United States Department of Agriculture

Natural Resources
Conservation Service

Plant Materials Program

May 2014

J.R. Flores
State Conservationist, Missouri

Jay Mar
State Conservationist, Iowa

Ivan Dozier
State Conservationist, Illinois

John Englert
National Plant Materials Program Leader

Joel Douglas
Central Region Plant Materials Specialist

Jerry Kaiser
Plant Materials Specialist

Plant Materials Center Staff
Ron Cordsiemon – *Manager*
Allen Casey – *Soil Conservationist*
Nick Adams – *Biological Technician*

Plant Materials Center
2803 N. Hwy. 79
Elsberry, Missouri 63343
Phone: 573-898-2012
Fax: 855-830-4761

Find us Online!

2011-2013 Technical Report

Elsberry, Missouri

Plant Materials Program

Helping People Help the Land

Notices

The 2011-2013 Annual Technical Report (ATR) is a report to the plant materials discipline and cooperating agencies. This ATR compiles the preliminary reports from various studies conducted by the Elsberry Plant Materials Center (PMC) staff at Elsberry, Missouri. These reports serve to document the progress and initial results from the studies being presented. 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 Elsberry PMC Manager for more information at 2803 N. Hwy. 79, Elsberry, MO 63343, or (573) 898-2012.

This ATR uses currently accepted scientific names as they appear in the PLANTS (Plant List of Accepted Nomenclature, Taxonomy, and Symbols) database where practical. The PLANTS website is maintained by the National Plant Data Collection Center. See the PLANTS website at http://www.plants.usda.gov/ .

Mention of trade and company names does not imply any guarantee, warrantee, 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.

Acronyms used in this report to identify various centers are those listed in the Plant Materials Operations and Management System (POMS) database.

On the Cover: Goats and a guard donkey at the Missouri Plant Materials Center as part of Using a Biological Approach (Small Ruminants) to Control Invasive Species with Emphasis on Bush Honeysuckle and Common Buckthorn study.

Citation:

Cordsiemon, R., A. Casey, N. Adams, and J. Kaiser. 2014. 2011-2013 Technical Report: Elsberry, Missouri Plant Materials Center. USDA-Natural Resources Conservation Service, Plant Materials Center, Elsberry, MO 63343. 288p.

Non-Discrimination Policy: The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the bases of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, or all or part of an individual's income is derived from any public assistance program, or protected genetic information in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases will apply to all programs and/or employment activities.) **To File an Employment Complaint:** If you wish to file an employment complaint, you must contact your agency's EEO Counselor (PDF) within 45 days of the date of the alleged discriminatory act, event, or in the case of a personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html. **To File a Program Complaint:** If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form (PDF), found online at http://www.ascr.usda.gov/complaint_filing_cust.html, or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter to us by mail at U.S. Department of Agriculture, Director, Office of Adjudication, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, by fax (202) 690-7442 or email at program.intake@usda.gov.
Persons with Disabilities: Individuals who are deaf, hard of hearing or have speech disabilities and you wish to file either an EEO or program complaint please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish). Persons with disabilities who wish to file a program complaint, please see information above on how to contact us by mail directly or by email. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.) please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
2011-2013 TECHNICAL REPORT
Elsberry Plant Materials Center

Plant Materials Center Advisory Committee

J. R. Flores, State Conservationist, Missouri, Chairman
Karen Brinkman, Acting State Conservationist, Missouri (2013)
Richard Sims, State Conservationist, Iowa (2011)
Jay Mar, State Conservationist, Iowa (2012-13)
William J. Gradle, State Conservationist, Illinois (2011)
Ivan Dozier, State Conservationist, Illinois (2012-13)
Dwaine Gelnar, State Resource Conservationist, Missouri
John D. Meyers, State Resource Conservationist, Iowa (2011)
Marty Adkins, State Resource Conservationist, Iowa (2012-13)
Richard G. Hungerford, Jr., State Resource Conservationist, Illinois (2011)
Kerry Goodrich, State Resource Conservationist, Illinois (2012-13)

National Program Leader

John M. Englert

Central Region Plant Materials Specialist

Joel L. Douglas

Plant Materials Specialist

Jerry U. Kaiser

Plant Materials Center Personnel

Ronald L. Cordsiemon II, Plant Materials Center Manager
P. Allen Casey, Soil Conservationist
Nicholas S. Adams, Biological Science Technician

Part-time Positions

Seeseei Toa, STEP (Summer 2011)
Saebyul (Christina) Choe, STEP (Summer 2012)
Ben Bruckerhoff, WAE (Summer 2013)
Garry Stewart, WAE (2011-2013)
Ronald K. Vaughn, WAE (2011-2013)

Earth Team Volunteers

Jimmy Henry, Bob Laird, Dean Tapley, and Jerrad Kaiser

[This page intentionally left blank]

CONTENTS

FORWORD

The United States Department of Agriculture (USDA) – Natural Resources Conservation Service (NRCS) owns and operates the Elsberry, Missouri Plant Materials Center (PMC) under the administration of the Missouri NRCS State Office. Conservation plant and soil studies at the PMC are directed by the PMC's Long Range Plan with guidance from a State Conservationists' Plant Materials Advisory Committee that includes representation from Missouri, Iowa, and Illinois.

The Elsberry PMC was established in June 1934 and is one of 27 PMC's in the United States. The PMC is located approximately 60 miles northwest of Saint Louis, Missouri, on Highway 79. The PMC includes 243 acres with varying soil types. The Elsberry PMC primarily serves Illinois, Iowa, and Missouri, but it makes significant contributions to other states in the Midwest and nationally.

INTRODUCTION

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

Emphasis is focused on using native plants as a healthy way to solve conservation problems and protect ecosystems. The program seeks to address priority needs of field offices and land managers in both public and private sectors by working with a broad range of plant species, including grasses, forbs, legumes, trees, and shrubs.

The Elsberry PMC assembles tests, selects and develops improved plants and reliable techniques for successfully establishing and maintaining plants for conservation uses.

Of particular importance is finding suitable plants for wetland situations, high traffic areas, wildlife food and habitat, farmstead and field windbreaks, wind barriers, pasture, riparian plantings, woodland, and erosion control on cropland. Each of the three states served by the Center has identified its plant materials problems, needs and priorities. PMC activities are directed toward meeting the needs and priorities set forth in the states' long-range plans. As early as 1939 the Center began searching for plants to respond to specific conservation problems. During the PMC's earlier existence it produced 10,000,000 seedlings for use in windbreaks during the dust bowl era. Today the Elsberry Plant Materials Center is still striving to solve a new realm of conservation problems in an ever changing world.

The Elsberry Plant Materials Center has released over 90 plants during its history. Currently, the Elsberry Plant Materials Center has 86 active releases, 82 of them are native to the Elsberry PMC service area.

COOPERATIVE EFFORTS

The PMC is involved in studies and projects that are shared with other natural resources organizations that include but are not limited to, Universities, USDA-Agriculture Research Service, seed growers, and nurseries. The PMC may provide seed for natural resources research and often technical assistance is provided. Some cooperators have projects that were located at the PMC and, in some cases, PMC labor and resources were provided. The following is a list that captures some of the major cooperative efforts from 2011-2013.

Cooperator	Affiliation	Research Interest
Charlotte Clifford-Rathert	Lincoln University Research and Extension	Brush control with small ruminants
Jim Kiniry	USDA-ARS Temple, TX	Bioenergy
Brian Baldwin	USDA-ARS Mississippi State University	Bioenergy
DoKyoung Lee	University of Illinois Urbana-Champaign	Bioenergy
Seth Dabney	USDA-ARS Oxford, MS	Soil Erosion/RUSLE2

TECHNOLOGY TRANSFER

The Missouri Plant Materials Program provides its customers with information that results from plant materials work in the form of presentations, tours, and published materials. Published materials may include, but are not limited to, newsletters, release brochures, technical notes, planning guides, technical reports, project reports, and progress reports. Most of the technology transfer items occurred in the year that it is reported, but may also include items that have not previously been reported.

2011

Events and Presentations

Conference Room: The PMC conference room is used by federal, state, and local agencies and groups for meetings and training activities. The following groups used the conference room for such activities.

Historic Preservation Society of Elsberry- June 25, 2011
Chestnut Growers Association- June 25, 2011

Events: The following are events that were hosted by the PMC.

Annual PMC Field Day – June 28, 2011.

Presentations: The following presentations were made by PMC staff to facilitate technology transfer and to update interested parties about local, state, regional, and national Plant Materials Program activities.

Face to Face: Presentations that were given to a live audience, often including a slide presentation.

Cordsiemon, R. 2011. History of the PMC. Historic Preservation Society of Elsberry. June 25, 2011.

Webinar: Presentations that were given either live or pre-recorded but were in a web presentation format.

Cordsiemon, R. Extending the Growing Season using high tunnels and hoop houses. November 2, 2011.

Tours: The PMC conducts tours to visitors. The following are groups or people to which a tour was provided.

Cordsiemon, R. 2011. Historic Preservation Society of Elsberry. June 25, 2011.
Cordsiemon, R. and J. Kaiser. Chestnut Growers Association. June 25, 2011.
Cordsiemon, R., J. Kaiser, N. Adams, and A. Casey. 2011 Annual PMC Field Day. June 28, 2011.

Publications

Abstracts: Published in conference proceedings or programs

Cordsiemon, R., R. Stoner, J. Douglas. 2011. Bur Oak Selection for Bottomland Hardwoods. Bottomland Ecosystem Restoration Conference Proceedings.

Fact Sheets: Developed to disseminate relevant information to NRCS field staff, partners, and the general public.

Casey, A., J. Kaiser, and R. Cordsiemon. 2011. Fact Sheet: Planting and Managing Giant Miscanthus (*Miscanthus* x *giganteus*) in Missouri for the Biomass Crop Assistance Program (BCAP). Elsberry, Missouri. September 2011. 2p.

Posters: Presented at various functions

Cordsiemon, R., R. Stoner, D. Wallace, and J. Douglas. 2011. Selection of Bur Oak for Hardwood Restoration. Collinsville, IL. March 7, 2011.

Cordsiemon, R. 2011 Collection, Evaluation, and Selection of Little Bluestem from the Midwest. NAPC-Iowa.

Reports: Annual and technical reports that document activities for a given period of time.

Cordsiemon, R., J. Kaiser, N. Adams. 2011. Year 2010 Progress Report of Activities. Elsberry, MO. January 2011. 4p.

Casey, A., R. Cordsiemon, J. Kaiser, and N. Adams. 2011. Elsberry Plant Materials Center 2010 Annual Technical Report. Elsberry, MO. May 2011. 188p.

Refereed Journal Articles: Refereed articles published in scientific journals.

Kiniry, J., M.V. Johnson, R. Mitchell, K. Vogel, J. Kaiser, S. Bruckerhoff, R. Cordsiemon. 2011. Switchgrass Leaf Area Index and Light Extinction Coefficients. Agronomy Journal. Madison, WI. 103:1. pp. 119-122. 4p.

Kiniry, J., M.V. Johnson, S. Bruckerhoff, J. Kaiser, R. Cordsiemon, D.R. Harmel. 2011. Clash of the Titans: Comparing Productivity Via Radiation Use Efficiency for Two Grass Giants of the Biofuel Field. Journal for Bioenergy Research. Temple, TX. 8p.

2012

Events and Presentations

Events: The following are events that were hosted by the PMC.

Annual PMC Field Day – June 20, 2012.

North American Butterfly Association, Butterfly Count – July 8, 2012

Presentations: The following presentations were made by PMC staff to facilitate technology transfer and to update interested parties about local, state, regional, and national Plant Materials Program activities.

Face to Face: Presentations that were given to a live audience, often including a slide presentation.

Cordsiemon, R. 2012. Presentation of PM Activities. For Iowa PM committee meeting. November 20, 2012. Des Moines, IA

Training Sessions: PMC staff conducts training sessions for NRCS staff, partners, and cooperators about various aspects of the Plant Materials Program and other natural resources topics.

Adams, N., R. Cordsiemon, A. Casey, J. Kaiser. Electric Fence Building. March 6, 2012.

