torr.) Gray]. Plant growth data for the Blue and White groups is summarized in Tables 2.8 and 2.9. In comparing growth data means for various plant parts, flowering plants were larger than non-flowering plants (Table 2.10). However, individual non-flowering plants (for example, 37.1 cm tall) exhibited greater size than individual flowering plants (for example, 15.2 cm tall), but flowering plants as a rule were greater in size.

Table 2.7 Summary of plant growth (length, width, caliper) means for the Buffalo Grass-Tall Grass (BG-TG) prairie ten year old plants.

Date	5/5	5/31	5/31
			Range
No. of Plants	7	7	---
No. of Stems	16	17	---
Plant Length (cm)	---	36.3	20.3-56.5
No. of stems sampled	---	17	---
Leaf Width (mm)	---	18.9	5-50
No. sampled	---	17	---
Leaf Length (mm)	---	66.1	49-90
No. sampled	---	17	---
Stem Caliper (mm)	---	2.9	1-5.8
No. sampled	---	17	---

Table 2.8 Summary of plant growth (length, width, caliper) means for the White Group nine year old plants.

Date	5/5	5/31	5/31
			Range
No. of Plants	5	6	---
No. of Stems	5	10	---
Plant Length (cm)	---	26.5	1.7-63.0
No. of stems sampled	---	8	---
Leaf Width (mm)	---	14.9	5-42
No. sampled	---	7	---
Leaf Length (mm)	---	52.6	22-70
No. sampled	---	7	---
Stem Caliper (mm)	---	1.4	1-6
No. sampled	---	8	---

Table 2.9 Summary of plant growth (length, width, caliper) means for the Blue Group nine year old plants.

Date	5/5	5/31	5/31
			Range
No. of Plants	8	12	---
No. of Stems	11	15	---
Plant Length (cm)	---	24.0	7.1-37.1
No. of stems sampled	---	15	---
Leaf Width (mm)	---	12.1	2-33
No. sampled	---	15	---
Leaf Length (mm)	---	63.1	17-95
No. sampled	---	15	---
Stem Caliper (mm)	---	2.5	1-6
No. sampled	---	15	---

Table 2.10 Size comparison of plant length, leaf width and length, and stem caliper of flowering and non-flowering Mead's milkweed plants at Manhattan, Kans. May 23, 2006.

Sampled			Plant Samples		Leaf Samples			Stem Samples	
Group	No. Plants	No. Stems	No. Stems	Length (cm)	No.	Width (mm)	Length (mm)	No.	Caliper (mm)
White f*	2	2	2	47.3	2	32.0	65.0	2	4.5
White n**	6	8	6	19.6	5	8.0	47.6	6	1.8
Blue f*	2	2	2	34.2	2	31.5	85.0	2	5.5
Blue n**	10	16	13	22.4	13	9.1	59.7	13	2.1
Red f*	1	1	1	50.0	1	21.0	73.0	1	3.0
Red n**	11	12	12	27.7	12	2.8	40.1	12	1.2
BGTG f*	3	7	7	49.3	7	37.0	71.7	7	4.4
BGTG n**	4	9	10	27.2	10	8.0	62.4	10	1.9
All f*	8	12	12	42.8	12	33.9	92.8	12	4.5
All n**	31	45	41	24.8	50	5.4	42.4	41	1.7

f*=flowering; n**=non-flowering

Reproduction vs. Establishment. Long-lived native forbs are known to develop extensive root systems in their early years at the expense of top growth (Weaver 1968). It is thought that while BG-TG plants were accumulating resources below ground, monoculture plants allocated more of their energy to reproduction than to root system development. Note in Table 2.12, Eight year floral history of White Group plants, 2001-2004 energy was invested in production of flowers, follicles, and seeds. Since 2005 reproduction has declined as well as stand, Fig. 2.1. It is deduced that stand has decreased due to insufficient resources to sustain the life of the plant. Plant competition may also be a factor. However, stand was not impacted in BG-TG where competition was great and reproduction was occurring, Table 2.13. No root systems were examined in this study as the plant would have to be sacrificed.

Fig. 2.1 Mead's milkweed survival for three scenarios at Manhattan, Kansas.

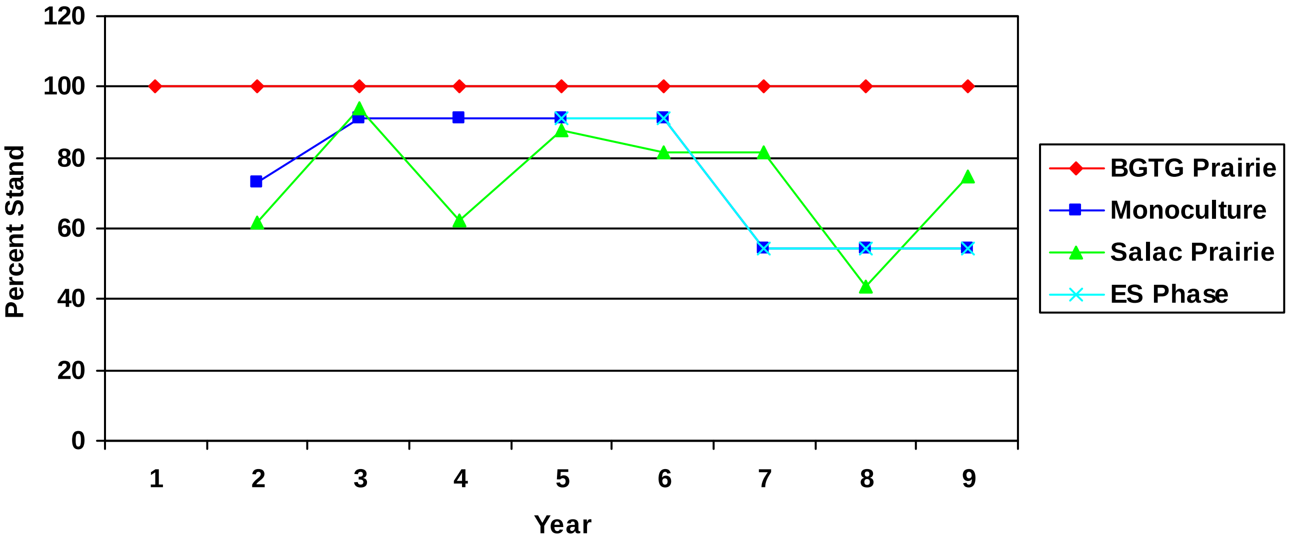


Table 2.12 Eight year floral history of White Group plants at Manhattan, Kansas.

	Growing Season							
No.	1999	2000	2001	2002	2003	2004	2005	2006
Flowering Plants	1	3	7	4	6	9	2	2
Umbels	1	5	15	11	14	10	3	2
Buds	---	58	150	102	197	127	21	20
Follicles	0	0	4	1	13	1	0	0
Seeds	0	0	260	33	1050	*	0	0
Buds/Umbel	---	11.6	10	9.3	14.1	12.7	7	10

* pod lost due to mechanical damage

Table 2.13 Floral history of BG-TG Group plants at Manhattan, Kansas.

	Growing Season				
No.	1998-2002	2003	2004	2005	2006
Flowering Plants	0	1*	2	0	3
Umbels	0	0	3	0	6
Buds	0	0	45	0	85
Follicles	0	0	0	0	0
Seeds	0	0	0	0	0
Buds/Umbel	0	0	15	0	14.2

* plant with potential, growing point attacked by insect

Containerized Stock. There was a notable difference in plant growth among the various container and growth medium combinations, Table 2.3. The seedlings grown in peat pellets produced the most vigorous plants the first year. In the 2nd year the benefits of using peat pellets was apparent. Plants grown in peat pellets exceeded all container grown plants for all parameters measured, Table 2.14.

Table 2.14 Mead's milkweed plant growth comparison for different types of media and containers, three-year old plants.

Group	Container	Medium	Percent Survival	No. Plants Sampled	Plant Length (mm)	No. Leaves	Leaf Length (mm)	Leaf Width (mm)	Stem Caliper (mm)
A	Pellet	Peat	88.2	14	298.9	11.7	59.5	12.4	1.55
C	Large Cone	Commercial Topsoil		6	235.8	12.3	45.2	3.3	1.31
E	Large Cone	Commercial Topsoil		1	224.0	17.0	29.0	2.0	1.22
G	Large Cone	Commercial Topsoil		4	197.5	11.8	45.3	4.0	1.13
H	Plant Band	PRO-MIX 'BX'	100	4	278.3	13.8	54.0	7.0	1.35

Literature Cited:

Betz, Robert F. 1989. Ecology of Mead's milkweed (*Asclepias meadii* Torrey). Proc. Eleventh North Amer. Prairie Conf. T.B. Bragg & J. Stubbendieck, eds. Univ. of Nebr. At Lincoln. p. 187-191.

USDA NRCS 2004 Annual Technical Report Manhattan Plant Materials Center, Manhattan, Kans. 112p.

Weaver, J. E. 1968. Prairie Plants and Their Environment. Univ. of Nebr. Press. Lincoln & London. 276p.

3. Study No. KSPMS-T-0001-CR - Conservation Field Trial: Revegetation of an exposed blue shale outcrop site in Jewell County, Kansas.

Introduction: Past management and natural slumping has exposed raw shale areas ranging in size from 1 to 5 acres. The geology of the area is such that the underlying impervious shale layer conducts groundwater along its interface with the overlying soil. Where the shale outcrops on hillsides, natural springs occur. Slumping results where the overlaying soil on hillsides becomes saturated and subsequently moves. Once these areas are exposed, they are prone to water erosion, resulting in offsite deposition, which degrades the downslope plant communities. Because of the exposed shale, the quality of water flowing offsite is also a primary concern. The quality of the water flowing offsite is very acidic (pH 3-5) which also results in severe degradation of the downstream plant communities. This study is being conducted in cooperation with Kansas Department of Health and Environment and the Jewell County Conservation District.

Problem: The need exists to evaluate plant species for potential use for site revegetation and subsequent stabilization.

Objective: Evaluate common reed [*Phragmites australis* (Cav.) Trin. Ex Steud.] for establishment, survival, rate of spread, and stabilization potential on a typical blue shale site.

Procedure: One typical blue shale site was selected for the planting and evaluation of the adaptability and survival of common reed. Approximately 2,000 common reed sprigs were planted on April 18, 2000. The sprigs were hand planted within select reaches of the primary drainageways within the study area. Planting was restricted to those areas within the study area that appeared to have the greatest potential for supplemental moisture.

Potential Product: Technology Transfer

Evaluation Factors: The plantings will be monitored for establishment, survival, and spread. Evaluations will continue through 2010.

Progress or Status: No evaluations were conducted this year.

Literature Cited:

Reclamation of Drastically Disturbed lands, Schaller, F.W. and P. Sutton, 1978.

Soil Survey for Jewell County, Kansas. Published USDA Soil Conservation Service, 1981.

4. Study No. KSPMC-T0501-RA - Longevity of native warm-season grass seed: storage viability vs. seedling vigor/stand establishment.

Introduction: Native warm-season grass seeds can remain viable for long periods of time under certain storage conditions. Buffalo grass seeds found in the 25-year old sod of a sod house in western Kansas were still germinable. The Manhattan Plant Materials Center (PMC) built a seed storage facility in 1973, where temperature and humidity levels are controlled. This has enabled the PMC to store carry-over seed lots for extended periods of time. Controlled storage is necessary in cultivar development and to meet the fluctuating needs for foundation seed by the seed industry. Periodic seed tests have indicated good viability under standardized temperature and moisture conditions in laboratory tests. Although seedling vigor has been questioned, it has not been investigated. Growers have questioned their ability to obtain a stand with carry-over seed.

Objective: Plant seed of warm-season grass species from multiple harvest years in comparison trials to test the ability to establish an acceptable stand for seed production purposes

Procedure: Draw samples of seed lots stored at the PMC to retest their germinability in the seed lab. Plant seeds (30 PLS/ft) in a 3.0 m (10 ft) row, 1 row per plot with 3 replications at 2 locations using a Kinkaid Plot Planter with 2.5 cm depth bands. The number of seeds to plant per foot of row was determined by information contained in Table 4.2 and Table 4.5 for the corresponding year's trial. Evaluate for stand and maintain for two growing seasons. Management: fertilizer – none; irrigation – none; weed control – pre-emergent and post-emergent herbicides; and mowing may be used. Stand was determined by using the line intercept method.

Evaluating factors: Stand

Potential Products: Technology Transfer

Progress or Status: 2005 Trial. Seed from 4 native, warm-season grass species from 3 crop years (Table 4.1) was planted according to the procedure described earlier. An additional crop year of sand bluestem was planted on the PMC, including a 1988 lot of hulled seed (naked caryopses) of sand bluestem. The planting was made on May 26, 2005, in Field B-3, on a Belvue silt loam soil (0-1 percent slope).

Table 4.1 Grass cultivar information for the 2005 warm-season grass trial.

Accession	Cultivar	Species	Common Name	Crop Years
421276	Kaw	*Andropogon gerardii*	big bluestem	1990, 1997, 2004
421277	Garden	*Andropogon hallii*	sand bluestem	1973, 1988, 1993, 2004
421553	Aldous	*Schizachyrium scoparium*	little bluestem	1973, 1990, 2003
421594	Osage	*Sorghastrum nutans*	Indian grass	1970, 1989, 2004

Table 4.2 Seed analysis information for crop years under test in 2005 trial.

Cultivar	Crop Year	Purity	Standard Germination %	Dormant Seed %	Pure Live Seed %	Test Date	Estimated Seeds Per Foot of Row
Aldous	1973	85.06	66	1	56.99	12/31/04	52.6
Aldous	1990	96.94	79	4	80.46	2/15/05	37.3
Aldous	2003	76.27	34	3	28.22	2/14/05	106.3
Garden	1973	96.39	46	2	46.27	12/30/04	64.8
Garden*	1988				77.00		38.9
Garden	1988	88.19	76	1	67.91	3/24/05	44.2
Garden	1993	69.00	67	1	46.92	1/30/04	63.9
Garden	2004	89.52	72	1	65.35	2/1/05	45.9
Kaw	1990	96.40	89	1	86.76	3/24/05	34.6
Kaw	1997	96.37	77	3	77.10	3/24/05	38.9
Kaw	2004	88.16	76	1	67.88	1/6/05	44.2
Osage	1970	92.57	49	12	56.47	3/20/05	53.1
Osage	1989	93.73	57	7	59.99	2/3/05	50.0
Osage	2004	98.25	86	4	88.43	1/27/05	33.9

*naked caryopses

Stand improved for all entries the second growing season. Stand more than doubled for over half of the entries. The increase in stand ranged from 148% to 259%. The smallest increases in stand occurred in entries that were most successful the initial growing season. Gains were noted in both basal growth and canopy. There were no significant differences in stand across seed ages for a species, Table 4.3. The only exception was a significant difference in stand for the 12-year old sand bluestem seed the initial year. Although the best stand of sand bluestem was obtained with the current year's seed, equally acceptable stands were obtained from the older age classes of seed with stands in the mid-to-upper 80s. Overall, the best stands were obtained with sand bluestem seed over any other species in the trial. Equally acceptable stands of big bluestem were obtained whether using one-year or eight-year old seed.

A better stand was obtained with naked caryopses in sand bluestem than with whole seed units of the same age (17-year old seed), however, there was no significant difference at $P<0.05$.

Table 4.3 Initial and second growing season stands for four warm-season grass cultivars for different age classes of seed planted May 26, 2005, Manhattan PMC, Manhattan, Kansas.

Species	**Crop Year**	**Seed Age (Yrs)**	**Stand (%)**	
			Initial Growing Season	**Second Growing Season**
big bluestem				
	2004	1	40 a[1]	81 a
	1997	8	41 a	81 a
	1990	15	35 a	68 a
% CV[2]			**30**	**14**
Indian grass				
	2004	1	33 a	76 a
	1989	16	29 a	73 a
	1970	35	23 a	69 a
% CV			**45**	**17**
little bluestem				
	2003	2	35 a	63 a
	1990	15	26 a	76 a
	1973	32	23 a	55 a
% CV			**46**	**27**
sand bluestem				
	2004	1	63 a	92 a
	1993	12	50 b	84 a
	1988	17	60 ab	86 a
	1973	32	56 ab	88 a
% CV			**10**	**5**

[1] Means in columns for a given species by growing season followed by the same letter are not significantly different at $P<0.05$
[2] Percent Coefficient of Variation

<u>2006 Trial.</u> Seed from 6 native, warm-season grass species from 3 crop years (Table 4.4) were planted according to the procedure described earlier. Exceptions were an additional crop year of sand bluestem, and there were only two crop years of little bluestem. The 1989 lot of sand bluestem was hulled seed. Plantings were made on May 19, 2006, in Field B-3, and June 7, 2006, in Field D-1, on a Belvue silt loam soil (0-1 percent slope).

Table 4.5 lists species, cultivar names, crop years, germination, purity, and test date information for each entry included in the plantings. With few exceptions, there was not a significant difference in stands produced by the youngest and oldest seed (Table 4.6). However, there was a significant difference in stand for big bluestem for all three age classes of seed for the May planting date. The current year's seed produced the best stand, however, only the 33-year old seed was significantly different in the June planting date. The best stand of little bluestem was from the 33-year old seed for both planting dates with only the May planting showing a significant difference. In the June planting, the best stands of Indian grass were from older age classes than from the current year's crop. Seed dormancy was a contributing factor that reduced stands for some entries. The current year's crop of Indian grass was impacted the most with a higher degree of dormancy, where 53% of pure live seed was dormant (Table 4.5). Another factor that could contribute to a reduced stand is the distribution of pure live seed in the row. This is a bigger problem where a large number of seeds need to be planted to meet the 30 PLS seeding rate. In big bluestem both the youngest and oldest seed had some dormancy; however, the stand for the current year's crop was not impacted. Twice as many seed units of the 33-year old seed were required to meet the required seeding rate and stand was impacted. In most cases the later planting date produced the best stands. The best stands in the trial were obtained with side-oats grama and switchgrass for both planting dates (Table 4.6).

Table 4.4 Grass cultivar information for the 2006 warm-season grass trials.

Accession	Cultivar	Species	Common Name	Crop Years
421276	Kaw	*Andropogon gerardii*	big bluestem	1973, 1990, 2005
421277	Garden	*Andropogon hallii*	sand bluestem	1973, 1989*, 1993, 2005
421281	El Reno	*Bouteloua curtipendula*	side-oats grama	1973, 1993-1994, 2005
421520	Blackwell	*Panicum virgatum*	switchgrass	1973, 1990, 2005
421553	Aldous	*Schizachyrium scoparium*	little bluestem	1973, 2005
421594	Osage	*Sorghastrum nutans*	Indian grass	1973, 1989, 2005

*naked caryopses

Table 4.5 Seed analysis information for crop years under test in 2006 trials.

Cultivar	Crop Year	Purity	Standard Germination %	Dormant Seed %	Pure Live Seed %	Test Date	Estimated Seeding Rate: Seeds Per Foot of Row
Aldous	1973	85.06	57	6	53.59	1/04/06	56.0
Aldous	2005	98.36	63	13	74.75	12/30/05	40.1
Garden	1973	96.39	53	4	54.94	1/04/06	54.6
Garden*	1989	99.32	64	0	63.56	5/08/06	47.2
Garden	1993	69.00	60	1	42.09	4/26/06	71.3
Garden	2005	93.34	75	0	70.00	1/25/06	42.9
Kaw	1973	82.31	33	14	38.69	1/04/06	77.5
Kaw	1990	96.40	80	2	79.05	4/20/06	38.0
Kaw	2005	92.21	73	11	77.46	2/17/06	38.7
Osage	1973	87.39	70	9	69.04	1/04/06	43.5
Osage	1989	93.73	58	9	62.80	4/20/06	47.8
Osage	2005	99.05	33	53	85.18	5/10/06	35.2
Blackwell	1973	99.88	89	0	88.89	1/5/06	33.7
Blackwell	1990	99.29	69	0	68.51	4/20/06	43.8
Blackwell	2005	99.94	68	3	70.96	3/17/06	42.3
El Reno	1973	92.17	59	1	55.30	1/4/06	54.2
El Reno	93-94	99.21	82	0	81.35	5/8/06	36.9
El Reno	2005	96.26	55	5	57.76	1/24/06	51.9

*naked caryopses

Table 4.6 Initial growing season stand for six warm-season grass cultivars for two planting dates and different age classes of seed in 2006, at Manhattan PMC, Manhattan, Kansas.

Species	Crop Year	Seed Age (Yrs)	Stand (%)	
			Planting Date	
			May 19	June 7
big bluestem				
	2005	1	80 a[1]	73 a
	1990	16	62 b	66 a
	1973	33	26 c	36 b
% CV[2]			**11**	**22**
Indian grass				
	2005	1	57 a	37 b
	1989	17	54 a	64 a
	1973	33	43 a	69 a
% CV			**16**	**22**
little bluestem				
	2005	1	29 b	37 a
	1973	33	49 a	57 a
% CV			**11**	**45**
side-oats grama				
	2005	1	80 a	83 ab
	1994-1993	12-13	75 a	77 b
	1973	33	72 a	91 a
% CV			**29**	**8**
sand bluestem				
	2005	1	64 a	71 a
	1993	13	70 a	68 a
	1973	33	57 a	50 a
% CV			**19**	**21**
switchgrass				
	2005	1	76 a	84 ab
	1990	16	64 a	74 b
	1973	33	80 a	92 a
% CV			**15**	**9**

[1] Means in columns for a given cultivar and planting date followed by the same letter are not significantly different at P<0.05

[2] Percent Coefficient of Variation

C. Initial Evaluations

1. Study No. 20I003L – Evaluation of miscellaneous grasses.

Introduction: This study serves as a clearinghouse for the evaluation of miscellaneous collections of grasses received by the Center that have potential for conservation use. These collections may be tested for adaptation to the local climate in a rod-row planting. Standards of comparison may be included, such as an existing cultivar that is available in the seed trade.

Objective: Provide a means to test plant materials where limited seed or plants are available.

Procedure: Plant seeds or plants in a 6.1 m (20 ft) rod row with a spacing of 2.2 m (6 ft) between rows, except where noted. A standard of comparison may also be planted.

Evaluating factors: Plant vigor, stand, seed production, growth factors, and resistance to disease, drought, and cold.

Potential Products: Cultivar Release and Technology Transfer

Progress or Status: Big bluestem (*Andropogon gerardii Vitman*), prairie sandreed, [*Calamovilfa longifolia* (Hook.) Scribn.], Canada wild rye [*Elymus canadensis* (L.)], riverbank wild rye [*E. riparius* (Wieg.)], sweetgrass, (*Hierochloë odorata* (L.) Beauv., and northern sweetgrass, [*Hierochloë odorata* (Schrank) Borbás spp. *artica* (J. Presl) G. Weim.], are species currently under test in this study. See Table 1.1 for evaluation data collected in 2006 for these grasses.

Big bluestem: Twelve plants of accession 9057029 were planted one foot apart in a rod row in Field B-3 at Manhattan PMC at the request of the Booneville Plant Materials Center, Booneville, Ark.

Prairie sandreed: The plant materials specialist for Michigan requested that the Manhattan PMC participate in an inter-center strain trial to test the adaptation of a selection of prairie sandreed to our local climate. The Rose Lake PMC at East Lansing, Michigan provided both plants and seed for the trial. Twelve plants of accession 9086408 were planted one foot apart in a rod row in Field B-3 at Manhattan.

Canada wild rye and riverbank wild rye: The plant materials specialist for Michigan requested that the Manhattan PMC participate in an inter-center strain trial to test the adaptation of accession 9084347, Icy blue Canada wild rye [*Elymus canadensis* (L.)] and accession 9086450, riverbank wild rye [*E. riparius* (Wieg.)]. Twenty plants of each accession were planted in rod rows May 24, 2006.

Table 1.1 Evaluation data for miscellaneous grasses, 2006.

Accession	Species	Plant Height (cm)	Percent Stand
9057029	*Andropogon gerardii*	181	83
9086408	*Calamovilfa longifolia*	154	100
9084347	*Elymus canadensis*	67	85
9086450	*E. riparius*	37	95

Sweetgrass Intercenter Strain Trial: Sweetgrass is a culturally significant plant to the American Indians with potential as a conservation plant and a plant community species for restorations. Five plant materials centers have been working with various strains of sweetgrass, Upper Colorado Environmental Plant Center, Meeker, Colo.; Manhattan Plant Materials Center, Manhattan, Kans.; Bridger Plant Materials Center, Bridger, Mont.; Roselake Plant Materials Center, East Lansing, Mich.; and Bismarck Plant Materials Center, Bismarck, N. Dak. In 2002, each Center shared some of its material with the other Centers to establish a comparison trial of the different strains of material. ‘Radora’, a release from South Dakota State University, was planted as a standard of comparison.

Ten plants of each line were spaced 0.7 m (2 ft) apart in rod rows in Field B-1 on a Belvue silt loam soil, June 2002, Table 1.1. Establishment was difficult due to hot dry weather at the time the plants were received. Establishment was also hampered by local herbivore activity. Radora was received late and did not establish. In 2003, replacement plants where available, were planted to fill in the missing spaces. The sweet grass trial was finalized in 2005. The plots remain to observe their continued spread, flowering, and seed production.

Table 1.1 Sweetgrass Intercenter Strain Trial Plot Layout.