Kaiser, J., R. Cordsiemon, N. Adams, A. Casey. Basic Field Training for New Employees. August 21-23, 2012

Tours: The PMC conducts tours to visitors. The following are groups or people to which a tour was provided.

Cordsiemon, R. J. Kaiser, A. Casey, N. Adams. 2012 Annual PMC Field Day. June 20, 2012

Publications

Abstracts: Published in conference proceedings or programs

Casey, A., C. Clifford-Rathert, M. Schulte, L. Wilbers, C. Cave, J. Caldweel, R. Cordsiemon, J. Kaiser, M. Kennedy, and J. Turner. 2012. The Economic and Ecological Potential for Biological Control Using Small Ruminants of Two Invasive Species of Forest Understory: Amur Honeysuckle and Common Buckthorn. Proceedings of the 65th Annual Meeting of the Society for Range Management. Spokane, WA. 2012. 1p.

Casey, A., C. Clifford-Rathert, M. Schulte, L. Wilbers, C. Cave, J. Caldweel, R. Cordsiemon, J. Kaiser, M. Kennedy, and J. Turner. 2012. Small Ruminant Biological Control of Amur Honeysuckle and Common Buckthorn: Is it a Viable Option? Proceedings for the Missouri Natural Resources Conference. Osage Beach, MO. 2012. 1p.

Posters: Presented at various functions

Casey, A., C. Clifford-Rathert, M. Kennedy, J. Turner, R. Cordsiemon, J. Kaiser, and N. Adams. 2012. The Economic and Ecological Potential for Biological Control Using Small Ruminants of Two Invasive Species of Forest Understory: Amur Honeysuckle and Common Buckthorn. 65th Annual Meeting of the Society for Range Management. Spokane, WA. 2012. 1p.

Casey, A., C. Clifford-Rathert, M. Kennedy, J. Turner, R. Cordsiemon, J. Kaiser, and N. Adams. 2012. Small Ruminant Biological Control of Amur Honeysuckle and Common Buckthorn: Is it a Viable Option? Missouri Natural Resources Conference. Osage Beach, MO. 2012. 1p.

Newsletters: The PMC periodically publishes a newsletter to highlight projects and information that is relevant to NRCS field staff, partners, and cooperators. From time-to-time PMC staff makes contributions to the newsletters of other organizations.

Casey, A., N. Adams, J. Kaiser, S. Choe, and R. Cordsiemon. 2012. Newsletter Volume 13 No. 2. Summer Outreach Edition. Elsberry, Missouri. July 2012.

Plant Guides: Produced to inform NRCS field staff, partners, cooperators, and the public about plant materials and natural resources information.

Casey, A. 2012. Plant Guide for Cereal Rye. Elsberry, MO. May 2012.

Reports: Annual and technical reports that document activities for a given period of time.

Cordsiemon, R., J. Kaiser, A. Casey, N. Adams. 2011. Year 2011 Progress Report of Activities. Elsberry, MO. January 2012. 4p.

Information Brochures and Flyers: Created to disseminate information about plant materials and natural resource concerns.

Elsberry Plant Materials Center. 2012. Cave-in-Rock Switchgrass Release Brochure. Elsberry, MO. 2p.

Elsberry Plant Materials Center. 2012. Iowa Germplasm Horsemint Release Brochure. Elsberry, MO. 2p.

Elsberry Plant Materials Center. 2012. OZ-70 Germplasm Big Bluestem Release Brochure. Elsberry, MO. 2p.

Elsberry Plant Materials Center. 2012. Rumsey Indiangrass Release Brochure. Elsberry, MO. 2p.

2013

Events and Presentations

Conference Room: The PMC conference room is used by federal, state, and local agencies and groups for meetings and training activities. The following groups used the conference room for such activities.

Lincoln University Small Ruminant Research Workshop – March 1, 2013

Events: The following are events that were hosted by the PMC.

Annual PMC Field Day – June 19, 2013.

North American Butterfly Association, Butterfly Count – July 13, 2013

Presentations: The following presentations were made by PMC staff to facilitate technology transfer and to update interested parties about local, state, regional, and national Plant Materials Program activities.

Face to Face: Presentations that were given to a live audience, often including a slide presentation.

Casey, A. 2013. Help for Declining Native Pollinators: Bees, Bats, and Butterflies, Among Others. Presentation for Kansas Audubon Society. Kansas Wesleyan University. Salina, KS. January 17, 2013.

Casey, A. 2013. Effects of Mixed Species Cover Crops on Soil Health. Presentation for Soil and Water Conservation District. Anna, IL. February 12, 2013.

Casey, A. 2013. Pollinators and the Plants that they Use. Presentation for Missouri Native Plant Society and the North American Butterfly Association. St. Louis, MO. March 27, 2013.

Casey, A. 2013. Soil Erosion: Dust Bowl to Today. Presentation for Kansas Native Plant Society. Kansas Wesleyan University. Salina, KS. September 14, 2013.

Casey, A. 2013. Pollinators and the Plants they Use. Presentation for St. Louis Community College's Continuing Education Program and the Master Naturalist's Program. St. Louis Community College. St. Louis, MO. September 17, 2013.

Webinar: Presentations that were given either live or pre-recorded but were in a web presentation format.

Cordsiemon, R. 2013. Plant Materials Activities. Presentation to the Illinois PM Committee. January 24, 2013.

Training Sessions: PMC staff conducts training sessions for NRCS staff, partners, and cooperators about various aspects of the Plant Materials Program and other natural resources topics.

Kaiser, J., R. Cordsiemon, N. Adams, A. Casey. Basic Field Training for New Employees. August 20, 2013

Tours: The PMC conducts tours to visitors. The following are groups or people to which a tour was provided.

Cordsiemon, R., A. Casey, N. Adams. Tour for Clopton, MO Elementary School. May 5, 2013

Cordsiemon, R., J. Kaiser, A. Casey, N. Adams. 2013 Annual PMC Field Day. June 19, 2013

Workshops: Workshops are put on or hosted by the PMC.

Soil Health and Cover Crop Workshop. November 7, 2013. Featuring cover crop demonstration plots at the PMC. Guest speakers: Keith Berns, Dave Robison, Rich Hoorman, Charlie Ellis, Doug Peterson, and Dave Skaer.

Publications

Abstracts: Published in conference proceedings or programs

Casey, A. S. Bruckerhoff, and R. Cordsiemon. 2013. Forage Quality of Selected Grasses in the Lincoln Hills of Missouri. Proceedings of the 66th Annual Meeting of the Society for Range Management. Oklahoma City, OK. 2013. 1p.

Posters: Presented at various functions

Casey, A. S. Bruckerhoff, and R. Cordsiemon. 2013. Forage Quality of Selected Grasses in the Lincoln Hills of Missouri. 66th Annual Meeting of the Society for Range Management. Oklahoma City, OK. 2013. 1p.

Newsletters: The PMC periodically publishes a newsletter to highlight projects and information that is relevant to NRCS field staff, partners, and cooperators. From time-to-time PMC staff makes contributions to the newsletters of other organizations.

Kaiser, J., A. Casey, R. Cordsiemon. 2013. Plants for Conservation Spring Newsletter Volume 14 No. 1. Elsberry, Missouri.

Reports: Annual and technical reports that document activities for a given period of time.

Cordsiemon, R., J. Kaiser, A. Casey, N. Adams. 2011. Year 2012 Progress Report of Activities. Elsberry, MO. January 2013. 5p.

Technical Notes: Created to deliver technical information.

Borders, B. A. Casey, J. Row, R. Wynia, R. King, A. Jacobs, C. Taylor, E. Mader. 2013. Pollinator Plants of the Central United States: Native Milkweeds (*Asclepias* spp.). Portland, OR. June 2013. 12p.

CLIMATIC DATA – CALENDAR YEAR 2011
TEMPERATURE (Fahrenheit)

Month	79 Year Monthly High Average	2011 Monthly High Average	2011 Monthly High Departure	79 Year Monthly Low Average	2011 Monthly Low Average	2011 Monthly Low Departure
January	38.03	34.90	-3.13	18.46	18.42	-0.04
February	43.04	45.32	2.28	22.44	23.07	0.63
March	54.09	57.19	3.10	36.55	36.19	-0.36
April	66.85	71.77	4.91	42.26	46.10	3.84
May	76.45	75.84	-0.61	56.57	54.32	-2.25
June	85.36	86.57	1.20	70.69	65.07	-5.62
July	89.44	93.97	4.52	64.80	72.29	7.49
August	87.56	89.97	2.41	62.81	66.71	3.90
September	80.31	78.63	-1.68	49.83	52.73	2.90
October	69.28	73.45	4.17	43.31	44.29	0.98
November	51.04	59.97	8.93	32.63	38.90	6.27
December	41.98	47.45	5.47	23.01	31.13	8.12
Total 2011	**65.29**	**67.92**	**2.63**	**43.61**	**45.77**	**2.16**

	2011	Typical
Last Killing Frost (26° and below)	3/11/11	4/15/11
First Killing Frost (26° and below)	11/11/11	10/15/11
Number of Frost-Free Days	**246**	**184**

CLIMATIC DATA – CALENDAR YEAR 2011
Precipitation (Inches)

Month	81 Year Average	2011 Total	Departure
January	1.90	1.40	-0.50
February	1.99	3.99	2.00
March	3.15	2.63	-0.52
April	3.62	3.03	-0.59
May	4.13	5.44	1.31
June	3.75	4.72	0.97
July	3.52	1.32	-2.20
August	3.33	2.11	-1.22
September	3.36	3.26	-0.10
October	3.00	1.11	-1.89
November	2.91	4.23	1.32
December	2.40	2.67	0.27
Total 2011	**37.06**	**35.91**	**-1.15**

CLIMATIC DATA – CALENDAR YEAR 2012
TEMPERATURE (Fahrenheit)

Month	80 Year Monthly High Average	2012 Monthly High Average	2012 Monthly High Departure	80 Year Monthly Low Average	2012 Monthly Low Average	2012 Monthly Low Departure
January	38.14	46.35	8.22	18.53	24.58	6.05
February	43.14	50.62	7.48	22.50	27.83	5.32
March	54.31	71.74	17.43	36.67	45.90	9.24
April	66.92	71.83	4.92	42.32	46.60	4.28
May	76.54	83.42	6.88	56.59	57.94	1.35
June	85.41	88.97	3.56	70.56	60.33	-10.23
July	89.55	97.71	8.16	64.87	70.13	5.26
August	87.58	89.39	1.81	62.81	62.42	-0.39
September	80.29	78.43	-1.86	49.90	55.23	5.33
October	69.26	67.77	-1.48	43.31	43.19	-0.12
November	51.13	58.23	7.10	32.62	31.67	-0.95
December	42.08	49.71	7.63	23.08	29.06	5.98
Total 2011	**65.36**	**71.18**	**5.82**	**43.65**	**46.24**	**2.59**

	2012	Typical
Last Killing Frost (26° and below)	3/5/12	4/15/12
First Killing Frost (26° and below)	10/29/12	10/15/12
Number of Frost-Free Days	**239**	**184**

CLIMATIC DATA – CALENDAR YEAR 2012
Precipitation (Inches)

Month	82 Year Average	2012 Total	Departure
January	1.89	1.01	-0.88
February	1.99	2.11	0.12
March	3.14	2.73	-0.41
April	3.67	7.65	3.98
May	4.09	1.04	-3.05
June	3.72	1.52	-2.20
July	3.48	0.60	-2.88
August	3.33	3.03	-0.30
September	3.37	3.88	0.51
October	3.02	4.82	1.80
November	2.89	1.20	-1.69
December	2.40	2.40	0.00
Total 2012	**37.00**	**31.99**	**-5.01**

CLIMATIC DATA – CALENDAR YEAR 2013
TEMPERATURE (Fahrenheit)

Month	81 Year Monthly High Average	2013 Monthly High Average	2013 Monthly High Departure	81 Year Monthly Low Average	2013 Monthly Low Average	2013 Monthly Low Departure
January	38.23	45.32	7.10	18.57	21.71	3.14
February	43.15	44.00	0.85	22.53	24.50	1.97
March	54.25	48.87	-5.38	36.57	28.74	-7.83
April	66.90	66.00	-0.90	42.30	40.93	-1.37
May	76.52	75.00	-1.52	56.54	52.31	-4.22
June	85.41	85.63	0.22	70.46	62.20	-8.26
July	89.52	87.39	-2.13	64.86	63.94	-0.92
August	87.57	86.94	-0.64	62.81	62.97	0.16
September	80.35	85.00	4.65	49.99	56.87	6.88
October	69.27	70.55	1.27	43.30	42.87	-0.43
November	51.17	53.97	2.80	32.58	29.30	-3.28
December	42.08	41.97	-0.11	23.03	18.52	-4.51
Total 2011	**65.37**	**65.89**	**0.52**	**43.63**	**42.07**	**-1.56**

	2013	Typical
Last Killing Frost (26° and below)	4/3/13	4/15/13
First Killing Frost (26° and below)	10/25/13	10/15/13
Number of Frost-Free Days	**206**	**184**

CLIMATIC DATA – CALENDAR YEAR 2013
Precipitation (Inches)

Month	83 Year Average	2013 Total	Departure
January	1.91	3.29	1.38
February	2.00	2.74	0.74
March	3.14	3.18	0.04
April	3.70	6.51	2.81
May	4.15	9.29	5.14
June	3.74	5.08	1.34
July	3.47	2.62	-0.85
August	3.31	1.65	-1.66
September	3.36	2.19	-1.17
October	3.01	2.22	-0.79
November	2.88	1.74	-1.14
December	2.39	1.54	-0.85
Total 2013	**37.06**	**42.05**	**4.99**

STUDIES

Studies are developed by PMC staff and NRCS specialists to address high-priority conservation issues of the nation and the PMC service area. All PMC studies are listed as part of the National Plant Materials Program projects. In the 2011-2013 years, 21 studies were active. Details of these studies can be found on the subsequent pages.

Table 1. Name and status of studies conducted 2011-2013

Study No.	Study Name	Site Location	Status	Start Date	End Date
29I093R	Miscellaneous Herbaceous Plant Evaluation	On	Final	1984	2013
29I097G	Assembly and Evaluation of Big Bluestem (*Andropogon gerardii* Vitman)	On	Active	1987	2015
29I108G	Assembly and Evaluation of Low Growing Rhizomatous Swithgrass (*Panicum virgatum* L.) for Use in Waterways, Filter Strips, and Other Conservation Uses	On	Final	1990	2013
29A116W	Evaluation of Miscellaneous Trees and Shrubs	On	Final	1994	2013
29I124G	Production of Native Iowa Ecotypes of Grasses and Forbs for Roadside, Critical Areas, and All Other Vegetative Plantings Where Native Grasses and Forbs are Now Being Planted	On/Off	Final	1990	2013
29A137O	Wetland/Riparian Propogation, Establishment, and Demonstration	On	Final	1994	2013
29I141G	Assembly and Evaluation of Little Bluestem (*Schizachyrium scoparium* Nichx.)	On	Active	1996	2015
29I142G	Production of Native Missouri Ecotypes of Grasses, Legumes and Forbs for Roadsides, Critical Areas, and All Other Vegetative Plantings Where Native Plants are Now Being Planted	On	Final	1997	2013
MOPMC-P-0001	Assembly, Evaluation and Selection of Bur Oak (*Quercus macrocarpa* Michx.)	On	Active	2000	2020
MOPMC-T0106	Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips	On	Final	2001	2013
MOPMC-P-0613	Evaluation and Release of a Shade Tolerant Big Bluestem, *Andropogon gerardii* L., for Silvopasture	Off	Final	2005	2013
MOPMC-T-0716	In-Field Weathering Effects on Biomass Yield and Biofuel Quality of Warm Season Grasses	On	Final	2007	2013
MOPMC-P-0717	Evaluation and Release of a Shade Tolerant Little Bluestem for Silvopasture	Off	Final	2007	2013
MOPMC-T-0718	Evaluation of the Flood Tolerance of Planted Oak Seedlings Derived from Different Seed Origins	On	Final	2007	2013

MOPMC-P-0820	Evaluation and Release of Native Plants for Urban Landscaping	On	Final	2008	2013
MOPMC-P-0821	Evaluation and Release of an Iowa Source, stiff stemmed Indiangrass, Sorghastrum nutans, for Biofuel	On	Final	2008	2013
MOPMC-P-0822	Inter Center Strain Trial – Yield and Persistence of 11 Big Bluestem Sources in Kansas, Missouri, Arkansas, and Mississippi	On	Final	2008	2013
MOPMC-T-1124	Using Biological Approach (Sheep/Goats) to Control Invasive Species with Emphasis on Bush Honeysuckle, *Lonicera maackii*, and Buckthorn, *Rhamnus cathartica*	On	Active	2009	2017
MOPMC-T-1126	Collection of Plant Attributes from Plantings of Giant Miscanthus for RUSLE2	On	Active	2009	2014
MOPMC-T-1127	Termination Timing of Selected Cover Crops Using a Roller Crimper	On	Final	2010	2013
MOPMC-T-1228	Effect of Mixed Species Cover Crops on Soil Health - National Study	On	Active	2012	2018
MOPMS-T-1125	Cool and Warm Season Cover Crop Evaluation	On	Final	2011	2013

Miscellaneous Herbaceous Plant Evaluation

Study No. 29I093

National Project(s): Critical Area 1.1; Cropland 2.1, 3.1, and 4.1; Natural Areas 1.1; Pasture/Hayland 1.1 and 2.1; Rangeland 1.1; Water Quality 2.1, 3.1, and 4.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Plants arrive at the Plant Materials Center (PMC) from many sources and for many different purposes. Most of the plants are assigned to a specific study. Plants are also received that are not tied to a specific study. These can be from other PMC's for area of adaptation or plants in advanced stages of evaluation. Plants are received from individuals who are interested in an unfamiliar species or a plant with unusual characteristics. Some species existing on the center are not involved with an active study addressing a specific problem.

Objective: Evaluate winter hardiness, insect and disease resistance, and vigor of plants for climatic adaptation. Plants brought in for other specific reasons like forage production, landscape beautification, shoreline stabilization, etc., will be evaluated accordingly.

Procedure: As miscellaneous plants are received at the center, they are assigned an accession number and as much background information as available or necessary are documented. The accession is then assigned a location for planting that best suits its needs for evaluation. Plants are evaluated as necessary. Many plants are left for plant identification sessions or demonstrations for several years.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

1984-1990
This study was initiated in April 1984 in the PMC pipeline area. There are approximately 150 different accessions of the following species of plants: Indiangrass, switchgrass, big bluestem, purpletop, little bluestem, buffalograss, wheatgrass, fescue, timothy, ryegrass, redtop, orchardgrass, kura clover, blackeyed susan, and lespedeza. Factors involved in evaluations dealt with area of adaptation.

1991-1994
Approximately 75 accessions were added during 1991. Forty of them were warm season grasses used in three FEP (Field Evaluation Planting) variety studies: 29A111G, 29A118G, and 29A127G. Twenty-six were accessions of common cool season grasses and legumes used for pasture and hay in the three-state area. These were commonly used for plant identification sessions.

1995-1998
The accessions added in 1997 are being looked at for forage. They include 'Steadfast' birdsfoot trefoil, 'Mandan' Canada wildrye, and several bermudagrasses including Hardy and OK-74-12-6. Also zoysia grass, centipedegrass, and buffalograss from the Fort Leonard Wood Wear Tolerance Study are being looked at for adaptation. Several big bluestem accessions from Study 29I097G are being evaluated as landscape plants.

1999
The accessions added in 1999 are a Lincoln County Missouri collection of Virginia wildrye and a Crawford County Missouri collection of Virginia wildrye variation geneses. These species are being looked at for shade tolerance for riparian areas and covercrop for tree plantings.

2000
No new accessions were added in 2000. Two species that are getting the most interest are the Lincoln County accessions of Virginia wildrye and 'Tufcote' bermudagrass.

The Lincoln County accession of Virginia wildrye is a shade tolerant cool season grass that has potential for a cover crop for woody plantings as well as a possible buffer species along riparian areas. This accession should be in commercial production and available soon.

The 'Tufcote' bermudagrass accession was tested at Fort Leonard Wood for wear tolerance and showed very good potential. It could be used on playgrounds, sports fields, lawns, as well as having potential for high livestock use areas. This species is not native and does show potential for spreading so it should not be planted in areas where it could escape and cause problems.

2001
Three new species of native legumes were added in 2001. Native legumes are seldom used in mixtures with warm season grasses planted for pastures primarily because of their cost, lack of availability, and lack of knowledge on which ones will perform best in a mixture.

The following species were planted for observational evaluation: goats rue, *Tephrosia virginiona;* sensitive brier, *Schrankin uncinata;* and Sampson's snakeroot, *Orbexilium peduncolatum*.

The Lincoln County Missouri collection of Virginia wildrye, accession 9083169, has shown excellent vigor and seed production. Forage quality is comparable to tall fescue, spring green-up earlier than tall fescue and seedhead emergence is approximately two weeks later than tall fescue. This accession is scheduled for release in 2002.

2002
One new collection was planted in the miscellaneous block. Accession 9083240, western wheatgrass, *Pascopyrum smithii*, was planted as greenhouse plugs May 10, 2002. This material was collected in Audrain County, Missouri.

The Lincoln County Missouri collection of Virginia wildrye, accession 9083169, was released as a selected class and given the name Cuivre River. The Cuivre River selection has early vigorous growth that is earlier than tall fescue. Booting occurred at the end of May to the first week of June at Elsberry. This is approximately two weeks later than tall fescue.

Although Cuivre River was released as a selection and only limited testing has been done, its anticipated uses are wildlife food/cover, plant diversity in wetland and riparian plantings, covercrop for woody plantings, erosion control, and forage.

Cuivre River has not been tested for grazing but forage clippings were taken at different stages of growth and compared to tall fescue clippings from adjacent plots. Forage quality of the Cuivre River selection compared favorably to tall fescue as indicated by data below.

Clipping Date	Percent Protein		Percent ADF		Percent NDF	
	TF	VWR	TF	VWR	TF	VWR
4/24/02		27		26		47
5/30/01	9	12	40	34	61	60
10/11/01	15	15	31	34	52	55
11/15/01	20	17	22	24	37	44

TF = tall fescue; VWR = Cuivre River Virginia wildrye; ADF = acid detergent fiber; NDF = neutral detergent fiber.

2003
One new accession was added during 2003 and this was the medium height, forage type switchgrass that was selected and isolated from the low growing switchgrass assembly.

2004
Three accessions of cluster fescue, *Festuca paradoxa*, were added during 2004. The plants were germinated in the greenhouse from seed and transplanted April 7, 2004, to the initial evaluation area, tier F/a. The accessions established well and had excellent survival the first year. The plants will be evaluated on percent stand, vigor, height, and seed production next year. See collection information below.

Genus	Species	Common Name	Accession No.	**Origin**
Festuca	paradoxa	Cluster fescue	9083254	Tucker Prairie, MO
Festuca	paradoxa	Cluster fescue	9083255	Paintbrush Prairie, MO
Festuca	paradoxa	Cluster fescue	9083252	Harrison Co, MO

2005
No new accessions were added in 2005. The *Festuca paradoxa* was evaluated along with the other species in the forage quality study. The plants became very dormant by early summer and did not recover but made significant regrowth in the fall.

2006/2008
New accessions planted are as follows;

Observational Nursery

Genus	Species	Common Name	Accn No.	From	Date Pltd
Desmodium	glabellum	Dillenius Tick Trefoil	9055415	MIPMC	5/5/06
Desmodium	glabellum	Dillenius Tick Trefoil	9005087	MIPMC	5/5/06
Desmodium	paniculatum	Panicledleaf Tick Trefoil	9055428	MIPMC	5/5/06
Calamovilfa	longifolia	Prairie Sandreed	9086408	MIPMC	5/5/06
Elymus	riparius	Riverbank Wildrye	9086450	MIPMC	5/5/06
Elymus	canadensis	Icy Blue Canada Wildrye	9084347	MIPMC	5/5/06
Salix	sericea	Riverbend Silky Willow		MIPMC	6/15/06
Paspalum	floridam	Harrison Florida Paspalum	9043874	ETPMC	4/15/06
Bouteloua	gracilis	Blue grama	421782	KSPMC	4/20/07

2009
No new species were planted during 2009.

2010
There were no new plantings of any species' added to this study. A total overhaul of these plots are needed to effective evaluate the survivability and vigor of each individual species. Many of the species have been sent from other PMC's to evaluate the "area of adaptation". Evaluations of each species' within this study will be taken late 2011.