Plot	Source	Species
Border	KSPMC	*Hierochloë odorata*
9063128	NDPMC	*Hierochloë odorata*
9050243	KSPMC	*Hierochloë odorata*
9070988	COEPC	*Hierochloë hirta*
9063351	MTPMC	*Hierochloë odorata*
9070255	MIPMC	*Hierochloë hirta*
Radora	SDSU	*Hierochloë odorata*
Border	KSPMC	*Hierochloë odorata*

North ►

2. Study No. 20I010K - Evaluation of miscellaneous trees and shrubs.

Introduction: Plantings of woody materials were initiated in 1961. Since that time plants have been added for evaluation with multiple objectives in mind. The evaluation of woody plant materials has been a cooperative effort between the PMC and interested parties in the Central Great Plains Region. These include: Kansas State University-Department of Horticulture and Forestry; the USDA-Agricultural Research Service (ARS) Plant Introduction System NC-7 Trials; and the State and Extension Foresters and NRCS staff foresters and biologists of Oklahoma, Nebraska, Kansas, and Colorado, and the Plains and Prairie Forestry Association (formerly the Great Plains Agricultural Council GP-13 Forestry Committee).

Problem: Adapted tree and shrub selections are needed to provide for windbreak, recreation, and multipurpose use in the High Plains region and provide multiple wildlife benefits throughout the four-state area.

Objectives: Identify superior specimens of shrubs and trees which have potential to solve conservation problems; produce or have produced, limited quantities of promising woody plants for field evaluation and field plantings; fulfill tree improvement committee efforts to find and test superior specimens and origins of woody plants; find a suitable replacement for the American and Siberian elms in Midwest urban conservation plantings; and develop and cooperatively release the best adapted cultivars for multiple uses in the area served by the PMC.

Procedure: Containerized or bare root stock is spaced 16 ft apart in rows spaced 16 ft apart. Drip irrigation is used to aid in establishment which may be needed for several years. In the miscellaneous woody tables, number planted (No. PLT) has been changed to number established (No. EST). The initial number of woody plants planted in a given plot is shown in parentheses where the number disagrees with the number established. This change results from the belief that a tree or shrub planted in a given year that does not recover the following spring did not establish. There may be a variety of reasons why the plant material failed to establish such as unfavorable environmental conditions in the initial growing season, planting stock in poor condition, predation, etc. Such conditions may not have any reflection on the plant material itself. It is possible that the plant material is simply not adapted to the site. However, in an initial evaluation, an attempt to reestablish the plant material should be made before declaring a plant material as not adapted to the site. Once woody stock has been established on site it can be evaluated for adaptation for a period of time, as much as 20 years or more for long-lived species. This change brings changes to the data in terms of survival ratings that were reported previously. In cases where it is clear that herbicides killed the plant, the survival rate is adjusted to compensate for such an intervention. This nursery is located primarily on a Belvue silt loam soil in fields F and G.

Potential Products: Information Technology and Cultivar Release

Progress or Status: The assembly consists of 137 accessions representing 90 species in 52 genera, of which 26 are named cultivars. Over 45 percent of the species are native to North America. The plant materials come from many sources such as other PMCs, NRCS field collections, and ARS collections: Wyoming Horticulture Station at Cheyenne, Wyoming; Southern Plains Research Station, Woodward, Oklahoma; and the North Central Regional Plant Introduction Station, Ames, Iowa.

Fifty-three accessions were evaluated this year. There were ten new acquisitions this year, Table 2.1, and five accessions were removed, refer to Table 2.3, for further information. Drought and wildlife pressures continue to impact the success of newly established woody entries in this study. Browsing and rubbing by deer has increased steadily over the past 8 to 9 years requiring year-round fencing of new plantings. Such fencing poses problems for plot maintenance.

Refer to Table 2.2, List of Miscellaneous Trees and Shrubs for further information regarding plot designations. Plot locations can be found in the map section at the end of this report, refer to Plot Map Figures 1.1 and 1.2, an x designates location of an existing plant in the plot. Plants removed at the end of the evaluation period are listed in Table 2.3. Evaluation data are presented in Table 2.4.

Table 2.1 New acquisitions to the miscellaneous trees and shrubs assembly at Manhattan PMC.

Species	Common Name	Accession Number	Origin/Source
Hydrangea arborescens	silver leaf hydrangea	9050498	/ARS-Ames, Iowa
Populus alba	white poplar	9050499	Kyonggi, South Korea /ARS-Ames, Iowa
Photinia melanocarpa	black chokeberry	9050500	/ARS-Ames, Iowa
Photinia melanocarpa	black chokeberry	323957	/NDPMC/PI Sta., Ames, Iowa
Carpinus caroliniana	American hornbeam	9050501	Johnson's Nursery, Inc. /ARS-Ames, Iowa
Forestiera neomexicana	stretchberry	9050502	/ARS-Ames, Iowa
Ulmus thomasii	rock elm	9050503	Dixon Co., Nebr. /ARS-Ames, Iowa
Cupressus bakeri	Modoc cypress	9050504	Kansas Forest Service
Celtis occidentalis	common hackberry	9050497	Forrest Keeling Nursery
Celtis occidentalis	common hackberry	9066613	Oklahoma/KSPMC/NMPMC

Table 2.2 Study No. 20I010K Initial Evaluation: List of Miscellaneous Trees and Shrubs, Manhattan, KS PMC 2006.

Location (F R No.)	Yr Pltd	Accn. No. or PI No.	Cultivar	Genus/ Species	Common Name	Origin /Source
				Block 1		
B1 17 1-10	1976	9004450		*Juglans microcarpa*	little walnut	Washita & Beckman Co., Okla.
B1 18 1-25	1964			*Taxodium distichum*	baldcypress	/Commercial/KSU Ext. Forestry
				Block 2		
B1 E 1-13	1990	483442	Flame	*Acer ginnala*	Amur maple	Eastern Asia /MOPMC
B1 E 14-35	1990	468117	Indigo	*Cornus amomum*	silky dogwood	Clinton Co., Mich. /MIPMC
B1 E 36-48	1990	478000	Midwest	*Malus baccata mandshurica*	Manchurian crab apple	Manchuria /NDPMC
B1 2 1-10	1984	9012932		*Cotoneaster zabelli*	cotoneaster	France
B1 3 1-20	2006	9069052	Riverbend GP	*Salix* sp.	willow	/MIPMC
B2 1 1	19	566824	Boomer	*Quercus macrocarpa*	bur oak	Custer Co., Okla. /KCPMC, Tex.
B2 2 1	19	9004392	Lippert	*Quercus macrocarpa*	bur oak	Payne Co., Okla. /KSPMC
B2 S	1930's	20-1303		*Syringa vulgaris*	common lilac	
B3 E1 1-23	1975	70314		*Castanea mollisima*	Chinese chestnut	/MDPMC
B3 E2 1-31	1975	70314		*Castanea mollisima*	Chinese chestnut	/MDPMC
B3 SE 17-26	1977	514275	Magenta	*Malus* sp.	Hybrid crabapple	Clinton Co., Mich. /MIPMC
B3 SW 9-42	1987	483442	Flame	*Acer ginnala*	Amur maple	Eastern Asia /MOPMC
C1 20 A-E	1961	9004302		*Fraxinus pennsylvanica*	green ash	Butler Co., Kans.
C1 21 A-E	1961	9004304		*Fraxinus pennsylvanica*	green ash	Franklin Co., Kans.
C3 W1 6-42	1967	20-1068		*Juniperus chinensis phitzeriana*	Phitzer juniper	/Riley Co., Kans.
C3 W2	1968	9001209		*Picea pungens*	Colorado blue spruce	Forrest Keeling Nursery, Elsberry, Mo.
E3 21 5-7	2001	9050416		*Quercus prinoides*	dwarf chinkapin oak	Salem, Nebr. /PI Sta., Ames, Iowa
				Block 1		
F1 1 1-2	1985	9049957		*Platanus occidentalis*	sycamore	Brownville, Nebr. /UNL
F1 1 10-19	1966	107630		*Ligustrum vulgare*	Cheyenne European privet	/PI Sta., Ames, Iowa
F1 2 1	1985	9049957		*Platanus occidentalis*	sycamore	Brownville, Nebr. /UNL
F1 2 2-3	1985	9049956		*Platanus occidentalis*	sycamore	Burt Co., Nebr. /UNL
F1 2 4	1985	9049957		*Platanus occidentalis*	sycamore	Brownville, Nebr. /UNL
F1 2 5	1985	9049955		*Platanus occidentalis*	sycamore	Marysville, Kans. /UNL
F1 3 1	1985	9049956		*Platanus occidentalis*	sycamore	Burt Co., Nebr. /UNL
F1 3 2-3	1985	9049955		*Platanus occidentalis*	sycamore	Marysville, Kans. /UNL
F1 3 4-5	1985	9049956		*Platanus occidentalis*	sycamore	Burt Co., Nebr. /UNL
F1 4 3-5	1997	9050263		*Celtis laevigata*	sugarberry	Newark, Ohio /PI Sta., Ames, Iowa
F1 5 1-10	1997	9050268		*Sorbaria tomentosa*	Lindley false spirea	Lublin, Poland /PI Sta., Ames, Iowa
F1 6 1-10	1997	9050265		*Sorbaria sorbifolia*	Ural false spirea	North Korea /PI Sta., Ames, Iowa
F1 7 1-10	1997	9050267		*Sorbaria* sp	false spirea	P R China /PI Sta., Ames, Iowa
F1 8 1-10	1997	9050264		*Sorbaria sorbifolia*	Ural false spirea	Lublin, Poland /PI Sta., Ames, Iowa
F1 9 1-10	1997	9050266		*Sorbaria sorbifolia* var. *stellipila*	Ural false spirea	South Korea /PI Sta., Ames, Iowa
F1 11 2-11	1989	9055585	Redstone	*Cornus mas*	Cornelian cherry dogwood	Cen Europe /N.Y. /MOPMC
F1 12 1-2	1984	325270		*Cotoneaster lucida*	cotoneaster	USSR /MDPMC
F1 18 1-5	1990	477010		*Ligustrum obtusifolium*	border privet	/MIPMC /PI Sta., Ames, Iowa
F1 19 1-5	2006	9050500	Iroquois Beauty	*Photinia melanocarpa*	black chokeberry	/PI Sta., Ames, Iowa
F1 19 6-10	2006	323957		*Photinia melanocarpa*	black chokeberry	/NDPMC/PI Sta., Ames, Iowa
F1 20 1-5	2003	9050482		*Viburnum rufidulum*	southern blackhaw	Holden Arboretum /PI Sta., Ames, Iowa
F1 20 6-10	2003	9050483		*Viburnum rufidulum*	southern blackhaw	ISU Hort. Farm /PI Sta., Ames, Iowa
F1 21 1-5	2001	9050417		*Spiraea flexuosa*		Northern Mongolia /PI Sta., Ames, Iowa
F1 21 6-10	2001	9050418		*Xanthoceras sorbilolium*	yellowhorn	Northern China/PI Sta., Ames, Iowa
F1 22 1-5	2002	9050425		*Cornus sanguinea*	bloodtwig dogwood	Iowa /PI Sta., Ames, Iowa

Table 2.2 Study No. 20I010K Initial Evaluation: List of Miscellaneous Trees and Shrubs, Manhattan, Kans. PMC 2006 (continued).

Location (F R No.)	Yr Pltd	Accn. No. or PI No.	Cultivar	Genus/ Species	Common Name	Origin /Source
F1 22 6-10	2002	9050426		*Cornus sanguinea*	bloodtwig dogwood	Iowa /PI Sta., Ames, Iowa
F1 23 1-5	2002	9050427		*Cotinus coggygria*	smokebush	Iowa /PI Sta., Ames, Iowa
F1 23 6-10	2006	9050498		*Hydrangea arborescens radiata*	silver leaf hydrangea	/PI Sta., Ames, Iowa
F1 24 1-5	2002	9050429		*Sorbus aucuparia*	mountain ash	Iowa /PI Sta., Ames, Iowa
F1 24 6-10	2002	9050430		*Sorbus torminalis*	wild service tree	Iowa /PI Sta., Ames, Iowa
F1 25 1-5	2002	9050431		*Shepherdia argentea*	silver buffaloberry	Iowa /PI Sta., Ames, Iowa
F1 25 6-10	2002	9050432		*Sorbus torminalis*	wild service tree	Iowa /PI Sta., Ames, Iowa
F1 26 1-6	1985	9050007		*Syringa vulgaris*	common lilac	Phillips Co., Kans.
				Block 2		
F2 4 1-10	1967	9006095	McDermand	*Pyrus ussuriensis*	Harbin pear	Morden, Manitoba, Can. /NDPMC
F2 7 1-6	1998	various		*Castanea mollissima*	Chinese chestnut	/MDPMC
F2 8 1-6	1998	various		*Castanea mollissima*	Chinese chestnut	/MDPMC
F2 9 1-6	1998	various		*Castanea mollissima*	Chinese chestnut	/MDPMC
F2 10 1-4	1989	9050011		*Diospyros virginiana*	common persimmon	Iowa /PI Sta., Ames, Iowa
F2 24 1-5	1973	9006225		*Syringa pekinensis*	Pekin lilac	/NDPMC
F2 24 6-10	1973	9034667		*Forsythia europaea* X *ovata*	early forsythia hybrid	/PI Sta., Ames, Iowa
				Block 3		
F3 2 1-11	1967	9001069		*Quercus palustris*	pin oak	/Manhattan Nurs., Manhattan, Kans.
F3 3 1-5	2002	486339	Dynasty	*Ulmus parvifolia*	lace-bark elm	Iowa /PI Sta., Ames, Iowa
F3 5 1-5	1969	9004305		*Fraxinus pennsylvanica*	green ash	Butler Co., Kans.
F3 7 1	2003	9050478	Varen	*Betula papyrifera*	paper birch	NDSU /PI Sta., Ames, Iowa
F3 7 2-4	2006	9050499		*Populus alba*	white poplar	South Korea/PI Sta., Ames, Iowa
F3 7 6-10	2003	9050481		*Tilia cordata*	littleleaf linden	Ukraine /PI Sta., Ames, Iowa
F3 8 1-5	2003	9050479		*Carpinus betulus*	European hornbeam	Ukraine /PI Sta., Ames, Iowa
F3 8 6-10	2003	9050480		*Carpinus betulus*	European hornbeam	Ukraine /PI Sta., Ames, Iowa
F3 10 1-10	1971	9034682		*Betula nigra*	river birch	Houston Co., MN /PI Sta., Ames, Iowa
F3 12 1-10	2006	9050497		*Celtis occidentalis*	common hackberry	Forest Keeling Nurs., Elsberry, Mo.
F3 13 1-10	2006	9066615		*Celtis occidentalis*	common hackberry	Oklahoma/KSPMC/NMPMC
F3 14 1-5	2006	9050501	J. N. Select	*Carpinus caroliniana*	American hornbeam	Minn., Wis./PI Sta., Ames, Iowa
F3 14 6-10	2006	9050503		*Ulmus thomasii*	rock elm	Dixon Co., Nebr./PI Sta., Ames, Iowa
F3 15 1-10	2006	9050502		*Foresteria pubescens* var *pubescens*	stretchberry	/PI Sta., Ames, Iowa
F3 18 1-10	1971	9004302		*Fraxinus pennsylvanica*	green ash	Butler Co., Kans.
F3 19 1-5	1971	341756	Groeneveld	*Ulmus* X *hollandica*	Holland elm hybrid	/PI Sta., Ames, Iowa
F3 19 6-10	1973	265620	Hessei	*Fraxinus excelsior*	European ash	W. Germany /PI Sta., Ames, Iowa
F3 20 1-5	1972	9034674		*Quercus* sp.	Swedish hybrid oak	/UNL /PI Sta., Ames, Iowa
F3 20 6-10	1972	9017646		*Quercus robur*	English oak	/ISU Hort Farm /PI Sta., Ames, Iowa
F3 21 6-10	1990	9050022		*Quercus phellos*	willow oak	TN /PI Sta., Ames, Iowa
F3 22 6-10	1972	9004392	Lippert	*Quercus macrocarpa*	bur oak	Payne Co., Okla.
F3 23 1-10	1973	434253	Athens	*Quercus acutissima*	sawtooth oak	/GAPMC
				Block 4		
F4 1 9-10	1968	9004461	Woodward	*Platycladus orientalis*	Oriental arborvitae	/Okla. State Nurs., Norman, Okla.
F4 3 6-10	1972	9004434		*Platycladus orientalis*	Oriental arborvitae	/Deuel Co., Nebr. /PI Sta., Cheyenne, Wyo.
F4 5 10-11	1973	323932	Emerald Sea	*Juniperus conferta*	shore juniper	/MDPMC
F4 10 1-7	2005	9050495		*Cupressus arizonica*	Arizona cypress	/Lawyer Nurs., Plains, Mont.
F4 10 9-13	1975	9004334		*Juniperus* sp.	columnar juniper	Custer Co., Nebr. /PI Sta., Cheyenne, Wyo.
F4 11 1-10	2006	9050504		*Cupressus bakeri*	Modoc cypress	/Lawyer Nurs., Plains, Mont.
F4 17 1-10	1982	477011	Affinity	*Thuja occidentalis*	northern white cedar	/MIPMC

Table 2.2 Study No. 20I010K Initial Evaluation: List of Miscellaneous Trees and Shrubs, Manhattan, Kans. PMC 2006 (continued).

Location (F R No.)	Yr Pltd	Accn. No. or PI No.	Cultivar	Genus/ Species	Common Name	Origin /Source
F4 18 1-6	1976	343949		*Pinus sylvestris*	Scots pine	Ankara, Turkey /MDPMC
F4 19 7-9	1976	343948		*Pinus sylvestris*	Scots pine	Ankara, Turkey /MDPMC
F4 20 1-10	1974	9034668		*Picea abies*	Norway spruce	/Griffith St. Nurs., Wisconsin Rapids, Wis.
F4 21 1-9	1973	9004363		*Pinus strobiformis*	Mexican white pine	Lincoln Co., NM /Rky Mtn Exp Sta., Nebr.
F4 22 1-10	1973	9004364		*Pinus nigra*	Austrian pine	N. Turkey /Rky Mtn Exp Sta., Nebr.
F4 25 8-17	1973	9034669		*Pinus heldreichii*	Heldreich pine	Yugoslavia /Rky Mtn Exp Sta., Nebr.
Block 1						
G 1 W'-B	1991	250278	Elsmo	*Ulmus parvifolia*	lace-bark elm	Rochester, N.Y. /MOPMC
G 1 C-E	1974	9004437		*Ulmus parvifolia*	lace-bark elm	Woodward /SO, Okla.
G 2 W'-Z'	1991	250278	Elsmo	*Ulmus parvifolia*	lace-bark elm	Rochester, N.Y. /MOPMC
G 2 A-E	1963	9004439		*Ulmus* sp.	Offerle elm	Edwards Co., Kans.
G 3 B-E	1963	9013711		*Ulmus parvifolia*	Chinese elm	/ARS, Woodward, Okla.
G 3 F-J	1963	9004256		*Celtis occidentalis*	common hackberry	Pottawatamie Co., Kans.
G 4 A-E	1963	9004440		*Ulmus* sp.	hybrid elm	/KSU Horticulture Farm
G 8 F-J	1963	9004255		*Celtis occidentalis*	common hackberry	Central Oklahoma
G 9 F-J	1963	9034679		*Carya illinoensis*	pecan	/KSU Forestry, Kans.
G 10 F-J	1963	9034680		*Carya illinoensis*	pecan	/KSU Forestry, Kans.
G 2 K-O	1963	9004329		*Juniperus virginiana*	eastern red cedar	/KSU Forestry, Kans.
G 4 K-O	1963	9004333		*Juniperus virginiana*	eastern red cedar	Harper Co., Okla.
G 6 K-O	1963	9004332		*Juniperus virginiana glauca*	silver eastern red cedar	/USDA-ARS, Woodward, Okla.
G 8 K-O	1963	9034671		*Pinus ponderosa*	ponderosa pine	/KSU Forestry, Kans.
G 9 K-O	1963	9013469		*Pinus nigra*	Austrian pine	/KSU Forestry, Kans.
G 15 U-Y	1964	9034673		*Quercus acutissima*	sawtooth oak	/GAPMC, Americus
Block 2						
G2 16 1-8	1976	9004462	Sapparo Autumn Gold	*Ulmus* sp.	elm	/Univ. of Wis./PI Sta. Ames, Iowa
G2 17 1-3	1977	9004312		*Juglans nigra*	black walnut	Doniphan Co., Kans.
G2 23 6-8	1981	9030309		*Aesculus glabra*	Ohio buckeye	/PI Sta. Ames, Iowa
G2 24 6-7	1981	9030308	Royal Red	*Acer plantanoides*	Norway maple	/PI Sta. Ames, Iowa
Block 3						
G3 16 1-8	1976	9008245		*Quercus acutissima*	sawtooth oak	/KCPMC, Tex.
G3 18 1-8	1976	9004392		*Quercus macrocarpa*	bur oak	City Park, Stillwater, Okla.
G3 19 7	1976	9034858		*Castanea crenata*	chestnut hybrid	MOPMC
Block 1						
HQ1 1 1	1966	9050506		*Nyssa sylvatica*	black gum	/Forrest Keeling Nursery, Elsberry, Mo.
HQ1 1 2				*Carya illinoensis*	pecan	
HQ1 1 3	1963	9050509		*Pseudotsuga menziesii*	Douglas fir	MOPMC
HQ1 1 4-11	1968	9001209		*Picea pungens*	Colorado blue spruce	/Forest Keeling Nursery, Elsberry, Mo.
HQ1 2 1	1983	9005161		*Crataegus phaenopyrum*	Washington hawthorn	DuPage Co., Ill. /MOPMC
HQ1 2 2	1977	514275	Magenta	*Malus* sp.	hybrid crabapple	Clinton Co., Mich. /MIPMC;
HQ1 2 3	1964	9050507		*Pinus edulis*	pinyon pine	/ARS, Woodward, Okla.
HQ1 2 4-6	1968	9001209		*Picea pungens*	Colorado blue spruce	/Forest Keeling Nursery, Elsberry, Mo.
HQ1 3 1	1966	9050505		*Tilia* X *euchlora*	Redmond Crimean linden	/Plumfield Nursery, Fremont, Nebr.
HQ1 4 1,3	1982	9030989		*Forsythia ovata*	early forsythia	
HQ1 4 2	1988	9049784		*Ribes odoratum*	buffalo currant	Dickinson Co., Kans.
HQ1 5 1-4	1982	9030990	Blue Star	*Juniperus squamata*	blue star juniper	Holland /PI Sta., Ames, Iowa
HQ1 5 1-4				*Yucca glauca*	soapweed	

Table 2.2 Study No. 20I010K Initial Evaluation: List of Miscellaneous Trees and Shrubs, Manhattan, Kans. PMC 2006 (continued).

Location (F R No.)	Yr Pltd	Accn. No. or PI No.	Cultivar	Genus/ Species	Common Name	Origin /Source
HQ1 7 1	1984	20-1846		*Picea abies*	Norway spruce	/Griffith State Nursery, Wisconsin Rapids, Wis.
HQ1 7 2	1964	9004392	Lippert	*Quercus macrocarpa*	bur oak	Payne Co., OK
HQ1 8 1		9050508		*Caragana boisii*	Siberian pea shrub	/ARS Hort. Sta., Cheyenne, Wyo.
HQ1 8 2		483442	Flame	*Acer ginnala*	Amur maple	Eastern Asia /MOPMC
HQ1 8 3	1977	9004363		*Pinus strobiformis*	Mexican white pine	Lincoln Co., NM /Rky Mtn Exp Sta., Nebr.
HQ1 9 1	1988			*Cerus canadensis*	red bud	Riley Co., Kans.
HQ1 9 2	1967	9001069		*Quercus palustris*	pin oak	/Manhattan Nursery, Manhattan, Kans.
				Block 2		
HQ2 1 1-15				*Crataegus phaenopyrum*	Washington hawthorn	/Lawyer Nursery, Plains, Mont.
HQ2 2 1-15		113095	Centennial	*Cotoneaster integerrimus*	cotoneaster	China /NDPMC
HQ2 2 2-14		540442	Regal	*Prunus tenella*	dwarf flowering almond	/NDPMC
HQ2 2 16	1976	9050510		*Syringa oblata dilatate*	Korean early lilac	/ARS Hort. Sta., Cheyenne, Wyo.
HQ2 3 1	1977	421614		*Ulmus davidiana* var *japonica*	Japanese elm	/ARS Nursery Crops Res. Lab., Delaware, Ohio
HQ2 3 2				*Pinus ponderosa*	ponderosa pine	
HQ2 3 3		516476	Redstone	*Cornus mas*	Cornelian cherry dogwood	Asia /MOPMC
HQ2 3 4-15				*Syringa vulgaris*	common lilac	
HQ2 3 16	1976	9050511		*Spiraea sargentiana*	Sargent spirea	/ARS Hort. Sta., Cheyenne, Wyo.
HQ2 3 17	1992			*Quercus robur*	English oak	Ill. /McKendree College
HQ2 3 18	1992	9004392	Lippert	*Quercus macrocarpa*	bur oak	Payne Co., Okla. /KSPMC
HQ2 3 19	1977	514275	Magenta	*Malus* sp.	hybrid crab apple	Clinton Co., Mich. /MIPMC
HQ2 4 1-6	1992			*Pyracantha*	firethorn	Blueville Nursery, Manhattan, Kans.
HQ2 4 7	1992	483442	Flame	*Acer ginnala*	Amur maple	E. Asia /MOPMC
HQ2 4 8	1992	478000	Midwest	*Malus baccata mandshurica*	Manchurian crab apple	Asia /Canada/NDPMC
HQ2 4 9	1966	9034666		*Euonymus atropurpureus*	wahoo	Riley Co., Kans.
P 21 1-6	2001	9050416		*Quercus prinoides*	dwarf chinkapin oak	Salem, Nebr. /PI Sta. Ames, Iowa
P 22 1-5	2001	566597	Patriot	*Ulmus* hybrid	elm	US Nat'l Arboretum /PI Sta., Ames, Iowa
P/S 1-6, 8-10	1977	399400		*Pinus nigra*	Austrian pine	Yugoslavia /PI Sta., Ames, Iowa
P/S 7, 11-30	1981	9034670		*Pinus nigra*	Austrian pine	/KSU Forestry
PQ/S 31-50	1977	399402		*Pinus sylvestris*	Scots pine	Yugoslavia /PI Sta., Ames, Iowa
P/ W 1	1966	9050512		*Liquidambar styraciflua*	American sweetgum	/Forest Keeling Nursery, Elsberry, Mo.
P/ W 2	1965	9050514		*Juniperus virginiana canaerti*	Canert juniper	/Nelson Nursery, Enid, Okla.
P/ W 3	1966	9050513		*Juniperus horizontalis glauca*	blue creeping juniper	/MIPMC
P/ W 4	1966	9000399		*Quercus rubra*	northern red oak	Eureka, Kans.
P/ W 5-6	1971	9001455	Emerald	*Fraxinus sp.*	ash	Marshall Nursery, Arlington, Nebr.
Q/ S 51-70	1977	399403		*Pinus sylvestris*	Scots pine	Yugoslavia /PI Sta., Ames, Iowa
Q/ S 71-90	1977	399404		*Pinus sylvestris*	Scots pine	Yugoslavia /PI Sta., Ames, Iowa

Table 2.3 Study No. 20I010K Initial Evaluation: List of Miscellaneous Trees and Shrubs Removed, Manhattan, Kans. PMC 2006.