2011
No new plantings were made in 2011. Desmodiums from the Michigan PMC were evaluated at seed maturity. Alcona, Marion, and Grant all measured between 30-32" in height, while Marion produced a substantial seed crop. Prairie Sandreed from the Michigan PMC was persistent even with extreme weed competition measuring over 8 feet in height and producing seed. Ice Blue Canada Wild Rye and Elymus riparius both from MIPMC were evaluated for survivability. The Ice Blue Wild Rye survived well, while the E. riparius died out, presumably due to weed competition.

2012-13
The plantings in the pipeline area were maintained, but no new evaluations were taken.

This study is discontinued and no other data or conclusions will be presented.

Assembly and Evaluation of Big Bluestem, *Andropogon gerardii* Vitman.

Study No. 29I097G

National Project(s): Critical Area 1.1; Cropland 2.1, 3.1, and 4.1; Natural Areas 1.1; Pasture/Hayland 1.1 and 2.1; Rangeland 1.1; Water Quality 2.1, 3.1, and 4.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Big bluestem is a tall, warm-season, perennial, native grass with stiff, erect culms; flattened and keeled sheaths; membranous ligules; and flat or folded leaf blades. Big bluestem has developed a very efficient spreading root system that may reach depths of 5-8 feet (150-200 cm). Big bluestem reaches a mature height of 3-4 feet (90-120 cm) in northern latitudes, and 6-8 feet (180-240 cm) or more in the southern part of its natural range. Although short rhizomes may be present, it usually makes a bunch type growth. Big bluestem is composed of many ecotypes with a wide range of adaptation to soil and climate. Big bluestem is one of the most widespread and important forage grasses of the North American tallgrass prairie region. It is usually associated with one or more of the other three dominant species, Indiangrass (Sorghastrum nutans (L) Nash.), switchgrass (Panicum virgatum L.), and little bluestem (Schizachyrium scoparium (Michx.) Nash.). Big bluestem occurs on subirrigated lowlands, nearly level to gently undulating glacial till plains, overflow sites, level swales and depressions, residual and glacial uplands, and stream terraces and bottomlands along rivers and tributaries. The abundant, leafy forage is palatable to all classes of livestock.

Objective: The objective is to assemble, evaluate, develop and cooperatively release an adapted variety and/or varieties of big bluestem for conservation use in the following Major Land Resource Areas: 116A, 116B, 117, 118, and 119.

Procedure: The assembly consists of vegetative materials from adapted ecotypes throughout Northwestern Arkansas and Southwestern Missouri Major Land Resource Areas: 116A, 116B, 117, 118, and 119. Collection dates were between November 9 and 13, 1987. Four collection sites per county within the geographic area of collection were made. The number of sites was determined by the size of the county. The study plan supplement lists the states and the number of sites per county.

Four collections per county in the targeted Major Land Resource Areas were requested. The intent was to get a broad genetic base of plant material; therefore, the site selection attempt was to get as diverse sampling as practical when selecting superior big bluestem plants in the field. If a county had more than one Major Land Resource Area, collections were made in each area. Collections were from typical locations, which included natural grasslands (range), relic areas, and road right-of-ways. Avoided areas were those that may have been artificially seeded. Where possible, collections came from diverse soil textural types, such as sandy and silty; or range site groupings such as: (1) Run-in sites represented by overflow, or subirrigated; (2) normal upland sites represented by sandy, silty or clayey. Six subsamples (6" x 6" x 8" deep) were collected vegetatively at each site.

The samples were transported in material provided by the Plant Materials Center that included cartons, plastic bags, accession data sheets, and instructions for handling. Plant Materials Center personnel picked up the cartons containing the samples at designated central locations within each administrative area in November 1987. Transplanting procedures included temporary storage and handling. The samples were first assigned accession numbers and placed in temporary storage. On February 15, 1988, each subsample was transplanted into separate containers and maintained under controlled greenhouse conditions. The plants were then divided between two locations, Elsberry, Missouri and Booneville, Arkansas Plant Materials Centers, and established in space plant initial evaluation nurseries.

Potential Products: Information Technology, Cultivar Release, FOTG Standards

Progress or Status:

1987-1989
A total of 370 accessions (collections) of big bluestem were initially collected during November, 1987, from the targeted areas: 194-Missouri; 85-Arkansas; 82-Oklahoma; and 8-Illinois. Individual plantlets were separated, transplanted into cone-tainers, and grown out in Forrest Keeling Nursery's greenhouse from February until May 1998. More than 4400 individual plantlets were transplanted into a space plant nursery with two replications and six plants per replication. The nursery is located in Field #14 at the PMC and was planted June 1988. The entire nursery was irrigated three times weekly in 1988 to insure good survival. Data collected in 1988 was mostly survival. Data collected in 1989 included survival, vigor, disease resistance, plant size, foliage size, and abundance and visual seed production. Accessions from each state were selected from the above criteria. The numbers selected from each state were as follows: Arkansas-14, Missouri-46, and Oklahoma-13. Table #1 shows the 73 accessions selected from the initial space plant nursery located in Field #14 on the PMC. These plants were vegetatively removed from the initial evaluation nursery in November 1989.

1990-1991
The plants selected in 1989 were transplanted into cone-tainers and grown out in the greenhouse that winter. These plants were planted in an isolated crossing block in Field #1 on May 23, 1990. Fifteen bulk pounds of clean seed were harvested in 1991.

1992-1993
The seed harvested in 1991 was sorted by weight and grown in cone-tainers in the greenhouse from January until April. Approximately 500 plants were planted in Field #7 in April and May 1992 for further evaluation.

Beginning in July 1993, the Mississippi River began flooding approximately 86 acres on the PMC. The area where this planting was located was completely inundated with approximately eight feet of water. Just prior to the flooding of this site (July 8, 1993), the PMC staff uprooted 62 selections of big bluestem and re-established them to an upland site on the PMC (Field #8).

1994-1996
The nursery block established in Field #8 in July 1993 was evaluated for forage quality and quantity, seed production, plant maturity differences, and disease and insect resistance. Twenty-eight of the 62 plants were selected and allowed to cross. Seed from this crossing block is a composite of the original 73 accessions collected and is the breeders' block for the new accession 9078831. Seed was harvested in 1995 and 1996 and a seed increase plot will be established in 1997. The Booneville PMC also has made their selection and both will be included in the advanced evaluation.

1997-1998
The diversity in the original nursery block containing all 370 accessions is tremendous. There is a lot of variation within this species. The need for plant diversity for prairie restoration led to the release of the source-identified composite of all 370 accessions. This composite was given the accession number 9062323 and given the name OH-370 which stands for a composite of 370 collections made from the Ozark Highlands of Southern Missouri, Northern Arkansas, Eastern Oklahoma, and Southern Illinois. This plant was released in April 1997.

A 0.4-acre increase planting of 9078832 was planted May 22, 1997, in Field # 6. This planting was established in a conventional seedbed in 36" rows. The first year the planting produced 10 pounds bulk clean seed and in 1998 it produced 27 pounds bulk clean seed. The 1998 seed tested poorly but it is not known why. When seed becomes available from the Arkansas PMC the study will begin an advanced evaluation to compare the new accession, 9078831 with available

varieties and also the accession Booneville has selected out of the original assembly of 370 collections.

The original planting was again evaluated the spring of 1997 looking for a tall, stiff stemmed, upright plant to use in wind barriers. Wind erosion is a problem in the flat and sandy crop fields in the boot-heel area of Missouri. Switchgrass wind barriers are being tried in areas where field windbreaks using trees are not acceptable. Big bluestem was requested by the Missouri plant materials committee as an additional species to go along with switchgrass since the nursery is still intact. Five accessions (Table #2) were selected and increased vegetatively in the greenhouse and transplanted into an isolation block in Field #4. This block contained 126 plants and of those, 34 plants were selected to represent the crossing block that will serve as the breeders' block for a wind barrier selection. The final accessions represented in this block are 9056960, 9056913, and 9056914. Selections were also made for landscape and beautification (Table # 3). These selections were transplanted into the rod row initial evaluation area for further evaluation.

1999
The increase plot of 9078831 was expanded in 1999 but did not develop as the 1997 original increase plot did. This accession is scheduled for release as a pre-varietal selection in 2000 if enough seed is available and field plantings are successful.

The wind barrier selection block was again evaluated in 1999 and narrowed down to a single accession, 9056960 (Table #2).

No additional selections were made for landscape plants in 1999 (Table #3).

2000
The increase plot of 9078831 was again expanded in 2000 but again was very slow to germinate. Seed was sent for testing and the sample contained a high percentage of dormant seed. This pre-varietal selection was scheduled to be released in 2000 and given the name OZ-70 that stands for Ozark Highland composite of 70 collections. The release has been delayed until a solution can be found for its high seed dormancy.

Seed was harvested from the wind barrier block and an increase planting will be made in 2001.

2001
The increase plot of 9078831 (OZ-70) was again expanded in 2001 but this year it was planted the first week of March to allow for stratification. Seed harvested in 2000 was used in the planting because seed less than one year old appears to have more dormancy than seed that has had time in storage. The portion of the plot that was planted in 2001 established well and even produced a small amount of seed the first year.

Seed harvested from the wind barrier accession was propagated in the greenhouse and transplanted into an evaluation nursery. The evaluation nursery has approximately 250 plants on a three-foot grid. These plants will be evaluated for two additional years for height, biomass production and lodging. This plant will be released as a tall, stiff stemmed selection.

2002
Field testing has shown possible problems with establishment of OZ-70 big bluestem. A trial was started using replicated plots to compare the establishment of OZ-70 with 'Rountree' big bluestem. First year data indicates that Rountree establishes quicker with higher stand density than OZ-70. It also indicated that the winter dormant plots (planted March 14, 2002) of OZ-70 were better than the spring planted plots (planted June 21, 2002). This was reversed with the Rountree. This information supports the high seed dormancy problem indicated in seed tests.

These plots will be monitored one more year to see if the slow establishment has to do with the long-term density of the plots.

A comparison between new seed and one-year-old seed is planned for 2003. Seed tests indicate a problem with seed dormancy in new seed. Storage for one year could help rectify this problem.

2003
A trial comparing new (previous year's harvest) and older seed (one to five years old) was conducted in 2003. Establishment was quicker if new seed was winter dormant planted. This supports that newly harvested seed has higher seed dormancy but all lots of seed developed into successful stands the establishment year.

The technical review committee recommended proceeding with a Selected Release for this accession and OZ-70 Germplasm Big Bluestem was released December 2003.

Release Documentation

The OZ-70 selection has very good forage production and vigor that appears to be comparable or better than Rountree. OZ-70 is approximately two weeks later in booting than Rountree and forage quality is better when tested at Elsberry (see below). Rountree exhibits considerable more rust when compared to OZ-70 in Southern Missouri. OZ-70 also has very good seed production with a 2003 yield of 280 bulk pounds of clean seed per acre.

Forage clippings of OZ-70 Germplasm were compared with Rountree. These samples were replicated and taken at different stages of growth. Forage quality of the OZ-70 selection compared favorably to Rountree as indicated by following data.

Clipping Date	Percent Protein		Percent ADF		Percent NDF	
	OZ-70	Rountree	OZ-70	Rountree	OZ-70	Rountree
6/19/02	14.3	8	30.9	35.7	55.8	60.8
7/8/02	8.2	5.8	34.1	33.0	59.3	60.5
8/30/02*	11.4	11.9	34.3	34.7	54.6	56.6

*Regrowth material from 7/8/02 clipping.
ADF=acid detergent fiber; NDF=neutral detergent fiber.

OZ-70 Germplasm big bluestem was compared to 'Rountree' big bluestem for establishment and Rountree was quicker to establish indicating better seedling vigor when new (previous year's harvest) seed was planted. A seeding trial was conducted in 2003 and compared seed harvested in 2002, 2001, and a mixture of seed harvested in 1997 through 2000.

The results below indicate some seed dormancy in new crop seed but all plots developed very good to excellent stands and had seed head production the first year.

	Stems Per Row Foot	Percent Cover
Winter dormant planting, 2002 seed	16	92
Winter dormant planting, 2001 seed	14	78
Winter dormant planting, 97-00 seed	8	65
Spring planting 2002 seed	10	60
Spring planting 2001 seed	14	87

	Stems Per Row Foot	Percent Cover
Spring planting 97-00 seed	10	75

2004
The tall, erect, lodging resistant big bluestem currently being evaluated as a wind barrier selection, (accession 9083274) was increased for advanced testing. Seed was harvested in 2003 from the remaining plants in the final evaluation block. The increase block established well but no seed was harvested in 2004. Limited seed production is anticipated for 2005 and available for advanced testing in 2006.

Shorter growing collections were also isolated and evaluated. Six collections were narrowed to three (accessions 9056902, 9056905, and 9056906) and allowed to cross. This composite (accession 9078832) was harvested in 2003 and used to establish an increase block in 2004. Seed production is anticipated for 2005 and available for advanced testing in 2006. This selection will be evaluated for use in vegetative buffers and filters.

2005
The two increase blocks of big bluestem that were established in 2004 (tall, lodging resistant, - accession number 9083274 and shorter growing, - accession 9078832) both produced seed in 2005. These blocks were planted April 28, 2004. Accession 9083274 produced 65.7 bulk pounds on 0.183 acre for a yield of 359 bulk pounds per acre. Accession 9078832 produced 144.9 bulk pounds on 0.51 acre for a yield of 287 bulk pounds per acre.

2006
The two increase blocks of big bluestem planted April 28, 2004 were again managed for seed production. Neither plot was enlarged.

The tall, lodging resistant accession, 9083274, yielded 59.1 bulk pounds on 0.183 acre for a yield of 323 bulk pounds per acre. The year was very dry during parts of the growing season. Seed quality was poor resulting in a very poor percent PLS.

The shorter growing accession, 9078832, yielded 193.2 bulk pounds on 0.51 acre for a yield of 379 bulk pounds per acre. Again seed quality was not very good resulting in a poor percent PLS.

The shorter growing accession (9078832) also is very resistant to lodging and these characteristics look good for this accession's use in conservation programs. With adequate seed on hand for field plantings and grower interest, this accession was released as a selected class release in 2006 as Refuge Germplasm (see 2006 releases section for release notice).

2007
The tall, lodging resistant accession (9083274) increase plot yielded 50.3 bulk pounds on 0.183 acre. The plot was also expanded by a few rows but was slow to establish. Seed from the breeder's block was limited and possibly of poor quality due to a very dry summer. Seed harvested in 2005 from the increase plot was used in the biofuels study plots (MOPMC-T-0716).

The increase field of Refuge Germplasm big bluestem (9078832) has begun showing different heights that indicate contamination of the breeder plot. It was decided to move and isolate the breeder's block and reestablish a new foundation field.

2008
The increase plot of the tall, lodging resistant accession (9083274) of big bluestem was flooded for an extended period of time in 2008 and was destroyed. A new breeders block was establish vegetatively and a new increase field is planned for 2010.

The increase plot of Refuge Germplasm big bluestem (9078832) was also destroyed in 2008.

2009
The new breeders block of the tall, lodging resistant accession (9083274) of big bluestem established in 2008 did very well in 2009. Approximately 5% of the 400 plants in the block were rouged before seed development due to lack of desired characteristics. Five pounds of bulk seed was harvested and used to reestablish an increase field. This accession is currently being evaluated in a biofuels study and also an inter center strain trial for big bluestem.

2010
A foundation plot of accession 9083274 was established in field 7A. The plot was harvested in the fall, though the tall stature that this accession was selected for was not evident. This plot will be looked at again in 2011 in order to evaluate this selection for its tall stature and whether or not this characteristic will breed true to the progeny. A possible reason for the 2010 plot not maintaining the tall height (9+ ft.) might be because the planting was seeded in late spring. Seed from this plot will be offered for field testing trials in 2011.

2011
The foundation planting of accession 9083274 in field 7 established very well. The 9 foot height that was observed in the evaluation blocks was not observed in the new planting, but average plant heights did exceed 8 feet. Competition among other plants within the rows competing for the same nutrients or the tighter bottom soils could have played a major factor in the shorter plants. Field trials of 9083274 will be offered in 2012 to gather side by side comparison data.

The increase plot of Refuge Germplasm big bluestem (9078832) is scheduled for 2013 and is based on available seed to establish a new SG1 production field.

2012
Accession number 9083274 has changed to 9083359 due to a selection prior to SG0 block being established on the Forrest Keeling Nursery property. SG0 and SG1 seed has been harvested and field plantings again will be offered to the field. If field tests show that 9083359 can maintain the tall stature and lodge resistance against other varieties of big bluestem, then accession 9083359 could be available for release as early as 2015.

SG0 seed of Refuge Germplasm was collected in very limited quantities, less than a 0.10 of a pound of seed was harvested. Seed harvested in 2012 will be used to start a SG1 seed production field, scheduled to be planted in the spring 2013. This field will be used to supply growers with seed for commercial production.

2013
Several field plantings of accession 9083359 were implemented in Iowa, Illinois, and Missouri this year. Performance from these collections will be collected in 2014 and 2015. The SG1 plot in field #7 was not harvested this year due to short staff and the 15-day “government shutdown” that occurred during the prime harvest period. Seed had shattered by the time staff was able to harvest the plot.

Refuge Germplasm SG0 seed was again harvested in 2013 from the plot at the Stewart Farm (leased). There were 3.0 pounds of seed harvested from the SG0 plot and will be used to establish a SG1 plot to produce seed that can be allocated to commercial growers.

Study 29I097G - Assembly and Evaluation of Big Bluestem, *Andropogon gerardii*, Vitman. **Table #1**

Accessions Selected for Crossing Block

Collector	State	County	Accession Number	MLRA	Soil
Levonna S. Vekman	Arkansas	Faulkner	9056956	118	Leadville
Mark L. Kennedy	Arkansas	Fulton	9056968	116A	Geesville
Luther O. Shaw	Arkansas	Izard	9056920	116A	Mako
NRCS-Field Office	Arkansas	Logan	9056964	118	Taff
NRCS-Field Office	Arkansas	Madison	9056962	118	Leadvale
Stephen T. Ford	Arkansas	Madison	9056945	117	Nixa-SL
John Y. Harrington	Arkansas	Madison	9056923	116A	Estate-SC
John Y. Harrington	Arkansas	Madison	9056952	116A	Estate-SC
Lane L. Gentry	Arkansas	Perry	9056922	119	Clebit
John D. Kopf	Arkansas	Scott	9056936	119	Carnasaw
Jeremy R. Funk	Arkansas	Sharp	9056914	116A	Gepp
NRCS-Field Office	Arkansas	White	9057058	118, 134	
NRCS-Field Office	Arkansas	White	9057060	118,134	
Robert S. Garner	Arkansas	Yell	9056908	119,118	Clebit-FSL
H. Dan Philbrick	Missouri	Barry	9056832	116B	
Dudley W. Kaiser	Missouri	Benton	9056840	116B	Bardley
NRCS-Field Office	Missouri	Camden	9056724	116A	Gatewood
William K. Quage	Missouri	Cedar	9056800	116B	Hector
Patricia A. Beneke	Missouri	Cole	9056821	115	Goutewood
Patricia A. Beneke	Missouri	Cole	9056806	115	Gatewood
Melodie Marshall	Missouri	Crawford	9056820	116B	
Melodie Marshall	Missouri	Crawford	9056886	116B	
Melodie Marshall	Missouri	Crawford	9056767	116B, 116A	Lebanon
Myron C. Hartzell	Missouri	Dent	9056773	116B	Coulstone
Myron C. Hartzell	Missouri	Dent	9056763	116B	Lebanon
John L. Lumb	Missouri	Douglas	9056833	116B	Doniphan
Art Kitchen	Missouri	Franklin	9056855	115	Crider
Art Kitchen	Missouri	Franklin	9065771	115	Union
NRCS-Field Office	Missouri	Gasconade	9056848	116B	Gladden
Clayton P. Robertson	Missouri	Gasconade	9056875	116B	
H. Lane Thurman	Missouri	Greene	9056716	116B	Chirty Silt Loam
NRCS-Field Office	Missouri	Hickory	9056839	116A	
Stanley Lamb	Missouri	Iron	9056774	116A	Midco
Howard Combes	Missouri	Howell	9056753	116A	Doniphan
Joe H. Everett	Missouri	Jefferson	9056842	115	GL
NRCS-Field Office	Missouri	LaClede	9056741	116A	Cherty Silt Loam
Kees VanderMer	Missouri	LaClede	9056791	116A	Union
Cecile Allen	Missouri	Lawrence	9056709	116B	Viraton
Ron R. McMurtrey	Missouri	McDonald	9056719	116A	
Larry E. Lewis	Missouri	Miller	9056732	116B	SIL
Larry E. Lewis	Missouri	Miller	9056868	116B	SIL
Henry E. Knipker	Missouri	Moniteau	9056890	116B	Glensted
Mary Beth Roth	Missouri	Morgan	9056831	116B	

Collector	State	County	Accession Number	MLRA	Soil
Mary Beth Roth	Missouri	Morgan	9056837	116B	
Stephen E. Robbins	Missouri	Organ	9056770	116A	
William R. Dilbeck	Missouri	Polk	9056828	116B	
NRCS-Field Office	Missouri	Pulaski	9056746	116A	Wilderness
Clarence Wagy	Missouri	Reynolds	9056701	116A	
Charles E. Johnson	Missouri	Ripley	9056895	116A	
Charles E. Johnson	Missouri	Ripley	9056894	116A	
Steve Wall	Missouri	Shannon	9056762	116A	
Claude A. Peifer	Missouri	Ste. Genevieve	9056819	116B	Bloomsdale
Edward L. Templeton	Missouri	St. Francois	9056845	116A	Crider
Carl Wehrman and Dude Davidson	Missouri	Taney	9056712	116A	Clarksville
Jeff A. Lamb	Missouri	Texas	9056728	116A	Goss
NRCS-Field Office	Missouri	Wayne	9056854	116A	
Patrick L. Adams	Missouri	Washington	9056817	116A	Silty Clay Loam
Patrick L. Adams	Missouri	Washington	9056870	116A	Silty Clay Loam
John N. Emerson	Missouri	Webster	9056737	116B	
Dan D. Divine	Missouri	Wright	9056733	116B	
Andrew R. Inman	Oklahoma	Adair	9056996	117	Hector Complex
Billy D. Dudley	Oklahoma	Cherokee	9057010	116A, 117	Newtonia
Billy D. Dudley	Oklahoma	Cherokee	9057016	116A, 117	Talpa-Rock
Kenneth W. Swift	Oklahoma	Choctaw	9057025	112	Muskogee SL
Warren R. Sanders	Oklahoma	Coal	9057005	119	Boham
Steve D. Clark	Oklahoma	Latimer	9057014	118, 119	Stigler SL
Robert E. Blackman	Oklahoma	Mayes	9056995	112, 116A	Hector
Sam L. Viles	Oklahoma	McIntosh	9057035	118	Karma SL
Patrick I. Bogart	Oklahoma	Okmulgee	9057032	112, 118	Taloka SL
Patrick I. Bogart	Oklahoma	Okmulgee	9057037	112, 118	Taloka SL
NRCS-Field Office	Oklahoma	Ottawa	9057030	116A, 112	ETA-SL
William R. Bin	Oklahoma	Pushmatoho	9957052	119	Bosville
William R. Bin	Oklahoma	Pushmatoho	9057046	119	Bernow FSL

Wind Barrier Selection Isolation Block **Table #2**

Collector	State	County	Accession Number	MLRA	Soil
	Arkansas	Logan	9056960	118	Laedvale

Study 29I097G – Assembly and Evaluation of Big Bluestem, *Andropogon gerardii*, Vitman.