Location (F R No.)	Yr Pltd	Accn. No. or PI No.	Cultivar	Genus/ Species	Common Name	Origin/ Source
C1 W 1-23	1973	40-57		*Juniperus scopulorum columnaris*	Rky. Mtn. columnar juniper	Okla. Panhandle/SW Kans. /ARS, Woodward, Okla.
C2 W 1-65	1973	40-57		*Juniperus scopulorum columnaris*	Rky. Mtn. columnar juniper	Okla. Panhandle/SW Kans. /ARS, Woodward, Okla.
F1 19 1-5	2001	9050413		*Genista tinctoria*	common woadwaxen	Okhtyrka, Ukraine /PI Sta, Ames, Iowa
F1 19 6-10	2001	9050412		*Genista tinctoria*	common woadwaxen	Klishchevka, Ukraine /PI Sta., Ames, Iowa
F1 23 6-10	2002	9050428		*Deutzia glabrata*	smooth Deutzia	Iowa /PI Sta., Ames, Iowa
F4 10 1-7	2005	9050495		*Cupressus arizonica*	Arizona cypress	Lawyer Nursery, Plains, Mont. /KSU State and Extension Forestry

Refer to page 67, legend for miscellaneous woody plant evaluations.

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans.

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
B1 3 1-20	SALIX	9069052	willow	06	06	7	7	100				30	55		
			Salix sp.			(20)									
			/MIPMC												
C1 20 A-E	FRPE	9004302	green ash	61	70	5	5	100	2			605	798	17	
			Fraxinus pennsylvanica		74		5	100	3			658	1054	20	
			Butler Co., Kans.		78		5	100	3			650	1150		
					79		5	100	3			800	1150		
					83		5	100	3	4	3	800	1175	27	
					85		4	80	3		4		1219	28	
					86		4	80	5	5		975		29	
					88		4	80	1			933		34	
					90		4	80	3	5					
					93		4	80					1372	36	
					05		4	80					1411		
					06		4	80						41	
C1 21 A-E	FRPE	9004304	green ash	61	70	5	5	100	1			566	833	17	
			Fraxinus pennsylvanica		74		5	100	3			622	1041	21	
			Franklin Co., Kans.		78		5	100	3			800	1100		
					79		5	100	1			800	1100		
					83		5	100	3	4	3	900	1310	30	
					85		5	100	3				1280	30	
					86		5	100	6			762			
					88		5	100	2			733		33	
					90		5	100	1	1					
					93		5	100					1292	36	
					05		4	80					1416		
					06		4	80						44	
E3 21 5-7	QUPR	9050416	dwarf chinkapin oak	01	01	9	9	100					23		
/P21 1-6			*Quercus prinoides*		02		8	89	6	7	5	26	31		Leaf cutter bee damage
			/PI Sta., Ames, Iowa		03		8	89				42	41		
					04		8	89				67	66		Some deer browse
					05		8	89				93	83		
					06		8	89		1	4	109	109		No. – 7 severe MD; No. – 6 DD
F1 1 1-2;	PLOC	9049957	*Platanus occidentalis*	85	85	4	4	100	3		2	89	178		
2 1,4			Brownville, Nebr./ UNL		86	4	4	100	4	4		260	240		
					87	4	4	100	5			442	487	6	
					88	4	4	100	3	3	3	553	615	10	
					89	4	4	100	5	5		587	714	13	
					95	4	4	100					1213	27	
					04	4	4	100					1786	36	

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F1 2 2-3; 3 1,4-5	PLOC	9049956	*Platanus occidentalis* Burt Co., Nebr./ UNL	85	85	5	5	100	3		2	93	189		
					86	5	5	100	2	4		176	290		
					87	5	5	100	3			401	492	6	
					88	5	5	100	2	3	2	505	607	10	
					89	5	5	100	4	5		545	707	12	
					95	5	5	100					1225	25	
					04	5	5	100					1625	31	
F1 2 5; 3 2-3	PLOC	9049955	*Platanus occidentalis* Marysville, Kans. /UNL	85	85	3	3	100	2		2	102	183		
					86	3	3	100	1	4		200	310		
					87	3	3	100	3			453	512	7	
					88	3	3	100	2	3	2	557	615	11	
					89	3	3	100	4	5		608	723	14	
					95	3	3	100					1304	30	
					04	3	3	100					1787	39	
F1 1 10-19	LIVU	107630	Cheyenne European privet *Ligustrum vulgare* PMC, Bismarck, N. Dak.	66	70	10	5	50	1			290	320		
					71		5	50	1			320	396		
					73		5	50	1						
					74		5	50	1			411	503		
					75		5	50	5			490	620		
					76		5	50	5			506	650		
					78		5	50	3			650	650		
					79		5	50	1			600	500		
					87		5	50	4			630	300		
					95		5	50					332		
					98		5	50					351		
					00		5	50					366		
F1 4 3-5	CELA	9050263	sugarberry *Celtis laevigata* /PI Sta., Ames, Iowa	97	97	3	3	100	5				107		
					99		3	100					337		
					00		3	100					465		
					01		3	100	1				558		
					02		3	100	4	1	3	509	593		
					06		3	100					908	18	
F1 5 1-10	SOTO7	9050268	Lindley false spiraea *Sorbaria tomentosa* Poland/PI Sta., Ames, Iowa	97	97	10	10	100	2						
					99		10	100	7				145		
					00		10	100				228	148		
					01		10	100	9				153		
					02		10	100	5			216	147		20% die back; few flowers
F1 6 1-10	SOSO2	9050265	Ural false spiraea *Sorbaria sorbifolia* North Korea/PI Sta., Ames, Iowa	97	97	10	10	100	3						
					99		10	100	2				153		
					00		10	100				185	155		
					01		10	100	3				171		
					02		10	100	6			228	150		40% die back; heavy flowering

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F1 7 1-10	SOSO2	9050267	Ural false spiraea	97	97	10	10	100	5						Insect damage
			Sorbaria sorbifolia		99		10	100	4	9			143		
			China/PI Sta., Ames, Iowa		00		10	100				179	158		
					01		10	100	7				177		
					02		10	100	7			215	171		50% die back; heavy flowering
F1 8 1-10	SORBA	9050264	false spiraea	97	97	10	10	100	1						Wind damage
			Sorbaria sp.		99		10	100	1				211		
			Poland/PI Sta., Ames,		00		10	100				254	218		
			Iowa		01		10	100	1				213		No. 3 – winter injury
					02		10	100	3			275	215		15% die back; mod. flowering
F1 9 1-10	SOSOS	9050266	Ural false spiraea	97	97	10	10	100	9						
			Sorbaria sorbifolia var.		99		10	100	2				144		
			stellipila		00		10	100				216	153		
			South Korea/PI Sta.,		01		10	100	5				169		
			Ames, Iowa		02		10	100	5			244	157		30% die back; mod. flowering
F1 11 1-11	COMA21	9055585	Cornelian cherry dogwood	89	89	11	11	100	2	5		3	8		
			Cornus mas		90		11	100	2	4	2	31	78		1,4-5 – frost damage, some die back
			C. Europe /N.Y. /MOPMC		91		11	100				45	98		
					92		11	100				53	135		
					93		11	100		3		92	173		
2-11					99	10	10	100				259	334		good fruiting; 1 – herbicide damage
					03	10	10	100					353		All but 2 with good fruit production
F1 18 1-5	LIOB	477010	border privet	90	90	5	5	100	1	2	1	58	55		
			Ligustrum obtusifolium		91		5	100				84	79		
			MIPMC /PI Sta., Ames,		92		5	100				111	102		
			Iowa		93		5	100				190	137		
					94		5	100	2			235	164		
					99		5	100				386	288		Excellent fruit production
					05		5	100					296		
F1 19 1-5	PHME13	9050500	black chokeberry	06	06	5	4	80					54		
			Photinia melanocarpa												
			/PI Sta., Ames, Iowa												
F1 19 6-10	PHME13	9050412	black chokeberry	06	06	5	5	100				42	46		
			Photinia melanocarpa												
			/NDPMC												
F1 20 1-5	VIRU	9050482	southern blackhaw	03	03	5	4	80	7			51	39		
			Viburnum rufidulum		04		3	60	6			30	34		
			/PI Sta., Ames, Iowa		05		3	60				38	62		
					06		3	60					76		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F1 20 6-10	VIRU	9050483	southern blackhaw	03	03	5	5	100	6			36	44		
			Viburnum rufidulum		04		5	100	5			33	46		
			/PI Sta., Ames, Iowa		05		5	100				47	69		
					06		5	100					84		
F1 21 1-5	SPFL9	9050417	*Spiraea flexuosa*	01	01	5	5	100	2			56	78		Weed comp; leaf cutter bee damage
			/PI Sta., Ames, Iowa		02		5	100	6	6	2	42	49		Heavy deer browse
					03		5	100	5			49	64		Fall flowers – 3 plants
					04		5	100	6			44	58		
					05		4	80				48	53		No. 5 - gone
					06		3	60				64	73		
F1 21 6-10	XASO3	9050418	yellowhorn	01	01	5	5	100	3			34	60		Weed comp; leaf cutter bee damage
			Xanthoceras sorbifolium		02		5	100	4	7	3	39	56		Medium deer browse
			/PI Sta., Ames, Iowa		03		5	100	4			81	89		5 – die back; recovered summer
					04		5	100	5			93	105		
					05		5	100				117	134		
					06		5	100		2	1	177	178		
F1 22 1-5	COSA81	9050425	bloodtwig dogwood	02	02	5	5	100	4	4	4	27	80		Heavy browse
			Cornus sanguinea		03		5	100	3		8	69	106		3 – tip breakage – boring insect
			/PI Sta., Ames, Iowa		04		5	100	6		7	170	148		
					05		5	100				260	198		
					06		5	100				297	224		Second flush - flowering/fruiting-Sept.
F1 22 6-10	COSA81	9050426	bloodtwig dogwood	02	02	5	5	100	3	6	5	42	57		Medium browse
			Cornus sanguinea		03		5	100	6		5	74	81		
			/PI Sta., Ames, Iowa		04		5	100	3		4	181	169		
					05		5	100				241	212		
					06		5	100				259	226		Second flush - flowering/fruiting-Sept
F1 23 1-5	COCO10	9050427	smokebush	02	02	5	5	100	2	3	2	50	84		Slight browse
			Cotinus coggygria		03		5	100	1			92	151		
			/PI Sta., Ames, Iowa		04		5	100	4			137	219		
					05		5	100				185	258		
					06		5	100				243	307		
F1 23 6-10	HYAR6	9050498	silver leaf hydrangea *Hydrangea arborescens radiata* /PI Sta., Ames, Iowa	06	06	5	5	100				15	36		
F1 24 1-5	SOAU	9050429	mountain ash	02	02	5	5	100	6	7	4	20	46		Browse
			Sorbus aucuparia		03		3	60	5			39	93		
			/PI Sta., Ames, Iowa		04		2	40	3			53	120		
					05		2	40				88	180		
					06		2	40				123	238		Deer damage

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F1 24 6-10	SOTO8	9050430	wild service tree	02	02	5	5	100	5	5	6	16	61		Browse
			Sorbus torminalis		03		5	100	6			21	68		
			/PI Sta., Ames, Iowa		04		5	100	3	6	6	17	92		2 – girdled by deer
					05		5	100				28	139		
					06		5	100				40	180		
F1 25 1-3	SHAR	9050431	silver buffaloberry	02	02	2	2	100	6	6	7	14	61		Browse
			Shepherdia argentea		03		2	100	3			31	104		
			/PI Sta., Ames, Iowa		04		2	100	5			82	176		Mechanical damage
					05	1	1	100				117	211		No. 1 – Disked out.
					06	(2)	1	100				146	268		
F1 25 6-10	SOTO8	9050432	wild service tree	02	02	4	4	100	7	1	2	16	47		Browse
			Sorbus torminalis		03		4	100	8			23	39		No. 9 – replanted
			/PI Sta., Ames, Iowa		04		3	60	5	5	5	17	60		3 – deer damage
					05		3	60				25	104		
					06		3	60				36	144		
F1 26 1-6	SYVU	9050007	common lilac	85	91	6	6	100							Transplanted from Field G
			Syringa vulgaris		92		6	100				106	121		Powdery mildew
			Phillips Co., Kans.		93		6	100				152	150		No. 6 – leaves dried up early
					94		6	100							Mildew
					95		5	83					186		
					05		5	83					252		
F2 4 1-10	PYUS2	9006095	Harbin pear	67	70	10	10	100	3			210	238		
			Pyrus ussuriensis		71		10	100	3			213	322		
			Morden, Manitoba, Can.		73		10	100	3						
			/PMC, ND		74		10	100	3			488	533		
					75		10	100	3			549	610		
					76		10	100	3			640	732		
					78		10	100	3			670	750		
					79		10	100				770	770		
					83		10	100	3	4	3	1000	825		
					88		10	100	2	2	3	1280	880		
					93		9	90					1045	24	Good fruit production; No. 6 – wind damage
					96		9	90	1				1119		
					01		8	80	4				974	24	
F2 10 1-4	DIVI5	9050011	common persimmon	89	89	4	4	100	9	3		3	13		
			Diospyros virginiana		90		4	100	1			22	45		
			/PI Sta., Ames, Iowa		91		4	100				29	68		
					92		4	100				70	129		
					93		4	100		3	5	125	203		
					98		4	100				345	476		Mean shoot growth – 42-cm
					99		4	100					605		No. 1-2 – herbicide damage
					03		4	100					605		No. 1 – a resprout; fruit amount - 5

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F2 23 1-5	SYPE2	9006225	Pekin lilac	73	73	5	5	100	3			78	70		
			Syringa pekinensis		74		5	100	3			157	130		
			/PMC, ND		75		5	100	3			210	230		
					76		5	100	3			310	315		
					78		5	100	3			440	400		
					79		5	100	1			440	500		
					83		5	100	1	3	2	700	610		
					93		5	100					665		
					02		5	100					768		
F2 23 6-10	FORSY	9034667	early forsythia hybrid	73	73	5	5	100	1			88	73		
			Forsythia europaea X		74		5	100	1			116	143		
			ovata		75		5	100	3			142	189		
			/PI Sta., Ames, Iowa		76		5	100	3			180	201		
					77		5	100	3			210	215		
					78		5	100	3			315	255		
					79		5	100	1			300	300		
					83		5	100	1	2	2	470	350		
					93		5	100					350		
					02		5	100					305		
F3 2 1-11	QUPA2	9001069	pin oak	67	70	11	9	82	3						
			Quercus palustris		71		9	82	5			290	332		
			Manhattan Nurs.,		74		9	82	5			457	518		
			Manhattan, Kans.		75		9	82				488	700		
					76		9	82				670	762		
					78		8	73				800	960		
					01		8	73					1334	37	
F3 3 2-6	ULPA	486339	lace-bark elm	02	02	3	3	100	4	1	3	19	58		
			Ulmus parvifolia		03	5	5	100				30	78		Added 2 new plants
			/PI Sta., Ames, Iowa		04		5	100	2	2	2	73	163		Good clean foliage
					05		5	100				123	250		
					06		5	100					317		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F3 5 1-5	FRPE	9004305	green ash	69	69	5	5	100	1						
			Fraxinus pennsylvania		71		5	100	2			213	271		
			Butler Co., Kans.		72		5	100	1			335	355		
					73		5	100	1			259	419		
					74		5	100	1			335	518		
					75		5	100	1			365	580		Abundant fruiting
					76		5	100	1			488	610		Moderate fruiting
					80		5	100	1			730	950		
					82		5	100	2			800	1100		
					83		5	100	2	4	5	900	1075		
					89		5	100	2	4			1099		No. 1 – blown down 6/03 - rot
					90		4	80	2	5					
					03		4	80					1178	33	
F3 7 1-5	BEPA	9050478	paper birch	03	03	5	5	100					147		
F3 7 1			*Betula papyrifera*		04		1	20	6	5	3	86	173		
			W. North Dakota /PI Sta.,		05		1	20				82	188		
			Ames, Iowa		06		1	20					191		Deer damage
F3 7 2-4	POAL7	9050499	white poplar	06	06	3	3	100					168		No. 2 – deer damage
			Populus alba												
			South Korea/PI Sta.,												
			Ames, Iowa												
F3 7 6-10	TICO2	9050481	littleleaf linden	03	03	2	2	100				20	40		
			Tilia cordata		04		1	50	5	4	5	51	67		
			Ukraine /PI Sta., Ames,		05		1	50				83	110		
			Iowa		06		1	50					167		
F3 8 1-5	CABE8	9050479	European hornbeam	03	03	5	5	100				22	67		
			Carpinus betulus		04		5	100	4	4	5	38	83		
			Ukraine /PI Sta., Ames,		05		4	80				58	104		
			Iowa		06		4	80					156		
F3 8 6-10	CABE8	9050480	European hornbeam	03	03	3	3	100				28	62		
			Carpinus betulus		04		3	100	5	4	3	32	61		
			Ukraine /PI Sta., Ames,		05		3	100				43	73		
			Iowa		06		3	100					90		
F3 12 1-10	CEOC	9050497	common hackberry	06	06	10	10	100					78		
			Celtis occidentalis												
			Forest Keeling Nurs.,												
			Elsberry, Mo.												

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F3 13 1-10	CEOC	9066615	common hackberry *Celtis occidentalis* Oklahoma /KSPMC/NMPMC	06	06	10	10	100					116		
F3 14 1-5	CACA18	9050501	American hornbeam *Carpinus caroliniana* Minn., Wisc./PI Sta., Ames, Iowa	06	06	5	5	100					60		
F3 14 6-10	ULTH	9050503	rock elm *Ulmus thomasii* Dixon Co., Nebr./PI Sta., Ames, Iowa	06	06	5	5	100					69		
F3 15 1-10	FOPOP	9050502	stretchberry *Foresteria pubescens* var *pubescens* /PI Sta., Ames, Iowa	06	06	10	10	100					92		
F3 18 1-10	FRPE	9004302	green ash *Fraxinus pennsylvanica* Butler Co., Kans.	71	75	10	10	100	1			305	457		
					76		10	100	1			396	518		
					78		10	100	1			475	670		
					86		10	100	5			732	1200		
					87		10	100	5				1043		
					88		10	100	2	3		798			
					90		10	100	4	2					
					95		9	90					1173		N0. 1 - dead
					05		8	80					1236		
F3 19 1-5	ULMUS	341756	Holland elm hybrid *Ulmus* X *hollandica* /PI Sta., Ames, Iowa	71	75	5	4	80	5			225	430		
					76		4	80	5			290	470		
					77		4	80	3			335	500		
					78		4	80	3			390	550		
					79		4	80	3			400	650		
					86		4	80	5			457	1200		
					95		3	60					1104		No. 1 – top dead
					05		3	60					1214		
F3 19 6-10	FREX80	265620	European ash *Fraxinus excelsior* W. Germany /PI Sta., Ames, Iowa	73	73	5	5	100				30	174		
					74		5	100				61	226		
					75		5	100	5			104	310		
					76		5	100	5			155	350		
					77		5	100	3			244	457		
					78		5	100	3			260	490		
					79		5	100	1			347	536		
					96		4	80					664	24	No. 4 – A sucker

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F3 20 1-5	QUERC	9034674	Swedish hybrid oak	72	72	5	5	100	3			9	37		
			Quercus sp.		73		5	100	3			27	61		
			UNL /PI Sta., Ames, Iowa		74		5	100	3			52	113		
					75		5	100	5			132	192		
					76		5	100	5			183	275		
					77		5	100	5			250	350		
					78		5	100	5			290	430		
					79		5	100	5			350	500		
					83		5	100	3	6	4	500	650	15	
					88		5	100	3	3	3	661			
					89		5	100					873		
					90		5	100	4	8	9				
					93		5	100					897	23	No. 3 – top out
					96		5	100	8				941		
					01		5	100					1000	29	
					06		5	100					1200	28	
F3 20 6-10	QURO2	9017646	English oak	72	72	4	4	100	3			15	73		
			Quercus robur.		73	(5)	4	100	5			61	107		
			ISU Hort Farm /PI Sta.,		74		4	100	3			94	183		
			Ames, Iowa		75		4	100	5			138	295		
					76		4	100	5			195	365		
					77		4	100	5			220	435		
					78		4	100	5			270	525		
					79		4	100	3			350	600		
					83		4	100	1	1	1	600	780	18	
					88		4	100	2		9	740		25	
					89		4	100	2	1	9		909		
					90		4	100	3						
					96		4	100	5				951	32	No. 6 – top dead
					01		4	100					984		
					06		4	100					1123	32	
F3 21 6-10	QUPH	9050022	willow oak	90	90	5	5	100		2	3	22	32		
			Quercus phellos		91		4	80				21	34		Severe deer browse
			TN /PI Sta., Ames, Iowa		92		4	80				52	81		
					93		4	80				97	151		No. 9 – small
					94		4	80	4			137	241	1	No. 9 – winter injury
					98		3	60							1 dead, mechanical
					99		3	60					363		
					04		3	60					504		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F3 22 6-10	QUMA2	9004392	bur oak	72	72	5	5	100	5			17	26		
			Quercus macrocarpa		73		5	100	3			82	125		
			Payne Co., Okla.		74		5	100	3			76	184		
					75		5	100	3			160	300		
					76		5	100	3			240	365		
					78		5	100	3			330	512		
					79		5	100	1			425	600		
					81		5	100	1		8	800	670	18	
					83		5	100	1	6	1		840	25	
					85		5	100	1				980		
					89		5	100	1				980	29	
					90		5	100	1						
					93		5	100	1				1021	32	
					96		5	100	1				1112		
					01		5	100	1				1171	36	
F3 23 1-10	QUAC80	434253	sawtooth oak	73	73		10	100	3			64	66		
			Quercus acutissima		74		10	100	3			111	137		
			/PMC, GA		75		10	100	3			200	270		
					76		10	100	3			275	305		
					78		10	100	3			400	550		
					79		10	100	3			450	650		
					83		10	100	1	3	3	650	800	20	
					89		10	100	3		1		951		
					93		10	100					959	43	No. 8 - suckers
					02		10	100					1230	30	
F4 1 6-10	PLOR80	9004461	Oriental arborvitae	68	75	5	5	100	3			396	427		
			Platycladus orientalis		76		5	100	3			396	457		
			Okla. State Nurs., Norman,		78		5	100	3			600	550		
			Okla.		79		5	100	5			600	640		
					83		5	100	3	3	4	700	620		
					93		5	100					820		
					96										Removed all but No. 10
F4 3 6-10	PLOR80	9004434	Oriental arborvitae	72	75		5	100	5			115	175		
			Platycladus orientalis		76		5	100	5			180	250		
			Deuel Co., Nebr. /PI Sta.,		78		4	80	5			270	400		
			Cheyenne, Wyo.		79		4	80	5			320	470		
					83		4	80	4	5	4	550	575		
					96		4	80					796		
					06		4	80					845		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F4 5 10-11	JUCO12	323932	shore juniper	73	75	7	7	100	5			100	25		
			Juniperus conferta		76	(9)	7	100	3			160	25		
			NPMC, Beltsville, Md.		78		7	100	3			170	40		
					79		7	100	3			245	50		
					83		7	100	2	3	3	400	50		
					93		7	100					59		
					02		7	100	3	5			46		
F4 10 1-7	CUAR	9050495	Arizona cypress	05	05	7	7	100					84		
			Cupressus arizonica		06		0	0							Not adapted
			/Lawyer Nurs., Plains, Mont.												
F4 10 9-13	JUNIP	9004334	columnar juniper	75	78	5	5	100	5			60	175		
			Juniperus sp		79		5	100	5			70	220		
			Custer Co., Nebr. /PI Sta.,		83		5	100	3	5	3	160	430		Cedar-Apple rust
			Cheyenne, Wyo.		99		5	100					963		
					04		5	100					1060		
F4 11 1-10	CUBA	9050504	Modoc cypress	06	06	10	10	100				17	35		
			Cupressus bakeri												
			/Lawyer Nurs., Plains, Mont.												
F4 17 1-10	THOC2	477011	northern white cedar	82	83	10	10	100	5	5	3	47	73		
			Thuja occidentalis		96		10	100	3				472		
			MIPMC, E. Lansing, Mich.												
F4 18 1-6	PISY	343949	Scots pine	76	76	(9)	4		7			20	15		
			Pinus sylvestris		77	6	6	100	5			40	30		
			NPMC, Beltsville, Md.		78		6	100	5			50	45		
					79		6	100	3			85	65		
					83		6	100	2	3	3	230	210	4	
					95		6	100					745		
					00		6	100					1027		
					05		6	100							
F4 19 7-9	PISY	343948	Scots pine	76	76	(9)	1		7			30	15		
			Pinus sylvestris		77	3	3	100	7			20	20		
			NPMC, Beltsville, Md.		78		3	100	7			35	32		
					79		3	100	5			40	60		
					83		3	100	3	3	3	215	185	2	
					86		3	100				340	370		
					95		3	100					691		
					00		3	100					924		
					05		3	100							No. 9 - 90% dead