Landscape Selection Rod Row Area **Table #3**

Collector	State	County	Accession Number	MLRA	Soil
Clarence Wagy	Missouri	Carter	9056703	N116A	Opequon
Clarence Wagy	Missouri	Reynolds	9056708	N116A	Clarksville
Myron Hartzell	Missouri	Dent	9056812	116A	Elsah
Kenneth W. Swift	Oklahoma	Latimer	9057025	119	Freestone Variant - Bernow Variant Complex
	Oklahoma	McCurtain	9057049	1336	Kinta Clay Loam
Dennis W. Shirk	Missouri	Maries	9056877	116A	Lebanon
Larry B. Cash	Arkansas	Carroll	9056934	116A	Nixa

Assembly and Evaluation of Low Growing, Rhizomatous Switchgrass, *Panicum virgatum* L. for Use in Waterways, Filter Strips and Other Conservation Uses

Study No. 29I108G

National Project(s): Cropland 2.1 and 4.1; Water Quality 3.1 and 4.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Switchgrass is a warm-season, perennial, native grass. Plants are usually green or glaucous, with numerous scaly creeping rhizomes. Culms are erect, tough and hard, one to two meters rarely to three meters tall; sheaths glabrous; blades 10-60 centimeters long, three to 15 millimeters wide, flat glabrous, or sometimes pilose above or near the base, rarely pilose all over; panicle 15-50 centimeters long; acuminate; first glume clasping, two-thirds to three-fourths as long as the spikelet. Switchgrass frequents a wide variety of habitat, usually sunny including dry or moist prairies, moist seepage of rocky glades and buff escarpments, gravel bars of streams, open woods and along railroad tracks.

Objective: The objective is to assemble, select, and develop a dense low growing strongly rhizomatous switchgrass, with good seedling vigor and seed characteristics, for use in waterways and stream bank corridors.

Procedure: The assembly consists of the collection of vegetative material from adapted ecotypes in Iowa, Illinois, and Missouri. The targeted collection area includes the following Major Land Resource Areas: 102b, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 131, and 134. Five collections from each NRCS administrative area were requested.

Vegetative collections were taken from natural prairie stands, prairie remnants or individual short growing plants growing in areas that are seasonally wet like a waterway. Total height of the plant was to be no more than three feet.

The samples were collected when the plant was dormant in the fall, divided into plantlets in the winter and placed into square open bottom containers and grown out in the greenhouse. Twelve plants per collection were grown out in the greenhouse.

The plants were planted into a randomized complete block with three replications. Each plot had three plants and all plants were planted on four-foot spacing. A border row was planted around the three replications. This study was planted into a clean tilled seedbed with recommended fertility and weed control. Plants were evaluated for survival, vigor, height, and spread that included rhizomatous characteristics, disease and insect resistance, lodging, and seed production.

Potential Products: Information Technology, cultivar release, FOTG standards

Progress or Status:

1990-1991
The collections of *Panicum virgatum* L., low growing highly rhizomatous switchgrass was initiated in November 1990 and extended through 1991. One hundred eighteen collections were obtained from Major Land Resource Areas 102B-116, 131 and 134 in Missouri, Illinois and Iowa. The total number of collections received was 22-Illinois; 28-Iowa and 68-Missouri. All collections were assigned accession numbers and stored in a cool damp building.

1992-1993
The collections were vegetatively propagated in cone-tainers and placed in the greenhouse in January 1992. These plants were then transplanted in Field #7c on the PMC on June 9, 1992, in a randomized complete block with three replications. Baseline evaluations were taken this year; survival, spread, height, and number of panicles per plant. More detailed evaluations were scheduled for succeeding years.

Beginning in July 1993, the great flood began inundating the area where this project was located. Prior to the flooding of this site (July 2, 1993), additional evaluations were started and 67 accessions were vegetatively moved to an upland site on the PMC for continued evaluation. Table #1 lists the selected accessions, origins, and collectors.

1994-1995
Evaluations were continued on the 67 accessions during 1994 and 1995. The original planting in Field #7c that was flooded in 1993 was also checked for survivors. The planting was flooded by as much as eight feet of water for almost eight weeks. Nine plants were found that showed life and were dug up and moved to an upland site. These nine plants represented three accessions (Table #2).

Five accessions were selected out of the block of 67 for a short growing rhizomatous type. The five accessions (Table #3) were allowed to cross and seed was harvested and grown out in the greenhouse. The five accessions were also dug and increased in the greenhouse in containers.

1996
The five selected accessions (Table #3) were planted into a crossing block June 26, 1996. Half the block was from clonal material from each of the five accessions and the other half was from seed harvested from each of the five plants that were allowed to cross with each other. The accessions of each half of the planting were replicated five times with five plants per replication. Unwanted plants will be eliminated and the remainder of the block will be used for seed increase.

1997-1998
The three accessions (Table #2) of flood tolerant switchgrass were vegetatively increased in the greenhouse. Approximately 250 plants were transplanted April 1997 in Field #7. This is now the breeders' block for the accession 9083170 that is a composite of the three accessions listed in Table #2. Seed was harvested from this plot the first year and used to start a small increase plot in 1998. A small amount of seed was harvested from this increase plot the first year. It is also planned to increase the size of this plot in 1999.

The low growing switchgrass block containing five accessions (Table #3) was again evaluated in 1997. Thirty-five plants were selected from the block of 250. Selected plants were allowed to cross and produce seed. This seed was also used to start an increase field in 1998. This small increase plot produced minimal seed the first year. Seed was again harvested from the 35 plants in 1998 and will be used to make the increase plot size bigger in 1999. The 35 selected plants are the breeder's block for the new accession 9083172 that is a composite of the five accessions in Table #3.

1999
The increase plot of flood tolerant switchgrass, accession 9083170, was expanded in May 1999. This planting did not do well, possibly poor seed germination combined with a very dry summer. Weed control was also poor. Establishment of field plantings was also poor. Expanding the increase plot will again be planned for 2000. Seed was harvested from the breeder's block and the 1998-increase plot. This seed was small due to dry weather.

The increase plot of low growing switchgrass, accession 9083172, was also expanded in May 1999. This planting also did poorly, again possibly poor seed germination combined with a very dry summer. Weed control was also poor. Field testing will begin when seed becomes available. Expanding the increase plot will be planned for year 2000. Seed was harvested from the original 35-plant breeder's block and also the increase field. This seed was also small due to dry weather.

2000
Increase plots of the flood tolerant switchgrass, accession 9083170, and the low growing switchgrass, accession 9083172, were again planted in 2000. These plantings were very sparse and slow to establish. The plantings made in 1999 contained some plants with minimal seed produced. Plantings will again be tried in 2001 with more stratification.

2001
The increase plots of the low growing switchgrass, accession 9083172, that were planted in 1998 and 1999 have filled in and produced seed. The plots planted in 2000 and 2001 have failed. This accession appears to have high seed dormancy and combined with excessive weed competition caused poor establishment. An increase planting is planned for 2002 on an upland site with less weed problems.

The increase plots of the flood tolerant switchgrass, accession 9083170 that was planted in 1998 produced seed in 2001. The 1999 planting was very thin and the 2000 and 2001 plantings have failed. This accession appears to have high seed dormancy. Another increase planting is planned in 2002 with additional stratification.

Accession 9062244 was observed in the nursery block in field eight as having high forage production (very leafy), medium height, and late maturity. Protein analysis of a sample taken was 15.6%. This plant was increased in the greenhouse from vegetative material and planted into a 200-plant nursery in 2000. Unwanted plants were rogued out and seed was harvested in 2001. Plants that germinate quicker from the heaviest seed will be placed in an evaluation nursery in 2002.

2002
The low growing switchgrass, accession 9083172, increase plots had limited seed production in 2002. The 17.3-pound bulk seed produced will be used in the field-planting program for advanced testing. An additional 1.5 acres increase field was planted in 2002. No seed was harvested the establishment year from this plot.

The flood tolerant switchgrass, accession 9083170, increase plots also had limited seed production in 2002. The 32.5-pound bulk seed produced will be used in the field-planting program. Due to an extremely wet spring, no additional seed increase field was planted in 2002.

The medium height forage type switchgrass, accession 9062244, was propagated in the greenhouse and plants were selected for quick establishment and seedling vigor. These plants were transplanted into an evaluation nursery in Field #1 at the PMC.

2003-2004
The low growing switchgrass, accession 9083172, increase plots have been expanded but are slower than expected to develop and produce seed. Available seed is being used in the field planting program for advanced testing.

The flood tolerant swithgrass, accession 9083170, increase plots have been expanded but are also slower than expected to develop and produce seed. Available seed is being used in the field planting program for advanced testing.

The medium height forage type switchgrass, accession 9062244, was again propagated in the greenhouse and the evaluation nursery was expanded in 2003. The plants were allowed to develop and mature in 2004 with evaluations to begin in 2005.

2005
Seed was harvested from the low growing and flood tolerant increase plots. Both of these accessions are being evaluated in the field planting program with mixed results. Seed dormancy is a problem and results in poor and inconsistent establishment.

The medium height switchgrass accession will be placed into a study of its own and go through a recurrent selection process in the development of an improved forage type switchgrass.

2006
Seed was again harvested from the low growing and flood tolerant increase plots. Both are showing poor stand development on heavy soil types with moderate to heavy clay content. These two selections will undergo more testing and selection to improve seedling vigor.

2007
Seed from the low growing and flood tolerant selections were put in the germinator and selected for quick germination, five days or less. Two new evaluation plots were established from the plants selected out of the germinator.

2008
In 2008, plans were to compare germination of seed taken off the selected plots with that of seed taken from the original plots. The data shows the difference between seed that has been stratified and seed that had no stratification period. Within each treatment, low growing, flood tolerant and 'Cave-in-Rock' switchgrass were test for superior germination. The low growing and flood tolerant switchgrass had both SG0 (original) seed and the cycle 1 (selected) seed tested. In the case of the low growing switchgrass, the cycle 1 (selection) made a significant increase in germination. The flood tolerant switchgrass did not appear to have any statistical difference. 'Cave-in-Rock' switchgrass was tested as a comparison.

2009
The two varieties of switchgrass were tested in the fall using seed that was harvested during the 2009 growing season. Comparisons between seed produced in 2008 (Table 1) and seed produced in 2009 (Table 2) are similar in their results. In all cases, except the non-stratified flood tolerant switchgrass from the spring 2009 tests (Table 1), the cycle 1 selections improved in germination. It is worth noting, that the flood tolerant switchgrass, both SG0 and cycle 1 plots, were inundated for approximately 4 weeks just prior to flowering. Also seed from Cave-in-Rock switchgrass for the spring 2009 test (Table 1) was older seed and not from the current growing season. The fall 2009 tests (Table 2) were ran using current growing season seed and is a more accurate test. This test will be ran once more using 2009 growing season seed and if the results show that the cycle 1 selections are still superior, then plans will be to move forward with production plots and field testing.

2010
In 2010, the switchgrass plots on the Elsberry Plant Materials Center were very poor. Germination of seed from all plots were close to "zero" and it was decided not to harvest any switchgrass in 2010. Unfortunately, this holds up the process of proceeding with further evaluations by another year. Plans were to combine 2009 and 2010 seed in order to have an

amount that could be used to start a SG1 plot. The plots of the “flood tolerant” and “low growing” selections will be planted in 2011 using 2009 seed and additional years of harvest will be added to these newly established plantings. These new plantings made at the PMC will be evaluated for seedling vigor and the ability to establish quickly. If these plantings do well, plans will be to offer seed from these plots in field plantings and make a comparison evaluation against another variety of switchgrass, such as Cave-in-Rock Switchgrass.

2011
A plot was identified in both field 7 and at the leased property at the Stewart Farm. Flood tolerant switchgrass, cycle 1, accession 9083325, was planted in field 7 and the low growing switchgrass, cycle 1, accession 9083326, was planted at the Stewart Farm. Both plots were planted in June and both were complete failures, with very few plants visible by the end of the growing season. It is believed that residual herbicide could have been the reason for the poor stand since moisture was not a problem at the time of planting. When there is available seed from both cycle 1 plantings, the increase plots will be planted again, potentially in 2012 or 2013.

2012
Seed from both the flood tolerant selection, 9083325, and the low growing selection, 9083326, was poor. Extreme dry conditions are a possible reason for the poor seed set. Seed collected from 2011 will be used to re-establish the next generation, seed production plots. Both plantings are scheduled for spring 2013.

2013
Seed from both accession 9083325 and 9083326 had poor germination tests. This study is discontinued and the seed from previous harvests are archived for potential future use.

This study is discontinued and no other data or conclusions will be presented.

Study 29I108G-Selected Accessions of Low Growing Switchgrass Table #1

Accession #	State	County	MLRA	Collector Name
9062155	Iowa	Louisa	108	Dean L. Pettit
9062157	Iowa	Cherokee	107	Lon Allan
9062158	Iowa	Clay	103	John P. Vogel
9062160	Iowa	Freemont	107	NRCS F. O.
9062163	Iowa	Hamilton	103	Dana C. Holland
9062165	Iowa	Woodbury	107	John P. Vogel
9062166	Iowa	Monona	107	Michael J. Kuera
9062178	Iowa	Muscatine	108	Douglas S. Johnson
9062181	Illinois	Champaign	108	Leon W. Wendt
9062188	Illinois	Macoupin	108	Ivan N. Dozier
9062189	Illinois	Macoupin	115	Ivan N. Dozier
9062190	Illinois	Macoupin	108	Ivan N. Dozier
9062195	Illinois	Carroll	105	Raymond J. Hudak
9062196	Illinois	Carroll	105	Raymond J. Hudak
9062205	Missouri	Barton	112	Jerry L. Cloyed
9062207	Missouri	Bates	112	Robert D. Bouland
9062208	Missouri	Pettis	116A	Thomas J. Hagedorn
9062209	Missouri	Christian	116A	C. Mark Green
9062211	Missouri	Ozark	116A	Carroll W. Foster
9062212	Missouri	Johnson	112	Robert T. Hagedorn
9062213	Missouri	Madison	116A	Sandra L. Lewis
9062214	Missouri	Ste. Genevieve	116B	Renee L. Phillips
9062215	Missouri	Oregon	116A	Stephen E. Robbins
9062216	Missouri	Shannon	116A	Steve Wall
9062217	Missouri	Reynolds	116A	Clarence W. Wagy
9062218	Missouri	Christian	116A	C. Mark Green
9062219	Missouri	Perry	116B	Claude E. Peifer
9062220	Missouri	Reynolds	116A	Clarence W. Wagy
9062221	Missouri	Dade	116B	Todd E. Mason
9062222	Missouri	Morgan	116B	James A. Maberry
9062223	Missouri	Franklin	116B	Arthur P. Kitchen
9062224	Missouri	Cedar	116B	Kim C. Ehlers
9062225	Missouri	Christian	116A	C. Mark Green
9062227	Missouri	Ozark	116	Carroll W. Foster
9062228	Missouri	Texas	116	Jeff A. Lamb
9062229	Missouri	Texas	116	Jeff A. Lamb
9062234	Missouri	Saline	107	Wayne E. McReynolds
9062237	Missouri	Ray	107	James M. Rehmsmeyer
9062238	Missouri	Worth	109	David A. Stevens
9062239	Missouri	Sullivan	109	Stuart A. Lawson
9062240	Missouri	DeKalb	109	Wm. A. Throckmorton

Table #1 - continued

Accession #	State	County	MLRA	Collector Name
9062242	Missouri	DeKalb	109	Wm. A. Throckmorton
9062243	Missouri	Buchanan	107	Rodney Saunders
9062244	Missouri	Dent	116	Myron C. Hartzell
9062246	Missouri	Sullivan	109	Stuart A. Lawson
9062247	Missouri	Buchanan	107	Rodney Saunders
9062248	Missouri	Sullivan	109	Stuart A. Lawson
9062250	Missouri	Nodaway	109	Kenton L. Macy
9062251	Missouri	Worth	109	David A. Stevens
9062252	Missouri	Daviess	109	James A. Sturm
9062253	Missouri	Daviess	109	James A. Sturm
9062254	Missouri	Maries	116A	Dennis W. Shirk
9062255	Missouri	Maries	116B	Dennis W. Shirk
9062256	Missouri	Maries	116A	Dennis W. Shirk
9062257	Missouri	Maries	116A	Dennis W. Shirk
9062259	Missouri	Shannon	116A	Steve Wall
9062261	Missouri	Shannon	116A	Steve Wall
9062265	Missouri	Sullivan	109	Stuart A. Lawson
9062267	Missouri	Gentry	109	Gary J. Barker
9062268	Missouri	Platte	107	Terry A. Breyfogle
9062269	Missouri	Sullivan	109	Stuart A. Lawson
9062270	Missouri	Platte	107	Terry D. Breyfogle
9062271	Iowa	Page	104	Kevin J. McCall
9062272	Illinois	Fayette	104	Brad S. Simcox
9062274	Iowa	Madison	108/109	Larry Beeler/Tom Oswald
9062193	Illinois	Fayette	113	Brad S. Simcox

Selected Accessions of Wet Tolerant Switchgrass **Table #2**

Accession #	State	County	MLRA	Collector Name
9062193	Illinois	Fayette	113	Brad S. Simcox
9062213	Missouri	Madison		Sandra L. Lewis
9062235	Missouri	Miller	116	Matt L. Burcham

Final Accessions Selected for Low Growing Switchgrass **Table #3**

Accession #	State	County	MLRA	Collector Name
9062205	Missouri	Barton	112	Jerry L. Cloyed
9062225	Missouri	Christian	116A	C. Mark Green
9062252	Missouri	Daviess	109	James A. Sturm
9062255	Missouri	Maries	116B	Dennis W. Shirk
9062257	Missouri	Maries	116A	Dennis W. Shirk

Table 1

Switchgrass Germination Test Spring 2009

	Non-Stratified					Stratified				
	Day 7	Day 14	Day 21	Day 28	% Germ	Day 7	Day 14	Day 21	Day 28	% Germ
Low Growing Switchgrass SG0	9	15	1	1	25	51	5	0	0	56
Low Growing Switchgrass Cycle 1	36	32	0	1	68	78	6	1	0	85
Flood Tolerant Switchgrass SG0	16	10	2	0	27	70	3	0	0	73
Flood Tolerant Switchgrass Cycle 1	15	5	2	1	22	70	5	1	0	76
Cave-in-Rock Switchgrass	37	44	0	0	81	80	5	0	0	85

There were 4 replications of 100 seeds per germination tray using seed harvested in 2008, with exception of Cave-in-Rock switchgrass. C-I-R seed came from a seed lot that was harvested from 1994 through1997.

Stratified seed (cold/moist) was put in the cooler for 2 weeks.

Non-statified seed was taken directly from the storage room and entered into the growth chamber.

Table 2

Switchgrass Germination Test Fall 2009

	Non-Stratified					Stratified				
	Day 7	Day 14	Day 21	Day 28	% Germ	Day 7	Day 14	Day 21	Day 28	% Germ
Low Growing Switchgrass SG0	1	6	2	1	10	38	4	0	1	43
Low Growing Switchgrass Cycle 1	1	6	3	2	12	41	7	1	1	49
Flood Tolerant Switchgrass SG0	0	3	0	0	3	48	3	0	0	51
Flood Tolerant Switchgrass Cycle 1	0	5	1	1	6	58	4	1	0	63
Cave-in-Rock Switchgrass	2	3	2	1	7	41	4	0	1	46

There were 4 replications of 100 seeds per germination tray using seed harvested in 2009.

Stratified seed (cold/moist) was put in the cooler for 2 weeks.

Non-statified seed was taken directly from the storage room and entered into the growth chamber.

Evaluation of Miscellaneous Trees and Shrubs

Study No. 29A116W

National Project(s): Forestland 1.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: The evaluation of woody plant materials on the USDA-NRCS Elsberry Plant Materials Center began in 1989. Since that time plants have been added for multiple purposes. The evaluations of these plant materials have been in cooperation with the USDA-ARS, Plant Introduction Station, Ames, Iowa; Missouri Department of Conservation; and other plant materials centers.

Objective: The objectives of this study are to assemble and evaluate woody plant materials (both collections in the wild and also released cultivars) for conservation uses, area of adaptation, and to select and increase limited quantities of promising woody plants for advanced evaluation. Superior accessions or those exhibiting unique characteristics will be placed in field evaluations and field plantings in the three-state area being served by the PMC.

Procedure: Plant materials of various woody species representing many species have been planted on the PMC. The sources include other PMC's, commercial nurseries, and other agencies.

Potential Products: Information Technology, cultivar release, FOTG standards

Progress or Status:

1994-2004
This study is a long-term ongoing evaluation of miscellaneous trees and shrubs that are not part of a collection made over several years. New species will be planted as they arrive at the Center. Although this study was started in 1989, it includes some species from past studies. Presently there are 29 different species included. Twenty-two are exhibiting 100 percent survival. Five species have failed to survive.

The trees and shrubs in this study are often utilized during plant identification courses held at the Center.

There were no evaluations conducted and no new species added in 2004. There are two new species planned for 2005 that will be received from the Plant Introduction Station in Ames, Iowa. The entire assembly is scheduled to be evaluated in 2005. Very little attention was given to this study in 2004 because the PMC was understaffed.

2005
An evaluation of survival was made in the summer of 2005. Trees and shrubs that had died were noted. The condition of the trees was also evaluated. Black chokeberry (*Aronia melanocarpa)* and common buttonbush (*Cephalanthus occidentalis)* were added to this study. These trees and shrubs will again be evaluated for their survivability and use in conservation.

2006
In April, three new species were added for evaluation, Musclewood (*Carpinus caroliniana*), Bur oak (*Quercus macrocarpa*), and Laurel willow (*Salix pentandra*). There were five trees planted of each species and evaluated for general conditions of the plants (bud break, plant injury, etc.) The buttonbush (*Cephalanthus occidentalis*) and black chokeberry (*Aronia melanocarpa*) were replanted in the fall, 11/14/2005, after dying from an earlier spring planting. They too were

evaluated, but for survival, height, spread, injury, type of care given, plant performance, and variations among plants.

2007
Evaluations were taken on tree species sent from the ARS - Plant Introduction Station in Ames, Iowa. Data was sent back to ARS via their online evaluation forms. Also survival of the miscellaneous tree assembly was taken. In August the Three State Technical Review Committee recommended several species of trees to be eliminated from the assembly. The primary species that were recommended for removal were non-native species or species that were performing poorly.

2008
In 2008, the trees and shrubs present in the study were evaluated for survival. Trees from the Plant Introductory Station in Ames, IA were evaluated and data was sent via online evaluation forms. The Introductory Station also sent 2 new species for evaluation, Physocarpus opulifolius (Common Ninebark) and Quercus alba (White Oak). They were planted on 5/2/08. There were no trees eliminated from the evaluation block in 2008. The recommended trees for removal are still scheduled to be removed.

2009
The Miscellaneous Trees and Shrubs study had several older species removed from the plot. Data was taken and the extra space will be prepared for future evaluations and observational plantings.

2010
An area in field 9, north of the pipeline area, was cleared for future observational plantings of tree and shrub material. Three new species were added to the study for evaluation from the North Dakota PMC; Prairie Red Plum, 9047203; Ribes americuum (Black Currant), 9082687; and Photinic melancarpa (Black Chokeberry), 323957. Eight plants of each were planted and in 2010 all plants were alive. In 2011, the miscellaneous tree study will have a full evaluation for height, spread, insect damage, disease resistance, fruit production, and overall plant vigor.

2011-2012-2013
Evaluations were on hold in 2011, 2012 and 2013. This study is discontinued and no other data or conclusions will be presented.