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
F4 20/ 1-10	PIAB	9034668	Norway spruce	74	74	10	10	100	5			23	27		
			Picea abies		75		10	100	5			25	40		
			Griffith State Nurs.,		76		10	100	5			40	60		
			Wisconsin Rapids, Wis.		77		10	100	3			60	75		
					78		10	100	3			80	100		
					79		10	100	3			110	120		
					83		10	100	4			230	240	4	
					94		10	100	1				642		
					98		10	100					832		
					02		8	80							
					03		8	80					932		
F4 21/ 1-10	PIST3	9004363	Mexican white pine	73	74	10	10	100	5						
			Pinus strobiformis		75		10	100	3			50	60		
			Lincoln Co. NM /Rky Mtn		76		10	100	3			75	95		
			Exp Sta., Nebr.		78		9	90	3			140	120		
					79		9	90	3			150	160		
					83		9	90	2			350	340	7	
					93		9	90					677	15	
					02		8	80					985		
F4 22/ 1-10	PINI	9004364	Austrian pine	73	75	10	10	100	3			70	75		
			Pinus nigra		76		10	100	3			120	110		
			N. Turkey /Rky Mtn Exp		78		10	100	3			190	195		
			Sta., Nebr.		79		10	100	3			200	220		
					83		10	100	1			430	465	15	
					93		10	100					843	23	No. 10 – disease resistant
					02		10	100					1112		
F4 25/ 8-20	PSME	9034669	Heldreich pine	73	73	13	13	100	7						
			Pinus leucodermis		74	(20)	10	77	7						
			Yugoslavia /Rky Mtn Exp		75		8	61	7			10	15		
			Sta., Nebr.		76		8	61	5			20	25		
					78		7	54	7			27	33		
					79		7	54	7			27	35		
					83		6	46	7			70	85		
					93		6	46					258		
					03		5	38					494	8	
GA 1 1-4	ULPA	250278	Chinese elm	91	91	10	10	100				14	53		
2 1-4			*Ulmus parvifolia*		92		10	100					59		
G 1/ A-B			Rochester, N.Y./MOPMC		93		10	100				60	96		
					94		10	100	2			84	113		Deer browse
					95		10	100					138		1 destroyed by deer, heavy browse
					05		10	100					742	11	

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
G 1/ B-E	ULPA	9004437	Chinese elm	74	77	4	3	75	3			130	175		
			Ulmus parvifolia		78		3	75	3			185	215		
			SO, Woodard, Okla.		79		3	75	3			220	300		
					83		3	75	4			400	600	8	
					93		3	75						16	
					98		3	75					1285		
					02		3	75					1321		
					03		3	75						30	
					04		3	75					1604		
G 2/ A-E	ULMUS	9004439	Offerle elm	63	70	5	5	100	5			323	643	10	
			Ulmus species		74		4	80	5			451	991	14	
			Edwards Co., Kans.		78		4	80	3			500	1050		
					79		4	80	1			500	1100		
					83		4	80	2			650	1330	27	
					93		4	80						33	
					97		3	60							C - dead
					02		2	40					1585	42	
G 3/ A-E	ULPA	9013711	Chinese elm	63	70	5	5	100	3			457	640	11	
			Ulmus parvifolia		74		4	80	3			564	914	18	
			ARS, Woodard, Okla.		78		4	80	3			500	1500		
					79		4	80	3			650	1450	28	
					83		4	80	3			600	1300	35	
					93		4	80							
					97		4	80					1574	39	
					02		4	80					1699		
G 3/ F-J	CEOC	9004256	common hackberry	63	66	5	5	100	2			415	445	6	
			Celtis occidentalis		70		5	100	2			530	713	15	
			Pottawatamie Co., Kans.		74		5	100	3			615	927	20	
					78		5	100	5			500	850		
					93		2	40						45	
					97		2	40					1387	55	
					02		2	40					1433		
G 4/ A-E	ULMUS	9004440	hybrid elm	63	70	5	5	100	3			299	689	10	
			Ulmus species		74		5	100	4			439	1006	15	
			KSU Horticulture Farm		78		5	100	3			400	1100		
					79		5	100	3			400	1300		
					83		5	100	5			400	1250	24	
					93		5	100						31	
					97		5	100					1428		
					02		5	100					1487	37	

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
G 8/ F-J	CEOC	9004255	common hackberry	63	66	5	5	100	1			390	427	5	
			Celtis occidentalis		70		5	100	3			597	668	14	
			Central Oklahoma		74		5	100	2			732	920	22	
					78		5	100	3			900	1100		
					79		5	100	1				1125		
					83		4	80	7			800	1200	33	I, J – much dead wood – herbicide
					93		3	60						45	
					97		3	60					1707		
					02		3	60					1960	54	
G 9/ F-J	CAIL2	9034679	pecan	63	70	5	5	100	5			183	326		
			Carya illinoensis		74		5	100	3			427	628	9	
			KSU Forestry, Kans.		83		5	100	3			450	1150	16	
					93		5	100						23	
					97		5	100					1747		
					02		5	100					1823	26	
G 10/ F-J	CAIL2	9034680	pecan	63	70	5	4	80	4			207	290		
			Carya illinoensis		74		4	80	3			436	695	10	
			KSU Forestry, Kans.		78		4	80	5			450	800		
					79		4	80	3			500	880		
					83		4	80	3			600	760	23	
					93		4	80						31	
					97		4	80					1833		
					02		4	80					1996	36	
G 2/ K-O	JUVI	9004329	eastern red cedar	63	70	5	5	100	1			323	421	9	
			Juniperus virginiana		74		5	100	1			451	567	15	
			KSU Forestry, Kans.		78		5	100	3			500	750		
					79		5	100	1			500	750		
					83		5	100	3			600	760		
					02		5	100					1055		
G 4/ K-N	JUVI	9004333	eastern red cedar	63	70	4	4	100	1			299	351	6	
			Juniperus virginiana		74		4	100	1			457	564	12	
			Harper Co., Okla.		78		4	100	1			500	700		
					83		4	100	3			600	825		
					02		4	100					1126		
G 6/ K-O	JUVI	9004332	silver eastern red cedar	63	70	5	5	100	1			378	424	9	
			Juniperus virginiana		74		5	100	1			530	530	17	
			USDA-ARS, Woodward,		78		5	100	3			550	700		
			Okla.		83		5	100	4			750	900		
					02		5	100					1256		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
G 8/ K-O	PIPO	9034671	ponderosa pine	63	70	5	3	60	7			131	152		
			Pinus ponderosa		74		3	60	7			296	375	9	
			KSU Forestry, Kans.		78		3	60	5			300	550		
					83		3	60	5			500	1250		
					02		3	60					1530		
G 9/ K-O	PINI	9013469	Austrian pine	63	70	5	5	100	6			143	140		
			Pinus nigra		74		5	100	4			311	341		
			KSU Forestry, Kans.		78		5	100	3			500	600		
					79		5	100	5			500	670		
					83		5	100	3			700	750		
					97		5	100							
					02		3	60					1311		
G 15/ U-Y	QUAC80	9034673	sawtooth oak	64	70	5	4	80	4			286	390	6	
			Quercus acutissima		74		4	80	3			533	701	12	
			PMC, Americus, Ga.		75		4	80	4			579	732		
					78		4	80	3			900	1000		
					79		4	80	3			850	1000		
					93		3	60					938	39	
					96		2	40					1055		
					98		2	40					1098	43	
					03		2	40						45	
					04		2	40					1205		
G1 17 1-3	JUNI	9004312	black walnut	77	77	3	3	100	3			10	45		
			Juglans nigra		78		3	100	1			80	117		
			Doniphan Co., Kans.		79		3	100	1			250	240		
					83		3	100		1		550	575	9	
					93		3	100					1155	18	
					01		3	100					1329	24	
					06		3	100					1600	31	
G2 16 1-8	ULMUS	9004462	elm	76	76	8	8	100	3			110	130		
			Ulmus sp.		77		8	100	3			270	174		
			PI Station, Ames, Iowa		78		8	100	1			420	315		
					79		8	100	1			600	400		
					83		8	100	1	3	3	900	860		
					86		8	100				914	1200		
					00		8	100					1551		
					05		8	100					1713		

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
G2 23 6-8	AEGL	9030309	Ohio buckeye	81	81	3	3	100				15	52		
			Aesculus glabra		82		3	100				15	58		
			PI Station, Ames, Iowa		83		3	100	6	6	3	24	64		Leaves dropping 8/20.
					85		3	100	5		8		88		
					86		3	100	4	4	5	95	142		
					91		3	100				206	236		
					93		3	100					278		
					05		3	100					501		
G2 24 6-7	ACPL	9030308	Norway maple	81	81	3	3	100				21	118		
			Acer plantanoides		82		3	100				30	104		
			PI Station, Ames, Iowa		83		2	67	6	5	5	55	110		
					85		2	67	5			120	274	5	
					87		2	67	5	5	5	100	280		
					93		1	33					364		
					05		1	33					478		
G3 16 1-8	QUAC80	9008245	sawtooth oak	76	76	8	8	100	5			25	40		
			Quercus acutissima		77		8	100	5			90	70		
			PMC, Knox City, Tex.		78		8	100	3			150	170		
					79		8	100	5			220	300		
					83		8	100	3	3	3	420	550	7	
					85		8	100	1	1	2	427	518		
					95		8	100					953	18	
					00		8	100					1055		
					05		8	100					1095	23	
G3 18 1-8	QUMA2	9004392	bur oak	76	76	8	8	100	3			15	80		
			Quercus macrocarpa		77		8	100	3			80	140		
			City Park, Stillwater, Okla.		78		8	100	3			100	180		
					79		8	100	3			260	300		
					81		8	100	3				425		
					83		8	100	3	1	4	560	575	13	
					85		8	100	5			457	518	23	
					86		8	100	2			549	600		
					89		8	100						22	
					93		8	100					853	27	
					95		8	100					933	30	
					00		8	100					1048		
					05		8	100					1042	35	

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
G3 19 7	CACR27	9034858	chestnut hybrid	76	76	1	1	100	5			5	15		
			Castanea crenata		77	(8)	1	100	3			25	45		
			PMC, Elsberry, Mo.		78		1	100	3			80	90		
					79		1	100	3			180	200		
					83		1	100	1	1	2	520	440		
					85		1	100	1			460	457		
					93		1	100					679		
					95		1	100					738		
					00		1	100					884		
					05		1	100					842		
HQ1 1/1	NYSY	9050506	black gum	66	66	1	1	100							
			Nyssa sylvatica		06	1	1	100					1050	22	
			Forrest Keeling Nursery,												
			Elsberry, Mo.												
HQ1 3/1	TIEU3	9050505	Redmon Crimean linden	66	66	1	1	100							
			Tilia X *euchlora*		06	1	1	100				1483	1580	88	
			Plumfield Nursery,												
			Fremont, Nebr.												
HQ1 5/1-10	JUSQ2	9030990	blue star juniper	82	82	4	4	100				10	5		Plants not hardened off; failed to establish.
			Juniperus squamata		83	(10)	4	100				12	6		
			Holland /PI Sta., Ames,		91		4	100				43	18		
			Iowa		96		4	100	3			53	24		
					98		4	100				63	27		
					06		3	75				61	30		Declining, competition from grasses
HQ1 8/3	PIAY	9004363	Mexican white pine	77	77	1	1	100							
			Pinus strobiformis		06	1	1	100					1150		
			Lincoln Co., N. Mex. /Rky												
			Mtn Exp Sta., Nebr.												
HQ2 2/16	SYOBD	9050510	Korean early lilac	76	76	1	1	100							
			Syringa oblate dilatate		06	1	1	100				24	268		
			/ARS Hort. Sta.,												
			Cheyenne, Wyo.												
HQ2 3/1	ULDAJ	421614	Japanese elm	77	77	1	1	100							
			Ulmus davidiana var		82	1	1	100	1	3	3	475	470	6	
			japonica		83	1	1	100	1	2	3	450	600	9	
			/ARS Nurs. Crops Res.		06	1	1	100					1925	75	
			Sta., Delaware, Ohio												

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
HQ2 3/19	MALUS	514275	hybrid crab apple	77	77	1	1	100							
			Malus sp.		06	1	1	100							
			Clinton Co., Mich. /PMC, East Lansing, Mich.												
P 22 1-5	ULMUS	566597	elm	01	01	5	5	100					103		
			Ulmus hybrid		02		5	100	1	2	2	74	125		Medium browse
			PI Station, Ames, Iowa		03		5	100				81	109		Severe rubbing and browse damage
					04		5	100			7	104	156		Heavy deer browse
					05		5	100				154	225		
					06		5	100		3	7	212	293		
P/S 1-6, 8-10	PINI	399400	Austrian pine	77	77	9	9	100	7			13	12		
			Pinus nigra		78	(10)	9	100	7			30	23		
			PI Station, Ames, Iowa		79		9	100	5			47	48		
					83		9	100	3			205	210	3	
					86		9	100	5			296	380		No. 9 produced seed
					96		9	100					668		
					01		9	100					817		
					06		8	89					1039		
P/S 7, 11-30, 55, 57, 83, 85	PINI	9034670	Austrian pine	81	83	25	25	100	5		3	28	22		
			Pinus nigra		86	(26)	23	92	5			64	62		No. 55 produced seed
			/KSU Forestry, Manhattan, Kans.		95		23	92					337		
					01		23	92					615	20	
					05		23	92					730		
PQ/S 31-35, 37-50	PISY	399402	Scots pine	77	77	20	20	100	3			14	21		
			Pinus sylvestris		78		20	100	3			33	36		
			PI Station, Ames, Iowa		79		20	100	3			52	56		
					83		19	95	2		3	230	225	4	
					86		19	95	5			345	342		No. 48 & 50 produced seed
					96		19	95					728		
					01		19	95					844	25	
					06		13	65					1009		
P/W 1/ 1	LIST2	9050512	sweetgum	66	66	2	2	100							
			Liquidambar styraciflua		06		1	50				1564	1430	72	
			/Forest Keeling Nursery, Elsberry, Mo.												
P/W 1/ 2	JUVI	9050514	Canert juniper	65	65	1	1	100							
			Juniperus virginiana canaerti		06	1	1	100							Over topped with vines
			/Nelson Nursery, Enid, Okla.												

Table 2.4 Study No. - 20I010K Initial Evaluation: Miscellaneous trees and shrubs, Manhattan, Kans. (continued)

Plot Location	PLT SYM	Accession Number	Species Origin/Source	YR PLT	YR REC	NO. EST	NO. SRV	PCT SRV	VI	DI	IN	CAN COV	PLT HGT	PLT DBH	Plot Remarks
P/W 1/ 3	JUHO2	9050513	blue creeping juniper *Juniperus horizontalis glauca* /MIPMC	66	66	1	1	100							
P/W 1/ 4	QURU	9000399	northern red oak	66	66	1	1	100							
			Quercus rubra		06	1	1	100				1501	1130	44	
			Eureka, Kans.												
P/W 1/ 5-6	FRPE	9001455	ash	71	71	2	2	100							
			Fraxinus *sp.*		06	2	2	100					1225	65	
			Marshall Nursery, Arlington, Nebr.												
Q/S 51-54, 56, 58-70	PISY	399403	Scots pine	77	77	18	18	100	3			18	24		
			Pinus sylvestris		78	(20)	18	100	3			35	36		
			PI Station, Ames, Iowa		79		18	100	3			55	57		
					83		18	100	1	4	3	245	240	5	
					86		18	100	5			381	413		52,53,58,61-62,65,68 prod. seed
					96		18	100					819		
					01		18	100					945	28	
					06		13	72					1178		
Q/S 71-82, 84, 86-90	PISY	399404	Scots pine	77	77	18	18	100	5			12	16		
			Pinus sylvestris		78	(20)	18	100	5			26	21		
			PI Station, Ames, Iowa		79		18	100	5			40	36		
					83		18	100	3	3	3	175	175	2	
					86		18	100	5			294	315		
					96		18	100					714		
					01		18	100					832	31	
					06		18	100					991		

Refer to Page 67, legend for miscellaneous trees and shrub evaluations.

Legend for miscellaneous trees and shrub evaluations:

Plot Location: Field number, row number, and plot (numbered spaces in the row).

E.g. B3 1 9-14 =	Field	Row	Plot numbers
	B3	1	9-14

CAN COV: Crown width or ground cover as measured in centimeters
DI: Disease Resistance, rating 1-9
IN: Insect Resistance, rating 1-9
NO. EST: Number Established
NO. SRV: Number Surviving
PCT SRV: Percent Survival
* May not agree with current plot number designations.

PLT DBH: Diameter at Breast Height in centimeters, measured at 137 cm above the ground
PLT HGT: Total plant height as measured in centimeters
VI: Plant Vigor, rating 1-9
YR PLT: Year Planted
YR REC: Year of Record

3. Study No. 20I026K - Evaluation of hackberry.

Introduction: Common hackberry (*Celtis occidentalis* L.) is a small-to-medium tree 9.1 to 15.2 m (30 to 50 ft) tall and 0.5 to 0.6 m (18 to 24 in) in diameter varying greatly in response to habitat. Potentially the species may attain heights upwards of 30.5 to 39.6 m (100 to 130 ft) and trunk diameters up to 1.2 m (4 ft). The crown is normally rounded and composed of large spreading branches. Hackberry is drought resistant and has survived extremely dry periods on the Great Plains. It is a long-lived species, believed to live 150 to 200 years (USDA Forest Service 1965; Rehder 1940).

A native to North America, common hackberry is commonly found throughout the eastern three-quarters of the Great Plains and stretching on east to the east coast. Hackberry grows on rich, moist soils along stream banks, on flood plains, and on rocky hillsides in open woodlands. In western Nebraska, hackberry grows on the north side of sand dunes and in river valleys.

Problem: There are no reliable seed sources for common hackberry cultivars adapted to western Nebraska and western Kansas. Existing nursery stock is very often of unknown origin and therefore of questionable quality. A tested and proven superior cultivar is needed to provide consistent, high quality plant material for farmstead and field windbreak plantings.

On-Center evaluations of plant materials for western Nebraska and western Kansas have proven to be unsatisfactory. Extreme differences in climate make initial evaluation at Manhattan unreliable and insufficient. For this reason, initial evaluations are being conducted where the species is needed.

Objective: Evaluate and select a superior accession of common hackberry as an adapted native tree for use in windbreak and wildlife plantings in western Kansas, western Nebraska, and northeastern Colorado.

Procedure: The original assembly consisted of 43 accessions. The seed was planted in a seedling nursery in the fall of 1979. Seedlings 0.3 m (1ft) tall were lifted in the fall of 1980 and placed in cold storage. An initial evaluation planting (IEP) at the Manhattan PMC and field evaluation plantings (FEP) at the Tribune Experiment Station and Sheridan Wildlife Area near Quinter, Kansas, were made in the spring of 1981. A field planting was made at Valentine, Nebraska. The only successful plantings were the Manhattan IEP and the Tribune FEP. The Manhattan IEP consists of one to six plants per plot in a non-replicated randomized planting; refer to Figures 2.1 and 2.2 in the map section of this report for plot locations. The Tribune FEP was established in a completely randomized design, three plants/plot and three replications. The spacing between plants was 4.6- x 5.5-m (15- x 18-ft).

Potential Products: Cultivar Release

Progress or Status: Minimal observation and site maintenance were performed this year.

Literature Cited:

Rehder, A. Manual of Cultivated Trees and Shrubs. The Macmillan Company, New York, 1940, 996 p.

USDA Forest Service. Silvics of Forest Trees of the United States. Agric. Handbook No. 271. Compiled and revised by H. A. Fowells. Washington, D.C., 1965.

4. Study No. 20I031K - Evaluation of Oriental arborvitae.

Introduction: Oriental arborvitae [*Platycladus orientalis* (L.) Franco] is a medium-sized tree reaching heights of 9 to 11 m (30 to 36 ft) at maturity. Growth habit is normally pyramidal or bushy. Many cultivars exhibiting unique characteristics of growth form and color have been selected for landscape use.

Oriental arborvitae is native to Asia occurring in northern and western China and Korea. It is an aromatic evergreen with scale-like appearance. Male and female flowers are borne on the same tree but usually on separate twigs or branches. Flower buds form in the fall and develop into small cones, 1.1 to 2.5 cm (0.4 to 1 in) long with 6 to 8 scales per cone. The cones mature the following spring. *Platycladus orientalis* is easily distinguished from a similar species native to the U.S.; eastern white cedar (*Thuja occidentalis* L.) which has a vertical disposition of leaf sprays, thick cone scales, and wingless seed.

Oriental arborvitae is adapted to a wide range of soil types and excellent survival can generally be expected from the use of bare-root stock.

Problem: Eastern red cedar (*Juniperus virginiana* L.) and Rocky Mountain juniper (*J. scopulorum* Sarg.) are two commonly planted evergreens in the Western Great Plains which serve as alternate hosts for cedar apple rust. In addition, eastern red cedar is often considered a weed pest in poorly managed pasture and rangeland. Evergreen species that do not pose a threat to fruit orchards or occur as a weed pest are needed for use in field and farmstead windbreaks. Diversity within windbreak plantings is desirable to ensure continued function with outbreaks of specific disease and insect pests. Oriental arborvitae offers a potential alternative evergreen for use in place of or in addition to eastern red cedar or Rocky Mountain juniper.

No adapted cultivars of oriental arborvitae are available for use in Major Land Resource Areas (MLRAs) 64, 65, 67, 71-73, and 77-80 in western Nebraska and Kansas. Oriental arborvitae is available through the Oklahoma State Forestry Nursery, but this material is unproven over a large portion of the total area for which the species could be adapted. A tested and proven cultivar of oriental arborvitae is needed to provide consistent high quality plant material for farmstead and field windbreak plantings in the Great Plains.

On-Center evaluation of plant materials for the Western Great Plains area has proven to be unsatisfactory. Evaluation of plant materials at Manhattan cannot adequately test for extremes of climate encountered in the High Plains of western Kansas, Nebraska, and Oklahoma. For this reason, initial evaluation will need to be conducted off-Center in areas for which the plant material is intended for eventual use.

Objectives: Select a superior accession or accessions of oriental arborvitae for use in windbreak and wildlife plantings in western Kansas, Nebraska, and Oklahoma.

Initial evaluation must be conducted off-Center in MLRAs for which the plant has been selected. Planting, evaluation, and plot maintenance should be conducted in a precise and controlled manner as outlined by the study plan.

Procedure: Fifty-five accessions were assembled from seed collections in Kansas, Nebraska, Oklahoma, and 27 foreign countries. Insufficient seedling numbers caused by low germination narrowed the field to 35 accessions to be evaluated. Accessions (N) were planted at the Manhattan PMC (35); Southern Plains Range Research Station (18), Woodward, Oklahoma; Mead (16), Nebraska; Alliance (22), Nebraska; Sheridan Wildlife Area (26), Quinter (26), Kansas; and Knox City (15), Texas, PMC. All plantings were made in 1983, using 2-0 stock in a randomized complete block design. With the exception of the Manhattan PMC and Knox City PMC, plantings contained 3 replications with 3 trees per plot on a 3- x 4.6-m (10- x 15-ft) spacing. The Manhattan and Knox City plantings were non-replicated plots consisting of 6 trees per plot and 5 trees per plot, respectively. Refer to Figure 3.1 in the map section of this report for plot locations at Manhattan.

Evaluation Factors: Factors for evaluation include survival, rate of growth, vigor, plant size, uniformity, foliage density, and stress due to climatic factors, insects, and disease. Special attention will be given to winter hardiness in northern plantings.

Potential Products: Cultivar Release

Progress or Status: Archiving seed of each tree was continued this year. It is desirable to retain seed of each tree before they are removed from the plantation. Seed was collected from each individual tree that produced seed at Manhattan. The amount of fruit was rated for each tree before collecting cones. A representative sample of cones was collected from each tree. The collection process began once cones had begun to open exposing the mature seeds. Collecting continued until enough cones were collected from each tree to fill up to an 11.5- x 12-cm (4.5- x 5-in) cloth bag. The cones were dried down and placed in the seed storage building until the collections can be processed. A fourth and final year of seed collecting is planned for 2007, from trees that have produced little seed.

Literature Cited:

Schopmeyer, C. S., Technical Coordinator, 1974. Seeds of Woody Plant in the United States. Agriculture Handbook No. 450. USDA Forest Service, Washington, D.C., 883 p.

5. Study No. 20I037K - Evaluation of selected common hackberry.

Introduction: The selection of woody plant materials is typically lengthy. The process can take 20 years or more. George and Frank (1973) observed that tree seedlings having larger stem diameters at 1 year continued to display that same characteristic following the second growing season in the nursery. Green ash (*Fraxinus pennsylvanica* Marsh.) seedlings graded into four grades based on height and stem diameters were field grown for 29 years. The growth rate of grade 1 stock exceeded the other grades in both diameter and height over the 29-year period. Grade 2 stock likewise exceeded grades 3 and 4. Similar results were observed for American elm (*Ulmus americana* L.) where grade 1 stock exceeded two other grades in height for 20 years, and diameter for 15 years. Clausen (1963) reported that birch trees originally classified as small, medium, and large, maintained their relative position after nine years in the field. A hypothesis was developed whereby superior seedling trees of common hackberry (*Celtis occidentalis* L.) might be selected from the nursery bed. The criteria for selection would be to select seedlings based on height, stem caliper, and form. It was theorized that such seedlings would prove to be superior. The work of George and Frank supports this theory. If true, the established trees would become the source material and eliminate the amount of time required to establish a productive seed orchard.

Problem: There are no reliable seed sources for hackberry cultivars adapted to western parts of Nebraska, Kansas, Oklahoma, and northeastern Colorado. Existing nursery stock is very often of unknown origin and therefore of questionable quality. A tested and proven superior cultivar is needed to provide consistent, high quality plant material for farmstead and field windbreak plantings. The process for selecting quality nursery stock is lengthy.

Objective: Evaluate and select a superior accession of common hackberry as an adapted native tree for use in windbreak and wildlife plantings in western Kansas, Nebraska, Oklahoma, and northeastern Colorado.

Procedure: The best single seedling was selected from 30 different accessions growing in a seedling production nursery at the PMC, Manhattan, Kansas. The origin of all accessions was from collection locations south of the Platte River in Nebraska. Seedlings (n) originating from Kansas (11), Nebraska (4), Missouri (8), Oklahoma (5), Iowa (1), and Arkansas (1), were selected. The 1-0 seedlings were planted in a spaced plant nursery on 9.1 m (30 ft) spacing, on a Belvue silt loam soil, March 21, 1988, in Field D-1 at the PMC.

Evaluating Factors: Plant vigor; growth rate and uniformity; and resistance to insects, disease, and climatic factors.

Potential Products: Cultivar Release

Progress or Status: Minimal observation and site maintenance were performed this year.

Literature Cited:

George, E. J. and A. B. Frank. 1973. Graded nursery stock in shelterbelt type planting evaluated over 29-year span. Tree Planters' Notes 24:30-32.

USDA Forest Service. Nursery selection affects survival and growth of birch. Research Note LS-31. Lake States Forest Experiment Station. K. E. Clausen. Washington, D.C., 1963.

6. Study No. 20I038K - Bur oak seed source study.

Introduction: Bur oak (*Quercus macrocarpa* Michx.) is a hardy, drought resistant, long-lived tree adapted to a wide range of growing conditions. On favorable sites it may attain heights of up to 30.5 m (100 feet). Bur oak is well known for its deep taproot system, which provides drought tolerance and resistance to wind-throw. The principal factor discouraging the use of bur oak in Great Plains shelterbelts has been slow growth, especially the first year after planting.

Bur oak is widely distributed in the Great Plains. Its range extends from Texas north to central Saskatchewan. Most of the native populations are found on deep soils in bottomlands and occasionally on upland sites. A Nebraska study, reported by Dickie and Bagley (1980), suggested that there is considerable genetic variability in the species and that further evaluation is warranted. At the 1990 Great Plains Tree Improvement Committee (GP13) meeting, a motion was passed to initiate a bur oak seed source study for the Great Plains.

Problem: No known cultivars of bur oak are available for conservation use. Superior bur oak cultivars are needed for watershed protection, for multi-row windbreaks, for landscape plantings for farmsteads and parks, for reforestation on disturbed lands, and for wildlife plantings throughout the Great Plains region.

Objective: The principal objectives of the study are to determine the nature and extent of genetic variation present among bur oak families from selected sources in the Great Plains, to provide genetically improved bur oak seed for shelterbelt planting, provide germ plasm that can be used for selection and trait improvement as well as advanced generation breeding, and to survey acorn weevil *Curculio* sp. distribution and its impact on seed quality.

Procedure: Acorns were collected from individual trees displaying superior phenotypic characteristics in the fall of 1990. Seed collections, consisting of 400 acorns, were shipped to the Nebraska Forest Service, Lincoln, Nebraska, for assembly of collections. Thirty acorns of selected accessions were shipped to trial sites for grow out. The Manhattan PMC requested 52 accessions from Central Great Plains sources. The PMC received only 22 accessions due to a poor acorn crop in some parts of the Great Plains. In addition to these collections, two local collections were included in the study at Manhattan, 'Lippert', accession 9004392 and accession 9050065. Accession 9050065, a collection that was made on the Center, was also entered in the GP13 assembly for planting out at other trial sites. Acorns were planted in a soil-less mix in 102 cm^3 (40 cu in) deep pots in the spring of 1991. The "cone-tainers" were placed in the greenhouse for grow out. Only enough trees from 16 accessions were available for the planting. The plot layout consisted of five replications with two plants per plot. The plants were spaced 4.6- x 4.6-m (15- x 15-ft) apart in a randomized complete block design in the fall of 1992. A second collection was conducted in the fall of 1992. Sixteen accessions were received by the

PMC from the second collection. These acorns were grown out in the greenhouse in 1993 and planted in the field June 14. There were enough seedlings to establish a 68.6- x 91.4-m (225- x 300-ft) field plot consisting of 26 accessions, Figure 4.1 (refer to the map section of this report). The plot was surrounded by a border row composed of trees from the same sources. Some of the northern sources and individual trees of other entries did poorly. These were replaced by either white oak, (*Quercus alba*), accession 9050077or by green ash, (*Fraxinus pennsylvania*), accession 9050087, to provide adequate competition for the remaining trees.

A complete list of sources established at Manhattan is listed in Table 6.1.

Potential Products: Cultivar Release

Progress or Status: Minimal observation and site maintenance were performed this year.

Literature Cited:

Dickie, S. G. and W. T. Bagley 1980. Variability of *Quercus macrocarpa* Michx. in an eastern Nebraska provenance study. Silvae Genet. 29(5/6):171-176.

7. Study No. 20I039E - Evaluation of switchgrass germ plasm for rhizomatous characteristics.

Introduction: Switchgrass (*Panicum virgatum* L.) is a perennial, warm-season grass that is widely distributed over much of the continental United States. It occurs naturally with other tall-grass prairie species such as big bluestem and Indian grass. Forage quality of switchgrass is generally recognized as being excellent for grazing. In addition to its forage value, it is widely used in areas where soil-conserving practices are needed. Switchgrass is also recognized as a species of wide diversity in growth forms, which often proves valuable in a plant-breeding program. Heritable variation has been observed in endemic strains collected from native grasslands. Newell and Eberhart (1959, 1961) discussed the heritability of certain morphological characteristics from switchgrass strains collected in different locations in the Great Plains. Their studies indicated that a significant proportion of the total variation is due to genetic differences. A source material collected in Roger Mills Co., Oklahoma, accession 9049968, was screened using recurrent selection techniques to select for a highly rhizomatous type of switchgrass at the Manhattan PMC.

Objective: The goal of this work is to select superior seed to improve the germination and seedling vigor of rhizomatous switchgrass to promote rapid establishment of this species for re-vegetation projects, waterway establishment, and commercial seed production.

Procedure: A sample lot of seed was obtained from switchgrass polycross nursery harvests in 2000, 2001, 2002, 2004, and 2005. All seed lots were handled and stored in the same manner. Seed lots were divided into two fractions, heavy and light, utilizing a South Dakota Seed Blower. These fractions were then weighed in ten replications of 100 seeds and recorded. Two germination strategies were used in the experiment, 1 week at 24^{o}C (75^{o}F), and 2 weeks cold, moist stratification, and one week at 24^{o}C. The results were recorded and analyzed.

Germination tests were performed on seed lots of rhizomatous switchgrass from 2000, 2001, 2002, 2004, and 2005. Each seed lot was split into 3 fractions, Unsorted, Light, and Heavy, using a South Dakota Seed Blower. This was done by pulling a small unsorted sample from each year’s seed lot, and then placing the rest of the seed, 30 to 50 ml at a time, in the South Dakota Seed Blower. It was blown for one minute with the opening set at 5.5 cm. (The 2005 seed was blown with the opening set at 6 cm; 5.5 cm for the 2005 lot of seed did not yield an even separation, so slightly more air was used to achieve a better separation.)

The 3 fractions, Unsorted, Light, and Heavy, from each year were subjected to two germination procedures. The first germination was done using 24°C for one week, and the second was accomplished using cold, moist stratification at 4°C two weeks. After the two weeks of cold, moist stratification, the seed was placed in a germinator at 24°C for one week. The germination was counted, recorded, and analyzed. There were 4 replications of 100 seeds for each treatment and seed lot. The germination was only recorded for one week due to the rapid establishment aspect of this study.

4 replications
2 treatments (24°C 1 week; cold, moist stratification 2 weeks)
3 seed samples (Unsorted, Light, and Heavy)
5 years (2000, 2001, 2002, 2004, 2005)

Evaluation Factors: Data such as plant height, spread, disease resistance, and flowering date, will be collected on the plants through out the growing season.

Potential Products: Cultivar Release

Progress or Status: There were significant differences at the .05 level between all variables in this experiment. The germination tests established that the heavier seed from rhizomatous switchgrass had increased germination and that cold stratification provided a significant improvement to the germination of this species. The 2005 seed lot showed a significant decrease in germ when compared to the older lots of seeds. When comparing all factors using Tukey's All Pair-Wise Comparison, the 2005 seed stood alone as being significantly worse in germination from the older seed. However, the heavier, cold stratified seed from 2005 did have the highest germination when compared to the other fractions and treatments from that year. This is important to the rapid establishment goal of this study. Though the seed from 2005 showed a decrease in germination compared to older lots of seed, the seed that did germinate might be used in a poly-cross nursery to decrease the amount of dormancy in this species.

Using the information gathered from the germination tests of rhizomatous switchgrass, a protocol for establishing seedlings for a poly-cross nursery was established. This protocol involves using the heavy fraction of seed from 2005 and placing it under a series of stresses during germination to aid in the selection of the most vigorous seedlings. The stresses for this portion of the study were heat, cold, acid, and salt.

<u>Heat Stress</u>: A small sample of heavy seed from the 2005 harvest of rhizomatous switchgrass was placed in cold storage for 2 weeks at 4°C on a moist germination pad. It was then planted into a seedling flat using a 50:50 ratio of Pro-Mix 'BX' and soil from the field. The soil from the field ensured that any pathogens present in field were also available to attack the seedlings during the stress test.

The seedling flat was then placed in a germinator set at 41°C (103°F) with a 16h dark/8h light photo period. This photo period was used on all the germinators during the stress testing. The seedlings were allowed to germinate and grow in the germinator. Special attention was given to these plants to ensure they had sufficient water. The seedlings remained in the germinator until they showed signs of dampening off. At this point, the flat was moved to the greenhouse. The plants were grown out for another week, and the biggest, healthiest seedlings were transplanted to cone-tainers for use in the poly-cross nursery.

<u>Cold Stress</u>: The cold stress was very similar to the heat stress. A portion of the same seed fraction which was used in the heat stress test was cold stratified for 2 weeks. After this time, the seeds were planted into a flat in the same manner as the heat stress test. The flat was them placed in a germinator set at 18°C (64°F). The flat showed no signs of germination after one week, so the temperature was increased a degree per week until enough seedlings had germinated for transplanting into cone-tainers. This procedure took about 4 weeks. The final temperature in the germinator was 22°C (72°F). These seedlings were then taken to the greenhouse and allowed to grow until they were large enough to transplant. The biggest, healthiest seedlings were then selected from this stress test and transplanted into cone-tainers for use in the poly-cross nursery.

Acid Stress: The acid stress test used the same heavy, stratified seed lot from the 2005 harvest. Five hundred milliliters of distilled water was brought to a pH of 3.15 by adding sulfuric acid (H_2SO_4). It only took a minute amount of acid, two or three drops, to lower the pH of the water to this level. The seed was then placed in a germination box on germination paper that had been moistened with the 3.15 pH solution. This was placed in a germinator set at 20/30°C (68/86°F). The time periods for each temperature were 16h dark and 8h light, respectively.

After one week the germination was checked. Some seed had germinated, and was allowed to grow in the germination box for another week until big enough to transplant. The seed was watered as needed with the pH 3.15 solution during this period. It was then transplanted straight into cone-tainers and placed in the greenhouse with the other seedlings.

Salt Stress: This test was very similar to the acid stress test. A solution of 5 parts per thousand NaCl was made. This can be done by placing 5 g of salt in 1000 g of water, 2.5 g of salt in 500 g of water, etc. Parts per thousand also translates into 5 mg/l, however 5 mg is a very small quantity to weigh. Grams are a much easier unit to work with and do not require the use of an analytical balance.

The heavy, stratified seed from 2005 was placed in a germination box on a piece of germination paper that had been moistened with the 5 ppt NaCl solution. It was then placed in the germinator with the same settings used in the acid test. The germination was checked after one week. The seedlings were then allowed to grow in the germination box just as in the acid test, and were watered with the 5 ppt NaCl solution as needed. When the seedlings were large enough, they were transplanted into cone-tainers and placed in the greenhouse with the other plants for use in the poly-cross nursery.

Selections: Materials from the stress test were grown out in the greenhouse. More plants than were needed for the poly-cross nursery were started. This is to compensate for any seedling that might die during transplanting, and to allow selections to be made from the healthiest seedlings from each stress test. The largest, healthiest plant materials were transplanted to the field in a Latin Square design. Seed was harvested at the end of the growing season and compared to the data from the previous year to mark any improvements in germination and seed size.

Literature Cited:

Eberhart, S.A. and L.C. Newell. 1959. Variation in domestic collections of switchgrass, *Panicum virgatum* L. Agronomy Journal 51:613-616.

Newell, L.C. and S.A. Eberhart. 1961. Clone and progeny evaluation in the improvement of switchgrass, *Panicum virgatum* L. Crop Science 1:117-121.

8. Study No. 20I041K - Evaluation of Siberian elm.

Introduction: Siberian elm (*Ulmus pumila* L.) has been planted and tested in the Central and Northern Plains States since the early 1900s. This species once became of interest to researchers because of its apparent rapid rate of growth. Thus, early tests indicated that it warranted further distribution and additional adaptability studies. Extremes in weather conditions have proven challenging to the species over the years on the Plains states. It begins blooming early in the year if weather conditions permit and is one of the last deciduous trees to defoliate in the fall. Therefore, this species tends to be frequently damaged by freezes early in the spring or fall of the year. Early fall ice or sleet storms on the Plains tend to damage Siberian elm more severely because of the late loss of leaves and brittle wood that is subject to breakage. This species is also susceptible to a number of diseases such as Tubercularia canker and Botryodiplodia canker and wet wood. Common insect pests are cankerworm and elm leaf beetle. Despite these faults and its relative short life span there are many locations where Siberian elm can be effectively utilized in shelterbelts and windbreaks.

Problem: The need exists to develop an improved Siberian elm for use in shelterbelt and windbreak conservation practices in semiarid regions of the service area: northeastern Colorado, western Kansas, western Nebraska, and southeastern Wyoming.

Objectives: Select individual seedlings from the available germ plasm with the following characteristics: improved initial survival, growth rate, insect and disease resistance, drought resistance, and earlier fall defoliation.

Procedures: Siberian elm accessions grown in raised beds at the PMC were lifted on March 25, 1999. Seedling production by the various accessions met with mixed success. Some accessions produced abundant, healthy seedlings and other accessions produced limited numbers of seedlings. The production of limited number of seedlings by some accessions cause evaluation plots to be limited in number and scope. Evaluation plots were designated for western Nebraska and eastern Colorado to test the accessions in the environment in which it will be utilized.

A three-replication, randomized evaluation plot containing 15 accessions and three seedlings per plot (MAPS Figure 5.1) was established on April 15, 1999, in Akron, Colorado. The plot was established in a recently tilled area on the USDA/ARS Central Great Plains Research Station, 4 miles east of Akron. The elm seedlings were planted using a tractor-drawn tree planter which made the planting quick and efficient. Due to the extremely windy conditions experienced the day of planting the weed barrier fabric [1.83 m (6 ft) Sunbelt] was not installed until May 19, 1999.

The Akron Site is located in Logan County, Colorado. The planting was established in cooperation with the USDA ARS Central Great Plains Research Station at Akron, Colorado. The site is located within MLRA 72. Average annual precipitation is 40.6 cm (16 in). The soils are classified as a Rago silt loam.

A three-replication, randomized evaluation plot containing 11 accessions and three seedlings per plot (MAPS Figure 5.2) was established on May 18, 1999, in Sidney, Nebraska. The plot was established in a disked area that was planted to wheat the previous growing season. The elm seedlings were planted by hand and then a tractor was utilized to apply the 1.83 m (6 ft) Sunbelt weed barrier fabric to the plot.

The Sidney Site is located in Cheyenne County, Nebraska. The planting was established in cooperation with the Nebraska State Forestry Service. The planting was established on the Tom Knighttengale farm located approximately 4 miles north of Sidney, Nebraska. The site is located with MLRA 72. Average annual precipitation is 40.6 cm (16 in). The soils are classified as Goshen silt loam.

Evaluating Factors: Factors for evaluation include survival, plant growth, vigor, winter injury, disease, and insect resistance.

Potential Products: Cultivar Release

Progress or Status: Evaluations were performed at the Akron and Sidney sites on October 4, 2006 with 97% survival and 85% survival, respectively. Heights ranged from 100 to 482 cm at Akron and 100 to 491 cm at Sidney with means of 351 and 316 cm respectively, Table 8.1. There was some loss in tree height from the previous year at both locations. Two accessions at Akron suffered losses in height due to die back and there was no change in height in one accession. At Sidney, four accessions experienced losses in tree height.

Table 8.1 Two-year tree height data and 2006 foliage retention ratings for Siberian elm at Akron, Colorado and Sidney, Nebraska.

Accession Number	Akron			Sidney		
	HGT 05 (cm)	HGT 06 (cm)	Foliage Retention Rating 10/04	HGT 05 (cm)	HGT 06 (cm)	Foliage Retention Rating 10/04
9050184	353	356	1.7	326	332	1.6
9050213	341	348	2.0	315	323	2.0
9050214	342	356	1.8	365	332	1.3
9050216	345	335	1.2	-	-	-
9050217	308	318	2.2	323	287	1.3
9050219	359	367	1.5	289	210	1.6
9050222	342	349	1.2	318	332	1.5
9050224	381	392	1.4	315	322	1.0
9050225	359	339	1.8	-	-	-
9050226	337	347	1.5	345	334	1.3
9050228	359	368	1.7	292	309	1.9
9050233	312	322	2.0	290	331	1.3
9050235	370	380	2.1	-	-	-
9050240	354	367	1.3	351	363	1.0
9050241	328	328	1.8	-	-	-
Mean	**346**	**351**	**1.7**	**320**	**316**	**1.4**

The trees at Sidney suffered three times more dieback than at Akron and mortality was five times greater. At Sidney, eighty-nine percent of the trees in accession 9050219, Stevens County, Kansas, suffered some degree of dieback and one was dead. Accessions 9050214 and 9050217, Beaver County, Oklahoma and Ellis County, Oklahoma, were among the worst performers. Each had two trees with dieback and three trees that were dead. There were four with dieback and one dead in accession 9050226, Custer County, Oklahoma. Overall there was a 27.4% incidence of dieback and a 15% mortality rate. At Akron the incidence of dieback was much less, only 6% and a mortality rate of just 2%, Table 8.2.

Leaf retention was rated a three levels, no leaf retention, one-half of the leaves were retained, and minimal leaf drop, a rating of 1 to 3 respectively, on October 4, 2006. Early leaf loss was identified as a desirable characteristic in this study in order to determine branch breakage due to ice storms; which was not noticeable after 6 years growth. Refer to Tables 8.3 and 8.4 for data on individual accessions.

Table 8.2 Leaf retention ratings and survival for Siberian elm at Akron and Sidney.

	Percent Leaf Retention			**Dieback**		**Dead**	
Location	**None**	**50%**	**Minimal**	**No.**	**%**	**No.**	**%**
Akron	61.1	6.9	32.1	8	6.1	3	2.2
Sidney	75.9	6.0	18.1	23	27.4	15	15

Table 8.3 Study No. – 20I041K Initial Evaluation: Siberian elm (*Ulmus pumila*), Akron, Colorado.

Accession Number	Origin/Source	YR PLT	YR REC	NO PLT	NO SRV	PCT SRV	FOL DEN	PLT HGT	BAS DIA	Remarks Plot Legend: e.g. 2-214-1 = rep-last three digits accn. no. – tree no.
9050184	Roger Mills Co., Okla.	99	00	9	9	100		173		
			01		9	100		244		
			02		9	100		245		
			03		9	100		282		
			05		9	100	94	353	10.4	
			06		9	100		356		
9050213	Woodward Co., Okla.	99	00	9	9	100		157		
			01		9	100		238		
			02		9	100		241		
			03		9	100		289		
			05		9	100	67	341	10.6	
			06		9	100		348		
9050214	Beaver Co., Okla.	99	00	9	9	100		180		
			01		9	100		262		
			02		9	100		262		
			03		9	100		276		2-214-1 – DBK
			05		9	100	78	342	12.0	
			06		9	100		356		2-214-1 – DBK
9050216	Ellis Co., Okla.	99	00	9	9	100		171		
			01		9	100		257		
			02		9	100		261		
			03		9	100		304		
			05		9	100	83	345	12.0	
			06		9	100		335		2-216-3 – DBK; dying
9050217	Ellis Co., Okla.	99	00	9	9	100		173		
			01		9	100		253		
			02		9	100		254		
			03		9	100		298		
			05		9	100	72	308	11.2	
			06		9	100		318		2-217-3 – DBK
9050219	Stevens Co., Kans.	99	00	9	9	100		185		
			01		9	100		268		
			02		9	100		273		
			03		8	89		310		
			05		8	89	75	359	11.5	
			06		8	89		367		2-219-1 – dead

Table 8.3 Study No. – 20I041K Initial Evaluation: Siberian elm (*Ulmus pumila*), Akron, Colorado (continued).

Accession Number	Origin/Source	YR PLT	YR REC	NO PLT	NO SRV	PCT SRV	FOL DEN	PLT HGT	BAS DIA	Remarks
9050222	Custer Co., Okla.	99	00	9	9	100		180		
			01		9	100		269		
			02		9	100		267		
			03		9	100		301		
			05		9	100	100	342	11.1	
			06		9	100		349		1-222-2 – DBK
9050224	Custer Co., Okla.	99	00	9	9	100		180		
			01		9	100		271		
			02		9	100		278		
			03		9	100		319		
			05		9	100	100	381	11.6	
			06		9	100		392		
9050225	Custer Co., Okla.	99	00	9	9	100		164		
			01		9	100		248		
			02		9	100		251		
			03		9	100		278		3-225-1 – DBK
			05		7	78	100	359	11.5	
			06		6	67		339		2-225-1 – DBK, resprout; 3-225-1 – dead
9050226	Custer Co., Okla.	99	00	9	9	100		173		
			01		9	100		258		
			02		8	89		260		
			03		8	89		290		
			05		8	89	100	337	11.5	
			06		8	89		347		3-226-3 – dead
9050228	Custer Co., Okla.	99	00	9	9	100		167		
			01		9	100		252		
			02		9	100		256		
			03		9	100		297		
			05		9	100	94	359	10.9	
			06		9	100		368		
9050233	Harper Co., Okla.	99	00	9	9	100		154		
			01		9	100		237		
			02		9	100		245		
			03		9	100		264		3-233-3 – DBK
			05		9	100	83	312	10.9	
			06		9	100		322		3-233-3 – DBK

Table 8.3 Study No. – 20I041K Initial Evaluation: Siberian elm (*Ulmus pumila*), Akron, Colorado (continued).

Accession Number	Origin/Source	YR PLT	YR REC	NO PLT	NO SRV	PCT SRV	FOL DEN	PLT HGT	BAS DIA	Remarks
9050235	Garfield Co., Okla.	99	00	9	9	100		169		
			01		9	100		261		
			02		9	100		262		
			03		9	100		317		
			05		9	100	83	370	11.2	
			06		9			380		
9050240	Cotton Co., Okla.	99	00	9	9	100		163		
			01		9	100		245		
			02		9	100		249		
			03		9	100		267		1-240-2 – DBK
			05		8	89	94	354	11.9	
			06		8	89		367		1-240-2 – DBK
9050241	Cotton Co., Okla.	99	00	9	9	100		178		
			01		9	100		252		
			02		9	100		255		
			03		9	100		278		1-241-2 – DBK
			05		9	100	94	328	10.5	
			06		9	100		328		1-241-2 – DBK

Legend for Siberian elm evaluations:

DBK: Die back
FOL DEN: Foliage Density, rating 1-9
NO. PLT: Number of trees planted
NO. SRV: Number Surviving

PCT SRV: Percent Survival.
PLT HGT: Total plant height as measured in centimeters
YR PLT: Year Planted.
YR REC: Year of Record

Table 8.4 Study No. – 20I041K Initial Evaluation: Siberian elm (*Ulmus pumila*), Sidney, Nebraska.

Accession Number	Origin/Source	YR PLT	YR REC	NO PLT	NO SRV	PCT SRV	FOL DEN	PLT HGT	BAS DIA	Remarks Plot Legend: e.g. 2-214-1 = rep-last three digits accn. no. – tree no.
9050184	Roger Mills Co., Okla.	99	00	9	9	100		186		
			01		9	100		232		
			02		9	100		285		
			03		9	100		312		
			05		9	100	67	326	11.4	
			06		9	100		332		2-184-1 – DBK
9050213	Woodward Co., Okla.	99	00	9	9	100		139		
			01		8	89		176		
			02		8	89		242		
			03		8	89		271		
			05		8	89	29	315	10.9	
			06		7	67		323		1-213-1 – dead; 3-213-1 – dead
9050214	Beaver Co., Okla.	99	00	9	9	100		197		
			01		9	100		243		
			02		9	100		290		
			03		8	89		315		
			05		7	78	93	365	11.9	
			06		6	67		332		1-214-1 – dead; 1-214-2 – 75% DBK; 2-214-2 – DBK; 3-214-1 & 2 – dead
9050217	Ellis Co., Okla.	99	00	9	9	100		178		
			01		9	100		215		
			02		9	100		255		
			03		8	89		272		
			05		8	89	50	323	11.9	
			06		6	67		287		1-217-1 – DBK; 2-217-1 – DBK; 2-217-3 – dead; 3-217-2 & 3 – dead
9050219	Stevens Co., Kans.	99	00	9	9	100		165		
			01		9	100		193		1-219-3 – resprout from base
			02		9	100		261		
			03		8	89		279		
			05		8	89	67	289	13.1	
			06		8	89		210		1-219-1 thru 3 – DBK; 2-219-1 &2 – DBK; 2-219-3 – dead; 3-219-1 – 90% DBK, 2&3 DBK
9050222	Custer Co., Okla.	99	00	9	9	100		155		
			01		9	100		193		
			02		9	100		256		
			03		9	100		278		
			05		9	100	56	318	11.5	
			06		8	89		332		1-222-3 – dead; 2-222-3 – 50% DBK; 3-222-2 – 50% DBK

Table 8.4 Study No. – 20I041K Initial Evaluation: Siberian elm (*Ulmus pumila*), Sidney, Nebraska (continued).

Accession Number	Origin/Source	YR PLT	YR REC	NO PLT	NO SRV	PCT SRV	FOL DEN	PLT HGT	BAS DIA	Remarks
9050224	Custer Co., Okla.	99	00	9	9	100		175		
			01		9	100		207		
			02		9	100		249		
			03		9	100		272		
			05		9	100	78	315	10.6	
			06		8			322		1-224-2 – dead; 3-224-1 – DBK
9050226	Custer Co., Okla.	99	00	9	9	100		165		
			01		9	100		200		
			02		9	100		257		
			03		8	89		291		
			05		9	100	78	345	13.4	
			06		7	78		334		1-226-1 – 98% DBK; 1-226-2 – 50% DBK; 2-226-1 – DBK; 2-226-2 dead; 3-226-1 – DBK
9050228	Custer Co., Okla.	99	00	9	9	100		172		
			01		9	100		206		
			02		9	100		230		
			03		8	89		247		
			05		8	89	81	292	13.2	
			06		8	89		309		1-228-1 – dead; 1-228-3 – 50% DBK
9050233	Harper Co., Okla.	99	00	9	9	100		150		
			01		9	100		190		
			02		9	100		226		
			03		9	100		251		
			05		9	100	75	290	12.3	
			06		8			331		1-233-3 – dead
9050240	Cotton Co., Okla.	99	00	9	9	100		165		
			01		9	100		211		
			02		9	100		254		3-240-2 – DBK
			03		8	89		276		
			05		8	89	99	351	12.5	
			06		8	89		363		2-240-3 – dead; 3-240-2 – 50% DBK; 3-240-3 – DBK

9. Study No. 20I042E - Evaluation of false indigo for use in streambank stabilization, shoreline protection, and wetland restoration and enhancement.

Introduction: False indigo (*Amorpha fruticosa* L.) is a native legume, deciduous, medium-to-tall growing shrub native to North America. Its range is from New Hampshire west to Saskatchewan, south to Texas, New Mexico, Arizona, California, east to Florida, and north to New England. False indigo has application for erosion control along shorelines and streambanks, for wildlife food and cover, and for ornamental purposes.

Problem: The Manhattan PMC Long-Range Plan has listed four program objectives that pertain to developing and using plant materials to address: improving water quality, riparian vegetation, streambank and shoreline protection, and wetland restoration and enhancement. The need exists for plant species of known origin and adaptability that are not currently available for conservation work in the Central Great Plains Region.

Objective: Assemble, test, and release adapted false indigo selections for streambank stabilization and shoreline protection, wetland restoration and enhancement plantings, and for the improvement of wildlife habitat.

Procedure: Seeds from 84 accessions were planted to 25.4 cm^3 Ray Leach Single Cell “Cone-tainers” in the spring of 2001. Seeds of accessions with poor quality seed had to be replanted but establishment of most accessions was successful. Enough seedlings were established from 76 of the accessions to support an initial evaluation planting. The plants were transplanted to a spaced plant evaluation nursery in Field C-3-D-3, May 29, 2002, on a Stonehouse-Eudora complex soil. The plot layout consisted of 3 plants per plot with 3 replications in a RCB design, refer to MAPS Figure 6.1. In-row spacing was 0.9 m (3 ft) and the between row spacing was 4.57 m (15 ft). The plots were irrigated throughout the growing season of the establishment year. Maintenance consists of mowing, disking, and hand weeding between the rows.

Potential Products: Information Technology and Cultivar Release.

Progress or Status: The plants continue to suffer from dry conditions and competition for available moisture resulting in dieback. While accessions suffered dieback, three experienced losses in numbers of surviving plants. Fruiting and fruit persistence were evaluated this year. The amount of fruit produced tended to be down from the 2004 rating period. Data on individual accessions can be referred in Table 9.1.

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans.

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9008041	no. plains /NDPMC	02	02	9	9	100							3.1		106	89	1.0	5.2
			03		9	100	4/14	9		8	9.0			7.0		142		10.9
			04		9	100		9	3.0	8	7.7							
			05		9	100										175		
			06		9	100				6	7.7	8.7						
9050188	Lyon Co., Kans.	02	02	9	9	100							1.8		80	77	1.0	4.6
			03		9	100	4/15	7		5	7.4			3.2		149		6.4
			04		9	100		9	4.6	9	5.0							
			05		9	100										216		
			06		9	100				8	5.2	6.9						
9050250	Johnson Co., Nebr.	02	02	9	9	100							2.4		105	114	1.6	4.8
			03		9	100	4/14	9		8	5.9			1.9		192		8.9
			04		9	100		9	3.1	9	4.0							
			05		9	100										253		
			06		9	100				9	4.3	5.4						
9050251	Pawnee Co., Nebr.	02	02	9	9	100							3.0		72	109	1.0	4.3
			03		9	100	4/15	3		3	7.8			3.1		186		6.2
			04		9	100		9	4.4	9	3.7							
			05		9	100										257		
			06		9	100				9	4.6	7.2						
9050253	Lincoln Co., Nebr.	02	02	9	9	100							3.4		67	102	1.0	5.2
			03		9	100	4/15	3		3	8.7			4.8		180		8.8
			04		9	100		9	3.8	8	6.2							
			05		9	100										279		
			06		9	100				9	4.6	7.2						
9050261	Douglas Co., Kans.	02	02	9	9	100							1.8		112	110	1.0	4.8
			03		9	100	4/15	8		7	6.2			3.3		195		9.2
			04		9	100		9	3.2	9	3.1							
			05		9	100										267		
			06		9	100				9	4.4	5.3						
9050262	Wheeler Co., Nebr.	02	02	9	9	100							2.2		98	101	1.0	8.1
			03		9	100	4/14	9		9	6.9			3.2		166		10.8
			04		9	100		9	2.6	9	2.8							
			05		9	100										240		
			06		9	100				9	5.2	6.6						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050269	Holt Co., Nebr.	02	02	9	9	100							3.6		102	102	1.6	6.4
			03		9	100	4/14	9		9	8.2			3.4		167		9.2
			04		9	100		9	2.8	9	4.4							
			05		9	100										216		
			06		9	100				9	5.3	7.0						
9050271	Neosho Co., Kans.	02	02	9	7	78							2.1		69	84	1.0	3.1
			03		7	78	4/16	6		6	5.6			3.1		153		6.3
			04		7	78		6	3.2	7	3.2							
			05		7	78										238		
			06		5	56				5	4.2	5.6						
9050272	Crawford Co., Kans.	02	02	9	9	100							1.6		106	116	1.0	5.6
			03		9	100	4/14	9		9	2.9			2.8		194		7.1
			04		9	100		9	3.0	9	3.0							
			05		9	100										263		
			06		9	100				8	4.6	5.9						
9050273	Anderson Co., Kans.	02	02	9	8	89							1.9		91	82	1.0	4.5
			03		8	89	4/14	5		5	5.6			3.3		159		8.8
			04		8	89		8	2.6	8	3.0							
			05		8	89										224		
			06		8	89				8	2.9	4.9						
9050274	Dickinson Co., Kans.	02	02	9	9	100							1.7		106	105	1.0	7.4
			03		9	100	4/15	9		9	5.4			2.0		186		8.4
			04		9	100		9	3.1	9	3.0							
			05		9	100										265		
			06		9	100				9	4.2	6.1						
9050275	Shawnee Co., Kans.	02	02	9	8	89							2.3		105	101	1.0	5.8
			03		8	89	4/14	6		5	8.8			2.9		170		9.8
			04		8	89		7	3.9	7	4.5							
			05		8	89										239		
			06		7	78				7	4.9	6.0						
9050277	Holt Co., Nebr.	02	02	9	9	100							3.6		109	115	2.3	6.1
			03		9	100	4/14	8		6	7.2			4.7		182		8.6
			04		9	100		9	2.3	9	5.2							
			05		9	100										253		
			06		9	100				9	5.0	6.8						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050279	Wheeler Co., Nebr.	02	02	9	9	100							2.8		103	135	1.4	7.7
			03		9	100	4/13	9		6	8.7			2.8		220		10.8
			04		9	100		9	2.3	9	3.7							
			05		9	100										286		
			06		9	100				8	5.9	7.6						
9050280	Dickinson Co., Kans.	02	02	9	9	100							1.4		102	114	1.0	4.6
			03		9	100	4/14	6		5	6.9			1.7		196		8.8
			04		9	100		9	3.2	9	3.2							
			05		9	100										274		
			06		9	100				9	4.1	5.8						
9050284	Reno Co., Kans.	02	02	9	8	89							1.9		73	129	1.0	4.5
			03		8	89	4/15	3		1	7.9			2.8		222		8.4
			04		8	89		8	2.9	8	2.4							
			05		8	89										305		
			06		8	89				8	3.9	6.0						
9050285	Hodgeman Co., Kans.	02	02	9	9	100							2.4		79	113	1.2	5.4
			03		9	100	4/15	1		1	8.3			2.9		206		8.7
			04		9	100		9	3.7	9	3.3							
			05		9	100										295		
			06		9	100				9	3.9	5.9						
9050292	Nuckolls Co., Nebr.	02	02	9	9	100							2.3		112	122	1.1	6.3
			03		9	100	4/15	7		7	5.0			2.9		205		12.6
			04		9	100		9	2.2	9	3.2							
			05		9	100										276		
			06		9	100				9	4.0	6.3						
9050293	Buffalo Co., Nebr.	02	02	9	9	100							2.0		81	104	1.0	5.6
			03		9	100	4/14	5		5	7.2			3.3		186		7.1
			04		9	100		9	3.1	9	3.0							
			05		9	100										267		
			06		9	100				9	5.2	6.2						
9050294	Greeley Co., Nebr.	02	02	9	9	100							2.0		95	126	1.6	5.4
			03		9	100	4/14	8		7	5.6			3.6		200		8.4
			04		9	100		9	2.3	9	3.3							
			05		9	100										272		
			06		9	100				9	5.2	6.2						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050295	Miami Co., Kans.	02	02	9	9	100							1.9		115	89	1.4	6.1
			03		9	100	4/14	8		6	6.4			2.7		156		12.1
			04		9	100		9	3.1	9	4.3							
			05		9	100										228		
			06		9	100				9	4.1	5.6						
9050297	Pawnee Co., Nebr.	02	02	9	9	100							2.8		81	100	1.0	3.7
			03		9	100	4/15	1		1	8.2			3.9		182		5.6
			04		9	100		9	2.9	9	2.3							
			05		9	100										250		
			06		9	100				9	3.6	5.4						
9050298	Cuming Co., Nebr.	02	02	9	9	100							3.3		111	119	1.9	4.7
			03		9	100	4/14	7		4	7.2			3.6		215		11.7
			04		9	100		9	3.3	9	3.1							
			05		9	100										277		
			06		9	100				9	4.2	5.3						
9050299	Pratt Co., Kans.	02	02	9	9	100							2.1		90	105	1.2	6.8
			03		9	100	4/15	6		5	7.4			3.3		177		13.3
			04		9	100		9	2.8	9	3.2							
			05		9	100										261		
			06		9	100				9	4.8	6.9						
9050300	Russell Co., Kans.	02	02	9	9	100							1.4		70	111	1.0	5.3
			03		9	100	4/16	4		2	8.7			1.6		191		8.9
			04		9	100		9	3.2	9	5.4							
			05		9	100										277		
			06		9	100				9	6.1	7.1						
9050307	Colfax Co., Nebr.	02	02	9	9	100							2.1		128	116	1.0	8.2
			03		9	100	4/15	7		7	5.3			3.1		208		14.4
			04		9	100		9	3.2	9	3.6							
			05		9	100										293		
			06		9	100				9	4.6	5.8						
9050308	Cheyenne Co., Kans.	02	02	9	9	100							2.9		110	127	1.2	6.2
			03		9	100	4/14	5		3	8.4			2.4		212		13.9
			04		9	100		9	4.1	9	3.9							
			05		9	100										301		
			06		9	100				9	5.3	6.7						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050309	Sioux Co., Nebr.	02	02	9	9	100							4.2		64	73	1.0	6.2
			03		9	100	4/15	2		0	9.0			6.3		109		11.8
			04		9	100		9	6.2	5	8.0							
			05		9	100										163		
			06		9	100				4	8.6	8.6						
9050310	Douglas Co., Kans.	02	02	9	9	100							1.8		99	104	1.0	3.9
			03		9	100	4/16	5		3	8.7			3.4		200		8.2
			04		9	100		9	3.0	9	4.0							
			05		9	100										276		
			06		9	100				9	4.0	5.9						
9050312	Knox Co., Nebr.	02	02	9	9	100							3.9		111	119	1.3	7.3
			03		9	100	4/14	8		8	5.9			3.1		200		11.8
			04		9	100		9	1.9	9	3.8							
			05		9	100										279		
			06		9	100				9	4.2	6.3						
9050313	Knox Co., Nebr.	02	02	9	9	100							3.8		105	126	1.8	6.6
			03		9	100	4/14	7		7	7.4			4.4		221		10.3
			04		9	100		9	2.4	9	3.4							
			05		9	100										282		
			06		6	67				6	5.3	7.1						
9050314	Dodge Co., Nebr.	02	02	9	9	100							1.9		110	125	1.3	6.3
			03		9	100	4/14	8		8	6.3			2.1		239		7.7
			04		9	100		9	2.8	9	3.2							
			05		9	100										319		
			06		9	100				9	4.7	5.6						
9050316	Kiowa Co., Kans.	02	02	9	9	100							1.7		79	130	1.3	6.0
			03		9	100	4/15	3		1	8.1			2.8		218		9.4
			04		9	100		9	3.0	9	3.0							
			05		9	100										309		
			06		9	100				9	4.7	6.3						
9050315	Trego Co., Kans.	02	02	9	9	100							3.0		92	105	1.6	6.9
			03		9	100	4/15	5		4	8.0			3.1		180		10.8
			04		9	100		8	4.1	7	5.7							
			05		9	100										264		
			06		9	100				8	6.0	6.7						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050317	Smith Co., Kans.	02	02	9	9	100							1.7		108	114	1.3	4.9
			03		9	100	4/15	7		4	8.4			2.8		195		12.1
			04		9	100		9	2.2	9	3.8							
			05		9	100										278		
			06		9	100				9	3.1	6.0						
9050318	Kingman Co., Kans.	02	02	9	9	100							2.2		94	100	1.2	6.7
			03		9	100	4/15	5		4	7.6			2.0		195		11.1
			04		9	100		9	2.3	9	3.8							
			05		9	100										275		
			06		9	100				9	4.6	6.3						
9050319	Keith Co., Nebr.	02	02	9	9	100							3.2		75	92	1.0	5.9
			03		9	100	4/15	4		1	9.0			4.4		152		8.7
			04		9	100		9	3.4	9	6.1							
			05		9	100										221		
			06		9	100				9	7.3	7.8						
9050321	Howard Co., Nebr.	02	02	9	9	100							2.5		102	122	1.8	8.3
			03		9	100	4/14	9		8	8.4			3.0		205		14.0
			04		9	100		9	3.1	9	4.1							
			05		9	100										277		
			06		9	100				9	4.8	6.4						
9050324	Harvey Co., Kans.	02	02	9	9	100							1.6		102	110	1.0	4.7
			03		9	100	4/15	8		7	6.4			3.6		201		7.7
			04		9	100		9	2.7	9	3.4							
			05		9	100										287		
			06		9	100				9	2.8	5.7						
9050325	Neosho Co., Kans.	02	02	9	9	100							2.0		103	114	1.0	5.7
			03		9	100	4/16	6		5	6.6			2.4		189		11.1
			04		9	100		9	3.0	9	3.1							
			05		9	100										250		
			06		9	100				9	4.7	5.7						
9050327	Graham Co., Kans.	02	02	9	9	100							2.0		86	105	1.3	7.1
			03		9	100	4/15	5		5	7.4			3.4		199		13.2
			04		9	100		9	3.2	9	4.9							
			05		9	100										277		
			06		9	100				8	5.4	7.1						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050328	Cherokee Co., Kans.	02	02	9	9	100							1.3		93	91	1.0	5.2
			03		9	100	4/16	6		6	5.6			2.6		160		8.0
			04		9	100		9	3.4	9	3.2							
			05		9	100										231		
			06		9	100				8	4.9	6.0						
9050329	Cherokee Co., Kans.	02	02	9	9	100							1.2		80	93	1.3	4.8
			03		9	100	4/14	6		6	6.1			3.1		177		8.2
			04		9	100		9	2.7	9	2.6							
			05		9	100										237		
			06		9					8	5.6	6.2						
9050334	Cotton Co., Okla.	02	02	9	9	100							2.8		82	117	1.0	7.3
			03		9	100	4/19	2		2	8.4			2.8		185		13.0
			04		9	100		8	4.8	8	4.0							
			05		9	100										266		
			06		9	100				9	5.9	7.2						
9050335	Cotton Co., Okla.	02	02	9	9	100							1.9		94	115	1.0	5.8
			03		9	100	4/18	3		3	8.1			3.1		187		10.6
			04		9	100		9	2.7	9	2.4							
			05		9	100										263		
			06		9	100				9	3.2	5.8						
9050336	Johnson Co., Nebr.	02	02	9	9	100							2.4		116	102	1.6	6.2
			03		9	100	4/15	5		4	7.4			3.1		212		9.7
			04		9	100		9	3.8	9	4.4							
			05		9	100										273		
			06		9	100				9	5.9	6.6						
9050337	Linn Co., Kans.	02	02	9	9	100							2.6		110	113	1.0	4.2
			03		9	100	4/15	7		7	5.6			3.1		185		7.8
			04		9	100		9	2.9	9	3.6							
			05		9	100										253		
			06		9	100				9	5.1	6.1						
9050342	Cleveland Co., Okla.	02	02	9	9	100							1.1		70	86	1.0	6.1
			03		9	100	4/17	2		0	9.0			2.3		190		8.7
			04		9	100		9	3.9	8	4.2							
			05		9	100										250		
			06		9	100				8	4.8	6.7						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050343	Cleveland Co., Okla.	02	02	9	9	100							2.3		80	119	1.0	4.6
			03		9	100	4/18	3		3	6.7			2.2		234		6.8
			04		9	100		9	3.4	9	3.6							
			05		9	100										339		
			06		9	100				9	4.4	6.8						
9050344	Harper Co., Kans.	02	02	9	9	100							1.2		102	115	1.0	7.0
			03		9	100	4/16	4		3	7.9			3.0		215		9.9
			04		9	100		9	2.7	9	4.3							
			05		9	100										304		
			06		9	100				9	4.4	6.7						
9050345	Elk Co., Kans.	02	02	9	9	100							1.8		107	101	1.0	7.0
			03		9	100	4/14	6		6	5.6			2.9		184		11.2
			04		9	100		9	2.3	9	2.0							
			05		9	100										244		
			06		9	100				9	4.2	4.3						
9050346	Greenwood Co., Kans.	02	02	9	9	100							1.2		108	102	1.1	6.0
			03		9	100	4/13	9		9	2.8			2.8		171		7.9
			04		9	100		9	2.4	9	3.1							
			05		9	100										231		
			06		9	100				9	4.2	5.4						
9050348	Greenwood Co., Okla.	02	02	9	8	89							2.8		103	118	1.4	6.5
			03		8	89	4/19	5		4	7.1			2.6		219		13.8
			04		8	89		8	2.1	8	3.0							
			05		8	89										291		
			06		8	89				7	4.8	6.3						
9050349	Haskell Co., Okla.	02	02	9	9	100							1.9		87	97	1.0	6.2
			03		9	100	4/15	4		3	7.7			2.0		197		8.0
			04		9	100		9	3.8	9	1.4							
			05		9	100										267		
			06		9	100				9	3.7	5.1						
9050353	Nance Co., Nebr.	02	02	9	9	100							3.2		117	115	1.4	6.0
			03		9	100	4/15	8		7	7.8			2.8		203		13.6
			04		9	100		9	2.7	9	3.9							
			05		9	100										270		
			06		9	100				9	5.0	6.8						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050354	Reno Co., Kans.	02	02	9	9	100							1.2		116	135	1.0	8.3
			03		9	100	4/16	5		5	6.9			4.0		225		12.3
			04		9	100		9	1.3	9	1.6							
			05		9	100										306		
			06		9	100				9	3.0	4.9						
9050355	Reno Co., Kans.	02	02	9	9	100							1.6		75	139	1.0	3.7
			03		9	100	4/15	2		2	8.0			2.6		216		8.7
			04		9	100		9	3.0	9	3.6							
			05		9	100										293		
			06		9	100				8	3.9	5.7						
9050356	Jefferson Co., Okla.	02	02	9	9	100							1.3		88	104	1.0	6.4
			03		9	100	4/18	1		1	8.7			3.2		205		10.2
			04		9	100		9	2.8	9	2.3							
			05		9	100										276		
			06		9	100				9	2.6	5.2						
9050361	Chautauqua Co., Kans.	02	02	9	9	100							2.8		97	103	1.0	5.8
			03		9	100	4/18	4		3	8.0			3.0		186		9.3
			04		9	100		9	3.4	9	2.3							
			05		9	100										234		
			06		9	100				9	4.2	5.7						
9050362	Alfalfa Co., Okla.	02	02	9	9	100							1.4		73	124	1.0	5.7
			03		9	100	4/18	0		0	9.0			2.3		214		7.3
			04		9	100		9	3.1	9	2.8							
			05		9	100										298		
			06		9	100				9	3.7	5.4						
9050365	McIntosh Co., Okla.	02	02	6	6	100							1.7		47	71	1.0	2.2
			03		6	100	4/16	3		2	7.8			2.3		141		7.2
			04		6	100		6	2.3	6	2.5							
			05		6	100										219		
			06		6	100				6	3.6	5.0						
9050366	Dodge Co., Nebr.	02	02	9	9	100							2.0		88	108	1.0	2.6
			03		9	100	4/15	8		7	7.9			3.2		186		5.1
			04		9	100		9	2.7	9	4.0							
			05		9	100										263		
			06		9	100				8	5.8	6.7						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050367	Thomas Co., Nebr.	02	02	9	9	100							4.2		90	90	1.0	7.9
			03		9	100	4/14	4		3	9.0			4.6		149		13.4
			04		9	100		9	4.1	9	5.0							
			05		9	100										235		
			06		9	100				9	7.1	8.2						
9050372	McPherson Co., Kans.	02	02	9	9	100							1.8		112	96	1.4	7.2
			03		9	100	4/15	6		6	6.1			2.9		182		12.7
			04		9	100		9	2.8	9	3.2							
			05		9	100										256		
			06		9	100				8	3.9	5.6						
9050373	Butler Co., Kans.	02	02	9	8	89							3.5		96	102	1.0	6.1
			03		8	89	4/15	4		4	6.9			2.5		171		11.0
			04		8	89		8	2.6	8	3.8							
			05		8	89										236		
			06		8	89				8	3.5	5.3						
9050374	Montgomery Co., Kans.	02	02	9	8	89							2.3		121	103	1.3	5.9
			03		8	89	4/15	6		5	7.3			2.4		191		14.9
			04		8	89		8	4.6	8	4.1							
			05		8	89										257		
			06		8	89					4.9	6.8						
9050377	Woodson Co., Kans.	02	02	9	9	100							2.2		91	92	1.1	6.0
			03		9	100	4/14	8		8	5.0			2.7		148		8.2
			04		9	100		9	1.6	9	3.8							
			05		9	100										212		
			06		9	100				9	2.7	4.8						
9050378	Republic Co., Kans.	02	02	9	9	100							3.1		109	124	1.2	5.3
			03		9	100	4/15	3		3	8.0			4.2		220		10.9
			04		9	100		9	3.4	9	3.8							
			05		9	100										291		
			06		9	100				9	4.3	6.1						
9050379	Richardson Co., Nebr.	02	02	9	9	100							2.4		99	120	2.2	5.8
			03		9	100	4/15	5		5	6.4			2.2		211		7.7
			04		9	100		9	2.1	9	2.8							
			05		9	100										283		
			06		9	100				9	4.0	6.8						

Table 9.1 Study No. – 20I042E Initial Evaluation: False indigobush (*Amorpha fruticosa*), Manhattan, Kans. (continued)

Accession Number	Origin/Source	YR PLT	YR REC	NO. PLT	NO. SRV	PCT SRV	SPR REC DAT	NO. BLM	BLM AMT	NO. FRT	FRT AMT	FRT PER	DI*	HEA STR	CAN COV	PLT HGT	STM BRK †	NO. BAS STM/PLT
9050383	Norton Co., Kans.	02	02	9	9	100							2.9		62	114	1.0	5.9
			03		9	100	4/15	6		4	9.0			4.6		191		11.9
			04		9	100		9	3.6	9	5.4							
			05		9	100										275		
			06		9	100				9	6.6	7.4						
9050384	Sumner Co., Kans.	02	02	9	9	100							1.0		93	125	1.0	5.7
			03		9	100	4/16	9		8	3.9			2.3		202		9.1
			04		9	100		9	2.6	9	2.7							
			05		9	100										288		
			06		9	100				9	3.9	5.7						
9050388	Antelope Co., Nebr.	02	02	9	9	100							3.1		96	111	1.0	4.6
			03		9	100	4/14	7		5	7.7			4.2		183		7.1
			04		9	100		9	4.1	9	4.4							
			05		9	100										253		
			06		9	100				9	7.1	7.7						
9050391	Washington Co., Kans.	02	02	9	9	100							2.6		92	87	1.0	5.4
			03		9	100	4/15	7		7	5.7			1.4		154		8.4
			04		9	100		9	2.6	9	4.8							
			05		9	100										225		
			06		9	100				9	3.4	5.4						
9050394	Pottawatomie Co., Kans.	02	02	9	8	89							2.9		97	105	1.5	6.3
			03		8	89	4/16	2		1	8.4			3.1		188		7.9
			04		8	89		8	3.8	8	3.4							
			05		8	89										271		
			06		8	89				7	4.8	5.8						
9050400	Clay Co., Kans.	02	02	9	9	100							1.4		88	101	1.0	6.6
			03		9	100	4/16	7		5	7.4			3.0		167		13.0
			04		9	100		9	2.8	9	3.7							
			05		9	100										240		
			06		9	100				9	4.6	5.7						

† 1-5 Rating = (Best-Worst); Refer to page 94, legend for false indigobush plant evaluations

Legend for false indigobush plant evaluations:

BLM AMT: Bloom Amount
CAN COV: Crown width or ground cover as measured in centimeters
DI: Disease Resistance, rating 1-9
FLW AMT: Amount of Flowers, rating 1-9
FRT AMT: Fruit Amount, rating 1-9
FRT PER: Fruit Persistance, rating 1-9
HEA STR: Heat Stress, rating 1-9
NO. BAS STM /PLT: Number of basal stem per plant
NO. BLM: Number of plants blooming
NO. FRT: Number of trees producing fruit
NO. PLT: Number of trees planted
NO. SRV: Number Surviving
PCT SRV: Percent Survival
PLT HGT: Total plant height measured in centimeters
SPR REC: Spring Recovery Date
STM BRK: Stem Breakage, rating 1-5
YR PLT: Year Planted
YR REC: Year of Record

10. Study No. KSPMC-T-0502-RA - Laboratory evaluation of plant materials to determine seed analysis, germination, and propagation techniques.

Introduction: Many native plant species produce seed that have an impermeable, hard, seed coat. This is used as a survival mechanism to combat unfavorable growing conditions. It allows for some seed from each year's production to be stored in the soil as a seed bank. It is a wonderful mechanism to ensure survival in the wild, but can cause difficulties when trying to establish stands of native plants for conservation purposes. Often a rapid response is needed to repair critical areas and restore them to their natural state. This is difficult to accomplish if the seed lies in the ground for 2-5 years before becoming viable.

Acid scarification is a useful means of breaking down the seed coat of hard seeded species, and increasing the germination rate. It can be precisely controlled by monitoring the concentration and exposure time of the acid. The acid partially dissolves the seed coat allowing it to become permeable to water and start the biochemical processes that lead to germination. As acid strength and exposure time increase, so does the amount of scarification. However, is there a critical point at which the acid penetrates the seed coat, causing damage to the embryo? This can have a detrimental effect on germination, and destroy the seed.

Objective: The object of this study was to determine the optimum amount of scarification needed to break dormancy and maximize germination for hard seeded legumes, and to gain experience using this procedure before handling smaller seeded legume species such as purple prairie clover.

Procedure: Concentrated sulfuric acid (H_2SO_4) was diluted with 100 ml of purified water to prepare molar solutions of 0 (control), 3, 9, 15, and 18, with 4 replications per treatment. The acid solutions were prepared using the formula $(M_1)(V_1) = (M_2)(V_2)$. M_1 represents the original concentration of the starting solution, and M_2 represents the desired concentration to be made. V_1 represents the volume needed to dilute the starting concentration to the desired concentration, and V_2 represents the desired amount of dilute solution.

Example:
A dilution of concentrated 18 M H_2SO_4 to yield 100 ml of 3 M solution was needed to create the acid bath for the first portion of the experiment.

18 M (V_1) = (3M) (100 ml)
18 M (V_1) = 300
V_1 = 16.66 ml of concentrated H_2SO_4
16.66ml – 100ml = 83.34 ml of Water

So, 16.66 ml of concentrated acid was needed to make a 100 ml, 3 M solution. This was done by adding the 16.66 ml of concentrated sulfuric acid to 83.34 ml of purified water.

Three samples of approximately 1,600 seeds were placed in Erlenmeyer flasks and labeled for each acid bath concentration. The appropriate acid solution and a magnetic stir bar were added to each flask, and they were placed on magnetic stirring plates. At the specified time intervals of 5, 15, and 30 minutes, the seeds were separated from the acid bath using a glass funnel and nylon mesh. The acid was collected in a 250 ml Erlenmeyer flask and set aside for later use with the other time intervals. It was discarded into a waste container after the 30 minutes time interval samples were collected. The seed was triple rinsed with purified water to remove any acidic residue from the seed coats. The rinsate was collected in a separate Erlenmeyer flask and discarded. A sample of 400 seeds was collected from each time interval and acid concentration to conduct germination tests. The samples were labeled according to species, acid concentration, time interval, and set aside to air dry over night after being rinsed.

Once dried, the germination tests were conducted. The seeds were placed in 10.16- x 10.16-cm (4- x 4-in) germination boxes on moistened germination paper. These were then placed in a germinator set at alternating temperatures of 20^{o}C for 16 hours and 30^{o}C for 8 hours. The germinator was also set for a diurnal photoperiod with 10 hours of light and 14 hours of darkness. The germination results were recorded weekly for 2 weeks, analyzed, and compared to the control.

a.) Acid Scarification Screening of Roundhead Lespedeza, *Lespedeza capitata*

Progress or status: The control averaged 53% germination over a 2-week period, Table 10.1. There was a significant difference between germination based on concentration as indicated by *P* = .0000. Tukey's All-Pairwise Multiple Comparison Tests showed no significant difference in germination between the control, 3 M treatments, and 9 M treatments. However, there was a significant increase in germination for the 15 M treatments. It also showed no interaction between time and concentration. The 15 M treatments were significantly better in germination from the other treatments, yet there was no significant difference between the 15 M treatments based on time.

Table 10.1 Two-week germination results for *Lespedeza capitata* using 3 acid concentrations and 3 time treatments.

	Control	5 Min	15 Min	30 Min	5 Min	15 Min	30 Min	5 Min	15 Min	30 Min
Rep	0 M	3 M	3 M	3 M	9 M	9 M	9 M	15 M	15 M	15 M
1	51	47	58	61	49	55	52	92	81	95
2	67	51	61	47	44	58	59	75	88	87
3	48	56	50	51	58	49	56	79	84	88
4	46	55	46	58	53	55	49	72	78	79
AVG	**53**	**52.3**	**53.75**	**54.25**	**51**	**54.25**	**54**	**79.5**	**82.75**	**87.25**

An additional test was conducted using longer exposure times and higher acid concentrations to determine if the germination continued to increase, and to help determine the critical point at which damage to the seed occurred. The time limit for the 15 M treatment was extended to 60 minutes, and three 18 M treatments were added, Table 10.2. The 18 M treatments were run for 30, 45, and 60 minutes in hopes of finding a critical point at which the acid scarification became detrimental, damaging the seed, and inhibiting germination.

Table 10.2 Additional germination results for *Lespedeza capitata* using stronger acid and increased time to determine the critical point of scarification.

Rep	15 M 60 Min	18 M 30 Min	18 M 45 Min	18 M 60 Min
1	93	17	67	34
2	96	20	63	45
3	83	8	54	32
4	92	3	56	30
Avg	**91**	**12**	**60**	**35.25**

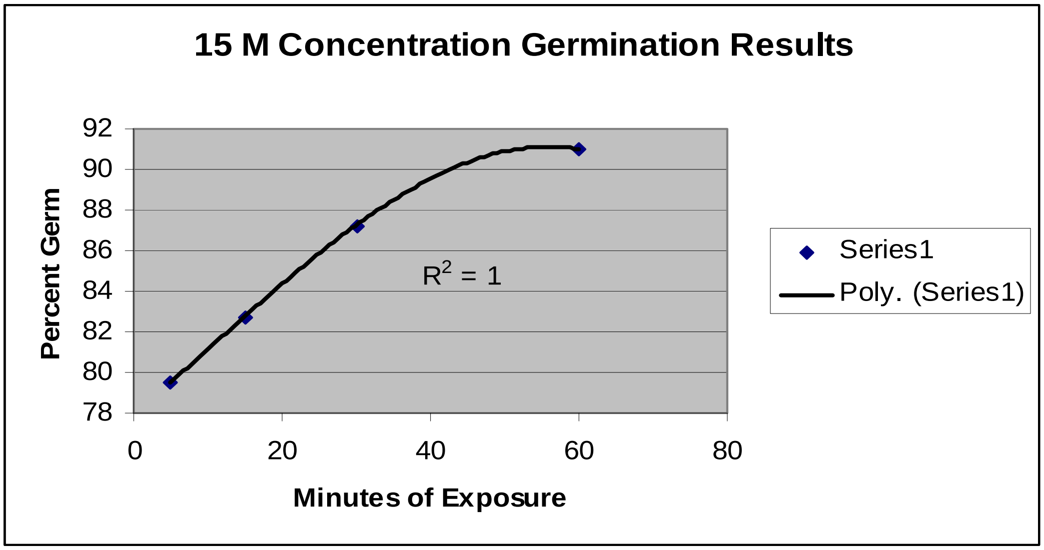
This additional test showed an increase in germination to 91% for the 15 M, 60-minute treatment and a decline in the 18 M treatments to 60% for the 45-minute treatment and 35.25% for the 60-minute treatment. The 18 M, 30-minute treatment results are shown, but were not included in the analysis. The hot plate on the magnetic stirrer was accidentally turned on during this portion of the experiment. The acid bath became very hot, cooking the seed, and causing an unusually low germination result. It should be repeated to obtain more accurate results.

Damage to the seed appeared to occur in the 18 M concentration treatments. There was a significant decrease in germination seen in the 18 M, 45-minute treatment compared to the 15 M, 60-minute treatment (*P* = .0015) for the germination X concentration interaction, and (*P* = .0001) for the interaction between the germination X concentration interaction for the 18 M, 60-minute treatment.

Further analysis of the 15 M treatments showed that there were slight statistical differences between exposure times (*P* = .0281).

Conclusion: The germination of *Lespedeza capitata* was improved from 53% in the control to 91% in the 15 M, 60-minute treatment, Figure 10.1. The germination appeared to decrease after the acid concentration was increased to 18 M. Treating the seed for 60-minutes with 15 M H_2SO_4 could greatly reduce the amount of seed and time needed to revegetate a specific area in a single growing season. More work needs to be done to determine the exact point at which damage occur to the seeds. This would be valuable information to aid the producers and conservationists. It would ensure that expensive seed is not destroyed by over scarifying. And help eliminate weed pressure by allowing a more uniform stand of plants and quicker establishment times.

Figure 10.1 Graph of germination vs. time for the 15 molar treatments of *Lespedeza capitata.*



b.) Acid Scarification Screening of Illinois Bundleflower, *Desmanthus illinoensis*

Progress or status: Most of the germination occurred within the first week of the experiment. The average germination for the control over the two-week period was 34.75%, Table 10.3. There were no significant differences in germination between the control and 3 M treatments for germination X concentration (*P* = .2167) and germination X time (*P* = .1221). The germination for the 15 M, 5-minute treatment also fell into the same range as the control and 3 M treatments. It would be reasonable to assume that it too had no significant difference from the control.

Table 10.3 Two week germination results for *Desmanthus illinoensis* using 4 acid concentrations and 3 time treatments.

	0 M	3 M	3 M	3 M	9 M	9 M	9 M	15 M	15 M	15 M	18 M	18 M	18 M
REP	0 Min	5 Min	15 Min	30 Min	5 Min	15 Min	30 Min	5 Min	15 Min	30 Min	5 Min	15 Min	30 Min
1	43	43	40	36	19	16	22	43	72	62	84	85	86
2	30	42	38	38	20	21	18	33	73	60	83	90	89
3	35	40	32	36	15	16	19	38	77	63	83	84	88
4	31	40	39	31	22	20	16	39	77	65	85	91	84
AVG	34.75	41.25	37.25	35.25	19	18.25	18.75	38.25	74.75	62.5	83.75	87.5	86.75

The 9 M treatments showed a drastic drop in germination from the control, 18.66% versus 34.75%. This was an unexpected result. To ensure that no errors had been made, the 9 M treatment was repeated using a new acid solution. The second 9 M treatment showed similar germination results, Table 10.4. Comparison of the 9 M treatment to the control showed a highly significant difference in germination (*P* = .0000) for the germination X concentration interaction.

Table 10.4 Repeated germination results for the 9 molar treatments to verify accuracy.

REP	5 Min	15 Min	30 Min
1	12	17	18
2	16	13	13
3	15	15	19
4	15	15	18
AVG	14.5	15	17

The 15 M treatments showed an increase in germination compared to the control. This increase was highly significant (*P* =.0133) for germination X concentration and (*P* =.0000) for germination X time. Tukey's All-Pairwise Comparisons Test broke the results for the 15 M treatments into 3 groups. The 15-minute treatment proved to be the best performing, followed by the 30-minute treatment. The third group consisted of the control and 5-minute treatment. Tukey's showed no significant difference between these two at the critical level of .05. This supports the earlier assumption that the 15 M, 5-minute treatment was not significantly different from the control or 3 M treatments. The 18 M treatments yielded the highest levels of germination for the study. It was significantly different from the 15 M treatments at all levels (*P* =.0000) for germination X time, germination X concentration, and germination X concentration X time.

Conclusion: The use of concentrated, 18 Molar, H_2SO_4 proved to be very effective at scarifying *Desmanthus illinoensis.* The 18 M, 15-minute treatment produced the highest germination results for the test at 87.5%. Tukey's All-Pairwise Comparisons Test showed that it was significantly better when germination was compared to time and concentration, yet when compared to the time X concentration interaction there was no significant difference within the 18 M treatments. However, the time X concentration interaction for the 18 M treatments were significantly better than any of the treatments using weaker acid concentrations according to Tukey's Test.

It was hoped that the upper threshold of scarification would be reached with this study by seeing a marked decrease in germination in some of the 18 M treatments. The 18 M, 30-minute treatment did show a slight drop in germination, however it was not significant. More work would need to be done to determine the point at which the acid bath becomes detrimental to germination for this species.

The decrease in germination in the 9 M treatments was unexpected. As mentioned earlier, this section was repeated to ensure no errors were made while mixing the acid. It is not known why the germination seemed to be inhibited by the 9 M acid. It may be that the 9 M treatment was strong enough to be detrimental to the seeds that were not hard, yet too weak to scarify the seeds that were hard. Another explanation is that it may have only slightly scarified the seed, triggered a mechanism to increase dormancy through some other biochemical process.

In application of this technique in the future, it may be more helpful to use the weaker, 15 M concentration of acid, for a longer period of time as opposed to the 18 M concentration. The 15 M treatments showed a steady increase in germination as time was increased. It uses less acid, and is easier to work with. The 18 M acid was very hard on the nylon mesh used to separate the seed from solution. It often melted the mesh, causing it to stick to the seed and became very cumbersome. Another study needs to be done to determine if a longer bath in 15 M acid is as effective as a shorter bath in 18 M acid for scarifying this species. The 15 M acid was much easier to work with than the 18 M acid, and when used at a longer time interval may yield equal results.

11. Study No. KSPMS-T-0201-CR – Plant species for revegetation of natural and man-induced saline areas.

Introduction: Small areas of pasture and rangeland have been damaged through the spillage of brine water associated with oil drilling activity. Natural saline seeps have formed in cropland fields due to cropping practices, soil geology, and drainage configuration. These areas while small in size (typically less than 5 acres) are extremely erosive and contribute heavy sediment loads (including contaminants) to adjacent water bodies. Because these sites are typically high in salts, poor in soil structure, and low in organic matter, revegetation is extremely difficult without considerable economic input.

Objective: To evaluate various plant species for use in revegetating saline areas and to evaluate the effect of various surface treatments on plant species establishment.

Procedure: Eighteen different species/selections will be seeded at four different locations; Perry, Oklahoma (1 site), Okmulgee, Oklahoma (2 sites), El Dorado, Kansas (1 site), and Eureka, Kansas (1 site). Sixteen different soil amendment treatments will be applied at the Eureka and El Dorado sites. Soil salinity analysis will be performed on all sites prior to and following species establishment. Plant species to be used are provided in Table 10.1. Treatments for the Kansas locations are provided in Figure 11.1. Okmulgee and Perry locations will be seeded in the spring of 2002. Evaluations will be completed annually through 2006. Locations will be evaluated for plant species establishment, growth, and persistence.

Potential Products: A summary of the study with appropriate recommendations regarding soil amendments and species selection will be developed and provided in the form of a technical note.

Progress or Status: The study sites located in Okmulgee and Perry, Oklahoma, did not materialize and are not being monitored as part of this study. They are failed plantings.

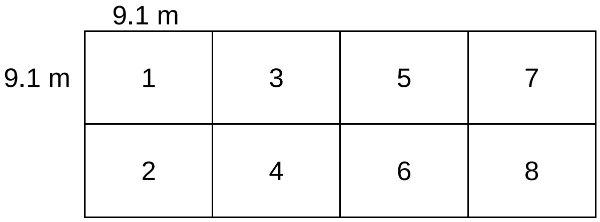
The Eureka and El Dorado sites were evaluated August 23, 2006. At the Eureka site, seedling establishment is primarily limited to areas with supplemental residue such as wheat straw. Grass in many areas could be observed in rows to the edge of the residue. Outside of the residue there would be little grass establishment. Results indicate the addition of crop residue to a saline site seeding is very important to the seeding success. Primary grasses at this site include inland saltgrass, ‘Jose’ tall wheatgrass and Alkali sacaton.

The El Dorado site also indicates that the addition of residue is important to seeding success. This site has off-site water that flows across the planting site during high rainfall events. This has disturbed the residue and has deposited additional deposits at this site. Seeding establishment is limited to areas that have additional residue. Plant species is limited primarily to inland saltgrass, ‘Jose’ tall wheatgrass and Alkali sacaton. There has been some browsing of livestock at this planting site.

Table 11.1 Plant species per location.

	Location			
Plant Species	Okmulgee	Perry	El Dorado	Eureka
Havard’s panic grass	X		X	X
Alkali sacaton, ‘Saltalk’	X	X	X	X
Big sacaton / 434453	X	X	X	X
Four-wing saltbush			X	X
Texas dropseed / 9029930	X	X	X	X
Texas dropseed / 9029932	X	X	X	X
Side-oats grama, ‘Premier’	X	X	X	X
Inland saltgrass	X	X	X	X
Blue panicum	X	X	X	X
Alkali-grass, ‘Fults’	X	X	X	X
Switchgrass, ‘Kanlow’	X	X	X	X
Western wheatgrass, ‘Barton’	X	X	X	X
Western wheatgrass / Knox City	X		X	X
Tall wheatgrass, ‘Jose’	X	X	X	X
Russian wildrye, ‘Bozoiski-Select’	X	X	X	X
Western indigo / Knox City	X		X	X
Illinois bundleflower, Reno Germplasm	X		X	X
Showy partridge pea, Riley Germplasm	X		X	X

Figure 11.1 Surface treatments for each site.



Treatment No.	
1 – Control: no amendment	5 – Incorporated wood chips* (manure)
2 – Incorporated gypsum	6 – Incorporated gypsum and wood chips* (manure)
3 – Incorporated straw	7 – Annual crop**
4 – Incorporated gypsum and straw	8 – Incorporated gypsum then seed annual crop**

*Wood chips applied at Eureka location; manure at El Dorado location
**Perennial species seeded 1 year after seeding of annual crop

Rate of Amendment Application and Incorporation

Gypsum – 385.4 net cwt/ha (7.8 t/ac) El Dorado; 523.8 net cwt/ha (10.6 T/ac) Eureka
Manure – 741.2 net cwt/ha (15 t/ac)
Wood chips – 642.4 net cwt/ha (13 t/ac)
Straw – 148.2 net cwt/ha 3 (t/ac)

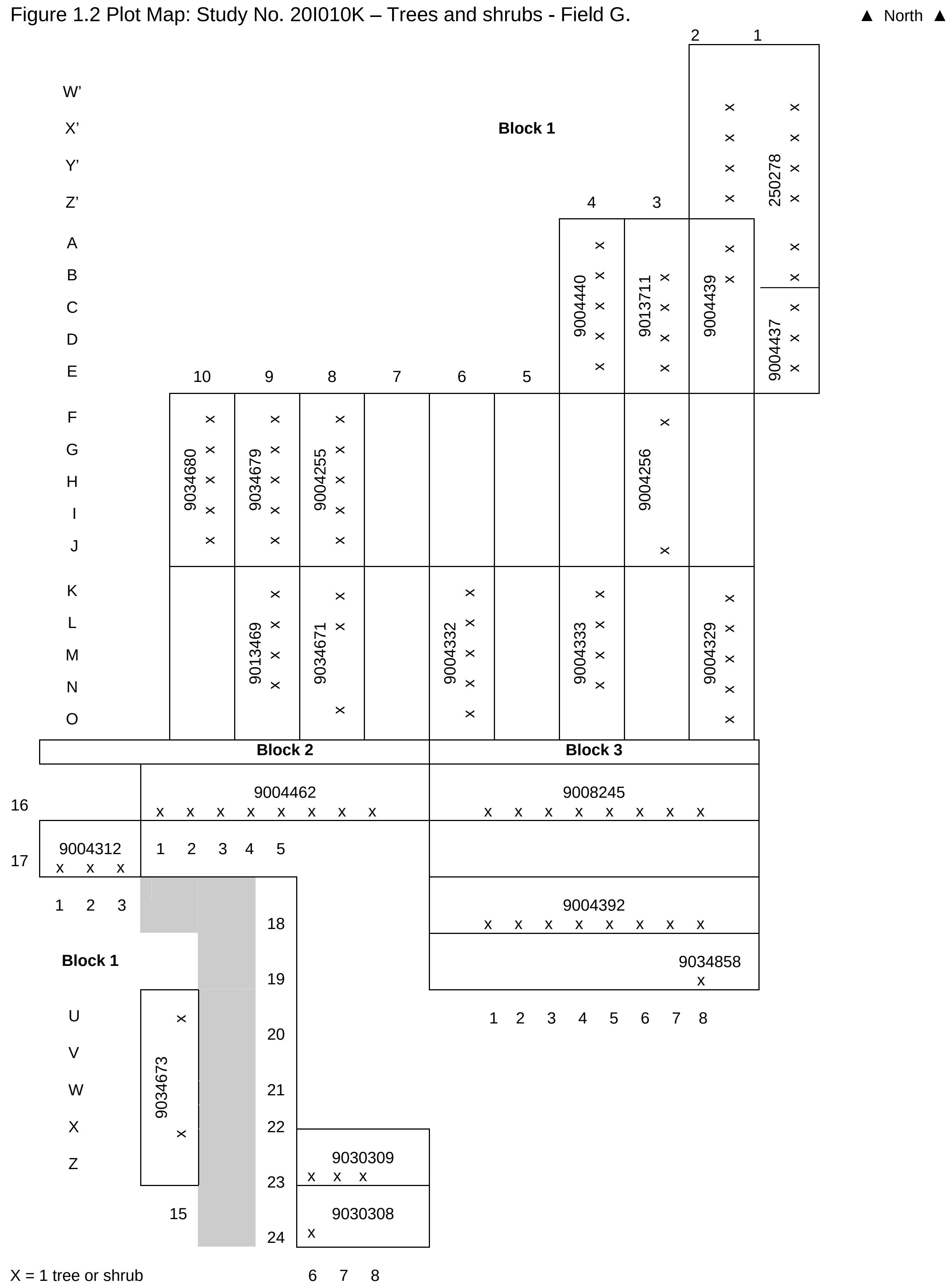
Rate of Surface Mulch Application

Straw – 148.2 net cwt/ha (3 t/ac)
Surface mulch will be applied to ½ of each treatment immediately after seeding of the perennial plant species.

Figure 1.1 Plot Map Field F. Study No. 20I010K – Trees and shrubs, Manhattan PMC. ▲ North ▲

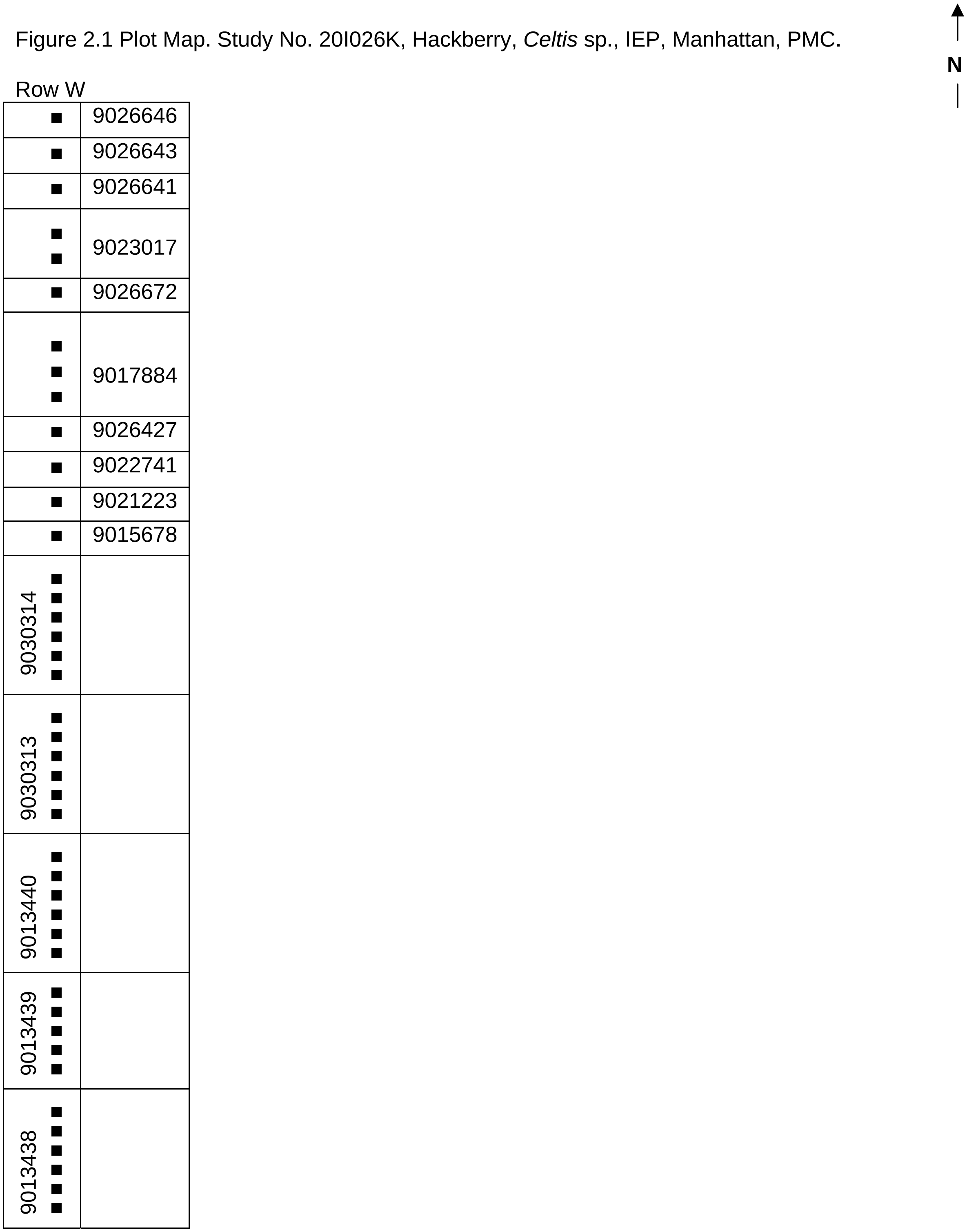
Row	Block 1	Block 2	Block 3	Block 4
1	x x 107630 x x x x x x x x x			9004461 x x
2	x x x x x		9001069 x x x x x x x x	
3	sycamores x x x x x		486339 x x x x x	9004434 x x x x x
4	9050263 x x x	9006095 x x x x x x x x		
5	9050268 x x x x x x x x x x		9004305 x x x x	323932 xx x x x x x
6	9050265 x x x x x x x x x x	chestnuts x x x x x		
7	9050267 x x x x x x x x x x	x x x x x	9050478 9050499 x x x x 9050481 x x x x x	
8	9050264 x x x x x x x x x x	x x x x x	9050479 x x x x x 9050480 x x x x x	
9	9050266 x x x x x x x x x x	9050011 x x x x		
10			9034682 x x x x x x x x x x	9004334 x x x x x
11	9055585 x x x x x x x x x x			9050504 x x x x x x x x x x
12	325270 x x		9050497 x x x x x x x x x x	
13			9066615 x x x x x x x x x x	
14			9050501 x x x x x 9050503 x x x x x	
15			9050502 x x x x x x x x x x	
				477011 x x x x x x x x x x
17	477010 x x x x x		9004302 x x x x x x x x	343949 x x x x x x
18	9050500 x x x x x 323957 x x x x x		341756 x x 265620 x	343948 x x x
19	9050482 x x x x x 9050483 x x x x x		9034674 x x x 9017646 x x x x	9034668 x x x x x x x x x x
20	9050417 x x x x x 9050418 x x x x x		9050022 x x x	9004363 x x x x x x x x x
21	9050425 x x x x x 9050426 x x x x x		9004392 x x x x x	9004364 x x x x x x x x x x
22	9050427 x x x x x 9050498 x x x x x		434253 x x x x x x x x x x	
23	9050429 x x x x x 9050430 x x x x x	9006225 x x x x x 9034667 x x x x x		
24	9050431 x x x 9050432 x x x x			9034669 x x x xxx
26	9050007 x x x x x	Windbreak x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x x		

Figure 1.2 Plot Map: Study No. 20I010K – Trees and shrubs - Field G.



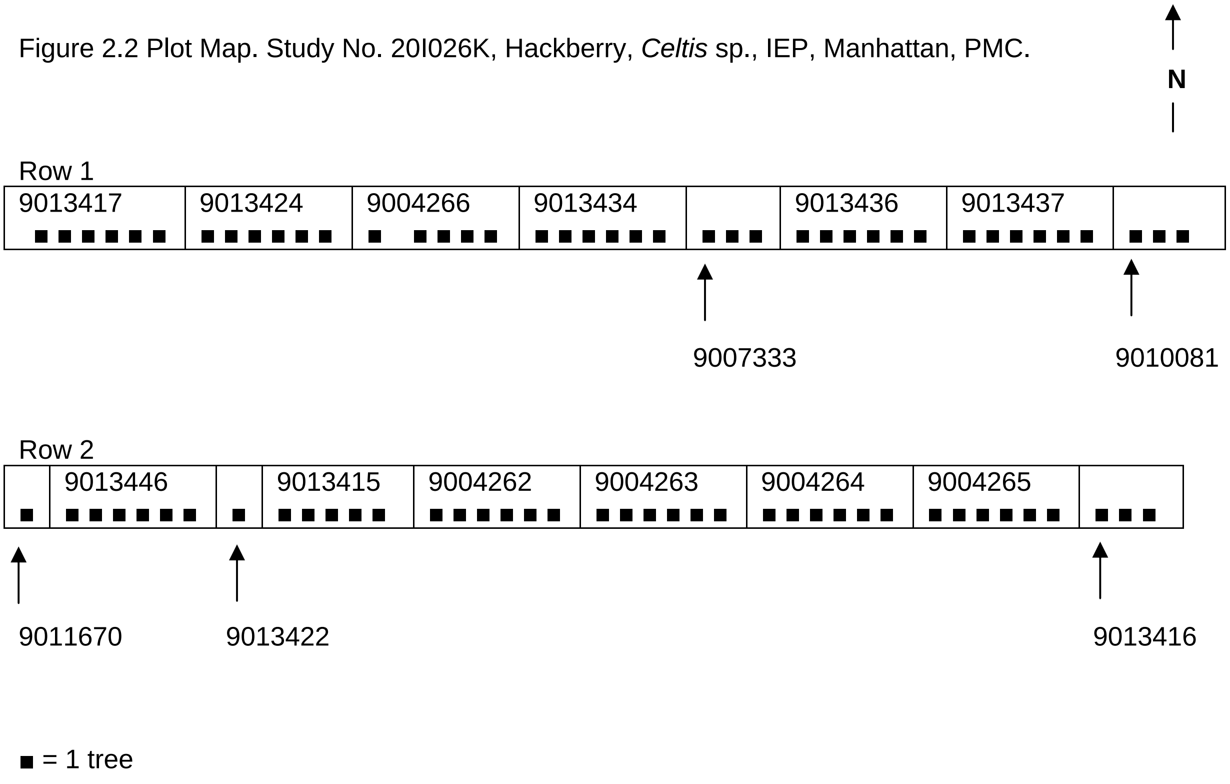
X = 1 tree or shrub

Figure 2.1 Plot Map. Study No. 20I026K, Hackberry, *Celtis* sp., IEP, Manhattan, PMC.



■ = 1 tree

Figure 2.2 Plot Map. Study No. 20I026K, Hackberry, *Celtis* sp., IEP, Manhattan, PMC.



← N ——

Figure 3.1 Plot Map. Study No. 20I031K - Oriental arborvitae, *Platycladus orientalis,* IEP, Manhattan PMC.

Field J

Col. 2	9017764 X X 0 0 X 0	9017879 0 X X 0 0 X	9018973 0 0 0 0 0 0	9019848 X X X X X X	9019849 X X X X X X	9019850 X X 0 0 0 0	9019853 0 X X X X X	9019854 0 0 0 X 0 0	9020979 0 0 0 0 0 0	9021012 0 X 0 0 0
Col. 1	9010076 0 0 0 0 0 0	9010077 0 X 0 X 0 0	9011202 0 0 0 0 0 0	9012467 X X X X X X	9013567 X X X X X X	9013568 0 0 0 0 0 0	9013569 0 0 0 0 0 0	9013570 X X X X X X	9013571 0 0 X 0 0 X	9013572 X 0 0 0 0 0

Field L

Col. 2	9023359 X X X X X X	9026610 X X X X X X	PMK-2925 X X X X X X	9026780 X 0 X 0 X 0	Blank	9013566 X	9019852 0 0	9026780 X X 0	9019852 X X	
Col. 1	9013573 0 0 0 0 X 0	9013574 X X X X X X	9013575 X X X X X X	9013576 X 0 X X X X	9013577 X X 0 0 X X	9013578 X X X X X X	9013579 X X X X 0 0	9013580 0 0 X 0 0 0	9014890 X 0 X X X X	9015329 0 0 X 0 0

Figure 4.1 Plot Map Field E-2. Study No. 20I038K - Bur Oak Seed Source Study - Manhattan PMC.

—— N →

B	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	B
B	520-1-1 9050170	520-1-2 9050170	267-1-1 9050162	267-1-2 9050162	137-1-1 9050156	137-1-2 9050156	567-1-1 9050175	567-1-2 9050175	Border	Border	Border	Border	Border	Border	B
B	125-1-1 9050154	125-1-2 9050154	246-1-1 9050163	246-1-2 9050163	392-1-1 9004392	392-1-2 9004392	262-1-1 9050159	262-1-2 9050159	274-1-1 9050167	274-1-2 9050167	265-1-1 9050161	265-1-2 9050161	510-1-1 9050169	510-1-2 9050169	B
B	253-1-1 9050160	253-1-2 9050160	087-1-1 9050087	523-1-2 9050172	521-1-1 9050171	521-1-2 9050171	225-1-1 9050157	225-1-2 9050157	267-1-1 9050162	267-1-2 9050162	122-1-1 9050153	122-1-2 9050153	245-1-1 9050158	245-1-2 9050158	B
B	501-1-1 9050168	501-1-2 9050168	087-1-1 9050087	275-1-2 9050065	249-1-1 9050176	249-1-2 9050176	241-1-1 9050164	241-1-2 9050164	132-1-1 9050155	132-1-2 9050155	556-1-1 9050174	556-1-2 9050174	554-1-1 9050173	554-1-2 9050173	B
B	267-2-1 9050162	267-2-2 9050162	241-2-1 9050164	241-2-2 9050164	249-2-1 9050176	087-2-2 9050087	501-2-1 9050168	501-2-2 9050168	125-2-1 9050154	125-2-2 9050154	225-2-1 9050157	225-2-2 9050157	271-1-1 9050166	271-1-2 9050166	B
B	275-2-1 9050065	087-2-2 9050087	392-2-1 9004392	392-2-2 9004392	271-2-1 9050166	271-2-2 9050166	554-2-1 9050173	554-2-2 9050173	265-2-1 9050161	265-2-2 9050161	137-2-1 9050156	137-2-2 9050156	556-2-1 9050174	556-2-2 9050174	B
B	246-2-1 9050163	246-2-2 9050163	567-2-1 9050175	567-2-2 9050175	122-2-1 9050153	122-2-2 9050153	523-2-1 9050172	523-2-2 9050172	269-2-1 9050165	269-2-2 9050165	274-2-1 9050167	274-2-2 9050167	520-2-1 9050170	520-2-2 9050170	B
B	087-3-1 9050087	521-3-2 9050171	253-2-1 9050160	253-2-2 9050160	132-2-1 9050155	132-2-2 9050155	245-2-1 9050158	245-2-2 9050158	521-2-1 9050171	521-2-2 9050171	510-2-1 9050169	510-2-2 9050169	262-2-1 9050159	087-2-2 9050087	B
B	262-3-1 9050159	262-3-2 9050159	249-3-1 9050176	077-3-2 9050077	510-3-1 9050169	510-3-2 9050169	087-3-1 9050087	523-3-2 9050172	253-3-1 9050160	253-3-2 9050160	125-3-1 9050154	125-3-2 9050154	077-3-1 9050077	554-3-2 9050173	B
B	225-3-1 9050157	225-3-2 9050157	269-3-1 9050165	269-3-2 9050165	137-3-1 9050156	137-3-2 9050156	271-3-1 9050166	271-3-2 9050166	265-3-1 9050161	265-3-2 9050161	556-3-1 9050174	556-3-2 9050174	267-3-1 9050162	267-3-2 9050162	B
B	241-3-1 9050164	241-3-2 9050164	501-3-1 9050168	501-3-2 9050168	392-3-1 9004392	392-3-2 9004392	245-3-1 9050158	245-3-2 9050158	520-3-1 9050170	520-3-2 9050170	132-3-1 9050155	132-3-2 9050155	122-3-1 9050153	122-3-2 9050153	B
B	262-4-1 9050159	262-4-2 9050159	269-4-1 9050165	269-4-2 9050165	245-4-1 9050158	245-4-2 9050158	274-3-1 9050167	274-3-2 9050167	275-3-1 9050065	275-3-2 9050065	246-3-1 9050163	246-3-2 9050163	567-3-1 9050175	567-3-2 9050175	B
B	132-4-1 9050155	132-4-2 9050155	501-4-1 9050168	501-4-2 9050168	567-4-1 9050175	567-4-2 9050175	249-4-1 9050176	249-4-2 9050176	253-4-1 9050160	253-4-1 9050160	520-4-1 9050170	520-4-2 9050170	125-4-1 9050154	125-4-2 9050154	B
B	241-4-1 9050164	241-4-2 9050164	521-4-1 9050171	521-4-2 9050171	271-4-1 9050166	271-4-2 9050166	392-4-1 9004392	392-4-2 9004392	556-4-1 9050174	556-4-2 9050174	267-4-1 9050162	267-4-2 9050162	510-4-1 9050169	510-4-2 9050169	B
B	265-4-1 9050161	265-4-2 9050161	274-4-1 9050167	087-4-2 9050087	225-4-1 9050157	225-4-2 9050157	137-4-1 9050156	137-4-2 9050156	275-4-1 9050065	275-4-2 9050065	523-4-1 9050172	523-4-2 9050172	122-4-1 9050153	122-4-2 9050153	B
B	267-6-1 9050162	267-6-2 9050162	392-5-1 9004392	392-5-2 9004392	271-5-1 9050166	271-5-2 9050166	087-5-1 9050087	122-5-2 9050153	554-5-1 9050173	554-5-2 9050173	246-4-1 9050163	246-4-2 9050163	554-4-1 9050173	554-4-2 9050173	B
B	249-5-1 9050176	249-5-2 9050176	501-5-1 9050168	501-5-2 9050168	245-5-1 9050158	245-5-2 9050158	265-5-1 9050161	265-5-2 9050161	556-5-1 9050174	556-5-2 9050174	521-5-1 9050171	521-5-2 9050171	262-5-1 9050159	262-5-2 9050159	B
B	275-5-1 9050065	275-5-2 9050065	523-5-1 9050172	523-5-2 9050172	087-5-1 9050087	077-5-2 9050077	274-5-1 9050167	087-5-2 9050087	269-5-1 9050165	269-5-2 9050165	225-5-1 9050157	225-5-2 9050157	241-5-1 9050164	241-5-2 9050164	B
B	253-5-1 9050160	253-5-2 9050160	246-5-1 9050163	246-5-2 9050163	267-5-1 9050162	267-5-2 9050162	520-5-1 9050170	520-5-2 9050170	125-5-1 9050154	125-5-2 9050154	567-5-1 9050175	567-5-2 9050175	137-5-1 9050156	137-5-2 9050156	B
B	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	B

Legend: Entry-Rep-Tree = 520-1-1
Accession No. = 9050170

Figure 5.1 Plot Map. Study No. 20I041K - Siberian Elm, *Ulmus pumila*, FEP - Akron, Colorado.

↑ N

Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border
Border	9050214 1-1	9050184 1-1	9050217 1-1	9050225 2-1	9050214 2-1	9050219 2-1	9050225 3-1	9050241 3-1	9050228 3-1	Border
Border	9050214 1-2	9050184 1-2	9050217 1-2	9050225 2-2	9050214 2-2	9050219 2-2	9050225 3-2	9050241 3-2	9050228 3-2	Border
Border	9050214 1-3	9050184 1-3	9050217 1-3	9050225 2-3	9050214 2-3	9050219 2-3	9050225 3-3	9050241 3-3	9050228 3-3	Border
Border	9050226 1-1	9050233 1-1	9050241 1-1	9050233 2-1	9050241 2-1	9050235 2-1	9050184 3-1	9050224 3-1	9050240 3-1	Border
Border	9050226 1-2	9050233 1-2	9050241 1-2	9050233 2-2	9050241 2-2	9050235 2-2	9050184 3-2	9050224 3-2	9050240 3-2	Border
Border	9050226 1-3	9050233 1-3	9050241 1-3	9050233 2-3	9050241 2-3	9050235 2-3	9050184 3-3	9050224 3-3	9050240 3-3	Border
Border	9050213 1-1	9050222 1-1	9050240 1-1	9050184 2-1	9050240 2-1	9050213 2-1	9050222 3-1	9050216 3-1	9050233 3-1	Border
Border	9050213 1-2	9050222 1-2	9050240 1-2	9050184 2-2	9050240 2-2	9050213 2-2	9050222 3-2	9050216 3-2	9050233 3-2	Border
Border	9050213 1-3	9050222 1-3	9050240 1-3	9050184 2-3	9050240 2-3	9050213 2-3	9050222 3-3	9050216 3-3	9050233 3-3	Border
Border	9050216 1-1	9050228 1-1	9050224 1-1	9050224 2-1	9050222 2-1	9050226 2-1	9050226 3-1	9050219 3-1	9050235 3-1	Border
Border	9050216 1-2	9050228 1-2	9050224 1-2	9050224 2-2	9050222 2-2	9050226 2-2	9050226 3-2	9050219 3-2	9050235 3-2	Border
Border	9050216 1-3	9050228 1-3	9050224 1-3	9050224 2-3	9050222 2-3	9050226 2-3	9050226 3-3	9050219 3-3	9050235 3-3	Border
Border	9050219 1-1	9050235 1-1	9050225 1-1	9050228 2-1	9050217 2-1	9050216 2-1	9050213 3-1	9050217 3-1	9050214 3-1	Border
Border	9050219 1-2	9050235 1-2	9050225 1-2	9050228 2-2	9050217 2-2	9050216 2-2	9050213 3-2	9050217 3-2	9050214 3-2	Border
Border	9050219 1-3	9050235 1-3	9050225 1-3	9050228 2-3	9050217 2-3	9050216 2-3	9050213 3-3	9050217 3-3	9050214 3-3	Border
Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border

<u>Legend</u>: Accession No. = 9050214
Rep-Tree = 1-1

Figure 5.2 Plot Map. Study No. 20I041K - Siberian Elm, *Ulmus pumila*, FEP - Sidney, Nebraska.

↑ N

Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border
Border	9050213 3-1	9050240 3-1	9050217 3-1	9050184 3-1	9050217 2-1	9050226 2-1	9050217 1-1	9050219 1-1	9050233 1-1	Border
Border	9050213 3-2	9050240 3-2	9050217 3-2	9050184 3-2	9050217 2-2	9050226 2-2	9050217 1-2	9050219 1-2	9050233 1-2	Border
Border	9050213 3-3	9050240 3-3	9050217 3-3	9050184 3-3	9050217 2-3	9050226 2-3	9050217 1-3	9050219 1-3	9050233 1-3	Border
Border	Border	9050233 3-1	9050226 3-1	9050214 3-1	9050240 2-1	9050233 2-1	9050214 1-1	9050226 1-1	9050240 1-1	Border
Border	Border	9050233 3-2	9050226 3-2	9050214 3-2	9050240 2-2	9050233 2-2	9050214 1-2	9050226 1-2	9050240 1-2	Border
Border	Border	9050233 3-3	9050226 3-3	9050214 3-3	9050240 2-3	9050233 2-3	9050214 1-3	9050226 1-3	9050240 1-3	Border
Border	Border	9050224 3-1	9050222 3-1	9050213 2-1	9050219 2-1	9050184 2-1	9050184 1-1	9050213 1-1	9050222 1-1	Border
Border	Border	9050224 3-2	9050222 3-2	9050213 2-2	9050219 2-2	9050184 2-2	9050184 1-2	9050213 1-2	9050222 1-2	Border
Border	Border	9050224 3-3	9050222 3-3	9050213 2-3	9050219 2-3	9050184 2-3	9050184 1-3	9050213 1-3	9050222 1-3	Border
Border	Border	9050228 3-1	9050219 3-1	9050222 2-1	9050224 2-1	9050214 2-1	9050228 2-1	9050228 1-1	9050224 1-1	Border
Border	Border	9050228 3-2	9050219 3-2	9050222 2-2	9050224 2-2	9050214 2-2	9050228 2-2	9050228 1-2	9050224 1-2	Border
Border	Border	9050228 3-3	9050219 3-3	9050222 2-3	9050224 2-3	9050214 2-3	9050228 2-3	9050228 1-3	9050224 1-3	Border
Border	Border	Border	Border	Border	Border	Border	Border	Border	Border	Border

Legend: Accession No. = 9050217
Rep-Tree = 1-1

Figure 6.1 Plot Map Part 1, Field C-3. Study No. 20I042E - false indigo, *Amorpha fruticosa,* IEP, Manhattan PMC.

↑ N

Rep 1	101 9050384	102 9008041	103 9050345	104 9050285	105 9050373	106 9050355	107 9050361	108 9050262	109 9050310	110 9050253
	120 9050324	121 9050277	122 9050313	123 9050336	124 9050327	125 9050309	126 9050362	127 9050294	128 9050366	129 9050327
	139 9050335	140 9050348	141 9050251	142 9050354	143 9050292	144 9050367	145 9050316	146 9050353	147 9050337	148 9050271
	158 9050317	159 9050269	160 9050379	161 9050344	162 9050307	163 9050308	164 9050378	165 9050394	166 9050329	167 9050391
Rep 2	201 9050292	202 9050334	203 9050284	204 9050312	205 9050319	206 9050324	207 9050272	208 9050294	209 9050373	210 9050349
	220 9050279	221 9050313	222 9050354	223 9050378	224 9050251	225 9050299	226 9050356	227 9050325	228 9050188	229 9050374
	239 9050297	240 9050309	241 9050253	242 9050348	243 9050337	244 9050277	245 9050372	246 9050394	247 9050383	248 9050343
	258 9008041	259 9050321	260 9050345	261 9050280	262 9050271	263 9050273	264 9050261	265 9050379	266 9050342	267 9050355
Rep 3	301 9050345	302 9050355	303 9050354	304 9050391	305 9050384	306 9050344	307 9050280	308 9050310	309 9050374	310 9050321
	320 9050379	321 9050300	322 9050343	323 9050325	324 9050346	325 9050317	326 9050298	327 9050275	328 9050295	329 9050388
	339 9050342	340 9050293	341 9050314	342 9050377	343 9050361	344 9050188	345 9050319	346 9050378	347 9050365	348 9050269
	358 9050356	359 9050365	360 9050307	361 9050372	362 9050373	363 9050297	364 9050400	365 9050277	366 9050251	367 9050299

Part 2 →

↑ N

Figure 6.1 Plot Map Part 2, Field D-3. Study No. 20I042E - false indigo, *Amorpha fruticosa,* IEP, Manhattan PMC (continued).

Part 1 ←

Rep 1	111 9050329	112 9050299	113 9050377	114 9050366	115 9050343	116 9050372	117 9050328	118 9050318	119 9050400
	130 9050293	131 9050383	132 9050346	133 9050388	134 9050250	135 9050298	136 9050188	137 9050284	138 9050342
	149 9050275	150 9050300	151 9050280	152 9050314	153 9050279	154 9050325	155 9050356	156 9050274	157 9050319
	168 9050272	169 9050334	170 9050315	171 9050297	172 9050312	173 9050349	174 9050261	175 9050273	176 9050295
Rep 2	211 9050328	212 9050269	213 9050275	214 9050388	215 9050310	216 9050307	217 9050308	218 9050391	219 9050317
	230 9050300	231 9050377	232 9050285	233 9050336	234 9050344	235 9050316	236 9050365	237 9050293	238 9050367
	249 9050327	250 9050362	251 9050262	252 9050361	253 9050400	254 9050298	255 9050315	256 9050314	257 9050329
	268 9050384	269 9050366	270 9050318	271 9050346	272 9050335	273 9050274	274 9050353	275 9050295	276 9050250
Rep 3	311 9050394	312 9050279	313 9050313	314 9050294	315 9050312	316 9050328	317 9050292	318 9050272	319 9050353
	330 9008041	331 9050271	332 9050285	333 9050250	334 9050274	335 9050334	336 9050335	337 9050321	338 9050309
	349 9050315	350 9050316	351 9050383	352 9050284	353 9050253	354 9050374	355 9050348	356 9050318	357 9050362
	368 9050261	369 9050349	370 9050308	371 9050273	372 9050367	373 9050262	374 9050336	375 9050324	376 9050337

NOTES