List of species included in study. **Table #1**

Common Name	Genus	Species	Accession Number	Source	Date Planted
'Densehead' mountain ash	*Sorbus*	*alnifolia*		F.K. Nursery	11/65
'Ruby' redosier dogwood	*Cornus*	*stolonifera*	443229	Big Flats PMC	5/89
Late lilac	*Syringa*	*villosa*	9006228	Bismarck PMC	5/89
'Redstone' cornelian cherry dogwood	*Cornus*	*mas*	9055585	Elsberry PMC	5/89
'Roselow' sargent crabapple	*Malus*	*sargenti*	477986	Roselake PMC	5/89
'Elsmo' lacebark elm	*Ulmus*	*parvifolia*	9004438	Asia	5/89
Blueleaf	*Lonicera*	*korolkowi*	9062152	Nebraska	5/89

Common Name	Genus	Species	Accession Number	Source	Date Planted
honeysuckle					
Birch	*Betula*	*species*	502295	Ames, IA	4/90
Willow oak	*Quercus*	*phellos*		Ames, IA	4/90
Fragrant epaulettetree	*Pterostyrax*	*hispida*		Ames, IA	4/90
Bradford pear	*pyrus*	*calleryana*		Ames, IA	4/69
Prairie rose	*Rosa*	*setigera*	495616	Ames, IA	4/90
Ural false spirea	*Sorbaria*	*sorbifolia*		Ames, IA	4/90
Weeping lilac	*Syringa*	*pekinensis*	478008	Ames, IA	4/90
Flameleaf sumac	*Rhus*	*copallina*		Ames, IA	4/90
Western paper birch	*Betula*	*occidentalis*	495882	Ames, IA	4/90
Amur honeysuckle	*Lonicera*	*mackii*	477998	Ames, IA	4/90
Mountain ash	*Sorbus*	*reducta*		Ames, IA	4/90
Blackhaw	*Viburnum*	*prunifolium*		Ames, IA	4/90
Largeleaf dogwood	*Cornus*	*macraphylla*		Ames, IA	4/90
Border privet	*Ligustrum*	*obtusifolium*	477010	Ames, IA	4/90
Willow oak	*Quercus*	*phellos*		Ames, IA	4/90
Arrowwood	*Viburnum*	*dentatum*		Elsberry, MO	4/90
Redbud	*Cercis*	*canadensis*	496399	Ames, IA	5/91
Birch	*Betula*	*species*	14942	Ames, IA	5/91
‘Wichita’ osage orange	*Maclura*	*pomifera*		Kansas	5/91
‘Denmark’ osage orange	*Maclura*	*pomifera*		Denmark, IA	6/92
Magenta	*Malus*	*species*	514275	Roselake PMC	4/93
Ocean view beach plum	*Prunus*	*maritima*	518824	Cape May PMC	5/93
‘Sandy’ rugosa rose	*Rosa*	*rugosa*		Cape May PMC	5/93
Wildwood bayberry	*Myrica*	*pennsylvanica*	548966	Cape May PMC	5/93
Wildwood bayberry	*Myrica*	*pennsylvanica*	434150	Cape May PMC	5/93
Wildwood bayberry	*Myrica*	*pennsylvanica*	548964	Cape May PMC	5/93
Ocean view beach plum	*Prunus*	*maritima*	518822	Cape May PMC	5/93

Common Name	Genus	Species	Accession Number	Source	Date Planted
Ocean view beach plum	*Prunus*	*maritima*	518823	Cape May PMC	5/93
'Oahe' hackberry	*Celtis*	*occidentalis*	476982	Bismarck PMC	5/93
'King Red' Russian olive	*Elaeagnus*	*angustifolia*	434029	NPMC	5/93
Black Chokeberry	*Aronia*	*melanocarpa*	9083269	Ames, IA	11/05
Common Buttonbush	*Cephalanthus*	*occidentalis*	9083270	Ames, IA	11/05
Musclewood	*Carpinus*	*caroliniana*	9083283	Ames, IA	04/06
Bur Oak	*Quercus*	*macrocarpa*	9004392	Ames, IA	04/06
Laurel Willow	*Salix*	*pentandra*	9083284	Ames, IA	04/06
Common Ninebark	*Physocarpus*	*opulifolius*	9083321	Ames, IA	05/08
White Oak	*Quercus*	*alba*	9083322	Ames, IA	05/08
Prairie Red Plum	*Prunus*	*spp.*	9047203	NDPMC	05/09
Black Currant	*Ribes*	*americuum*	9082687	NDPMC	05/09
Black Chokeberry	*Photinic*	*melanocarpa*	323957	NDPMC	05/09

Production of Native Iowa Ecotypes of Grasses and Forbs for Roadside, Critical Areas, and All Other Vegetative Plantings Where Native Grasses and Forbs are Now Being Planted

Study No. 29I124G

National Project(s): Critical Area 1.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Well-adapted native grass, legume, and forb plantings offer many advantages as low cost sustainable vegetative cover for management of soil and water resources. Native plant communities resist noxious weed invasion, provide excellent erosion control, and generally require relatively low maintenance.

These characteristics make them an excellent selection for use in roadside plantings, critical areas, long term land retirement programs, and all other vegetative plantings where mono-cultures of native grasses are being planted. This is especially true along public transportation right-of-ways. These transportation corridors constitute a major land resource and management problem in the state of Iowa. Based on 1987 Natural Resources Inventory (NRI) data, over one million acres of Iowa land are devoted to rural transportation.

Proper vegetation management along these corridors is an important element in controlling soil loss and unwanted weedy plant species. Many of these acres are now seeded to introduced cool-season grass and legume species which are often invaded by noxious weeds requiring extensive mowing or herbicide treatment programs. These management techniques are expensive and can also result in additional water quality problems where herbicides are used extensively.

Managing or re-seeding these acres to promote native grasses, legumes, and forbs offers a low cost environmentally sound approach to roadside vegetation management. Herbicide use, soil erosion, and most mowing can be reduced significantly where a vigorous native grass, legume, and forb mixture dominates a roadside right-of-way. In addition, these goals are consistent with on-going NRCS programs designed to improve ground and surface water quality, reduce soil loss and increase wildlife habitat.

Many adapted native species are either currently not commercially available or available only in very limited quantities. When native species are available, the origin is often from considerable distance away and adaptation can be a concern. The species that are available are often as a ‘variety’ that has been developed for pasture and hay. These are generally high forage producing and more vigorous than wild collections of seed that have not been through an evaluation and breeding program. Seed of local origin that have not been improved or selected for superior forage yield is more likely to remain in a prairie mixture without crowding out other species and becoming monoculture. There is a need for additional native grass, legume, and forb species for use in roadside and other types of conservation plantings.

Objective: The objective of this study is to accelerate the collection and increase of selected native grass, legume, and forb species through a cooperative program between the University of Northern Iowa (UNI), USDA Natural Resources Conservation Service (NRCS), and the Iowa Roadside Integrated Vegetation Management Program (IRVM).

Procedure: The state of Iowa was divided into three zones: North, Central, and South (Table #1). Seed collected from within each zone was kept separate from the other zones. The IRVM office organized seed collections from each zone. Collections were made from native prairie remnants throughout each zone striving for a relatively equal and representative collection. Seed from each collection site was inventoried by location and a small portion was started in the

greenhouse at UNI and transplanted into plots. The remainder of the seed was sent to the PMC, cleaned, and seeded for increase plots. Seed from the plots at UNI was hand harvested and also used to start increase plots or mixed with additional seed and became available to seed growers. When enough seed becomes available, the species is released as 'Source Identified' germplasm from the zone in which it was collected. Source identified seed has not been improved by evaluation and selection or plant breeding procedures.

Potential Products: Information Technology, cultivar release, FOTG standards

Progress or Status: The study officially started October 1, 1990, at the beginning of fiscal year 1991 with agreements signed. Seed collections had started earlier in the year and seed was available for increase plots the spring of 1991. Most of the plots started from 1991 to 1993 were destroyed in the flood the summer of 1993. Plant re-establishment started in 1994 and new plots have been started each year.

2000
New increase plots established in 2000 were *Liatris asper*, rough blazing star; *Monarda fistulosa*, horsemint; and *Lobilia siphilitica*, great blue lobelia. Surflan was used for weed control and the horsemint was not resistant.

New plant releases for 2000 were Northern Iowa Germplasm Big Bluestem, Northern Iowa Germplasm Tall Dropseed, Northern Iowa Germplasm Roundhead Lespedeza, and Southern Iowa Germplasm Prairie Blazing Star.

2001
There were no new plant releases through the plant materials program in 2001 but seed of previous releases was allocated to growers. Initial seed increase is now in production at the new UNI Native Roadside Vegetation Center at the University of Northern Iowa, Cedar Falls, Iowa. A new plot of Southern Iowa June grass was established at the PMC from plants started in the greenhouse. This species exhibits very slow growth and a serious problem is weed control.

2002
There were no new increase plots established in 2002. Seed production and allocation to growers continued on previously established plots.

New plant releases for 2002 were Northern, Central and Southern Iowa Germplasm New England Aster, Northern and Southern Iowa Germplasm Pale Purple Coneflower, Southern and Central Iowa Germplasm Rigid Goldenrod, and Southern Iowa Germplasm Tall Dropseed.

2003
In 2003 there were no new plantings or increases added. Production and allocations to growers continued from previously established plots. Weed control was maintained by using a non-selective herbicide in late winter/early spring on most plots, followed by a pre-emergent herbicide on all plots. Late spring and summer weed control was achieved by manual labor and selective herbicides.

There were eight new plant releases for 2003. They were Southern Iowa Germplasm Wild Burgamot (*Monarda fistulosa*), Northern, Central, and Southern Iowa Germplasm Rough Blazing Star *(Liatris aspera*), Northern Iowa Germplasm Purple Prairie Clover (*Dalea purpurea*), Central Iowa Germplasm Switchgrass (*Panicum virgatum*), Northern and Central Iowa Germplasm Junegrass (*Koelaria macanthra*). Refer to the table of contents for a complete list of PMC releases.

2004
The Iowa Ecotype Program continued to produce seed for the three different zones on the center in 2004. Although there were no new plots established and no plot increases, the PMC plans to introduce five new Iowa releases in 2005. Weed control was very similar to that of 2003, with the use of non-selective herbicide early and manual labor and selective herbicide later in the growing season. There were some plots taken out of production in 2004 because of consistently low seed production.

2005
The releases scheduled for 2005 were held off until 2006 because there was a lack of available seed. Plots were maintained the same as the past two years. Unproductive plots that had a supply of seed on inventory were mowed and not maintained or harvested.

2006
In fiscal year 2006 the PMC released Central Iowa Germplasm Pale Purple Coneflower (*Echinacea pallida*), 9068612. Future releases are still planned. Each species that the PMC is working with should have a release from each of the three zones. Those releases that are not represented will be a priority for the next few years. Fiscal year 2007 is scheduled to have two releases, northern and central zones of wild bergamot, (*Monarda fistulosa*). In fiscal year 2008 and 2009 the PMC will finish out the Iowa Ecotype Program with the releases of southern zone purple prairie clover, (*Dalea purpurea*), southern zone Junegrass, (*Koeleria macanthra*), and northern and southern zones of switchgrass, (*Panicum virgatum*). The Elsberry PMC and the University of Northern Iowa cooperatively grow and have seed on hand for commercial production.

2007
The Iowa Ecotype Program had two more releases in 2007 with the release of Northern and Central Iowa Germplasm horsemint (also known as wild bergamot), *Monarda fistulosa*. There are limited quantities of seed from both zones currently available and being produced at the Elsberry PMC. More production plots are being phased out as the Tallgrass Prairie Center in Iowa continues to grow and manage more production plots. Plots at the Elsberry PMC that have been taken out of production are being mowed until needed for other uses or the plot needs to be re-established.

2008
In 2008, Iowa ecotype plots, primarily from southern collections, were maintained and harvested for seed production.

2009
Few plots are left in production from the Iowa Ecotype Program. This past growing season only four plots were harvested for seed production. The southern zones for little bluestem and pale purple coneflower and central zones of little bluestem and prairie blazing star produced small amounts of seed and will be added to inventory. Emphasis on this program has fallen off and the PMC will continue to harvest readily available seed and hold on inventory, if there is ever a need to re-establish these stands. The Tallgrass Prairie Center, located on the campus of the University of Northern Iowa, is currently maintaining the releases from this program and has seed available to potential growers.

2010
In 2010, the Elsberry PMC harvested seed from Southern Iowa Germplasm big bluestem, Central Iowa Germplasm little bluestem, and Northern Iowa Germplasm and Southern Iowa Germplasm Indiangrass. This will likely be the final year that the Elsberry PMC harvest from the Iowa Ecotype Program plots, unless plots need to be re-established for future production. The Tallgrass Prairie Center will maintain the established releases and the Elsberry PMC will secure production information from them annually.

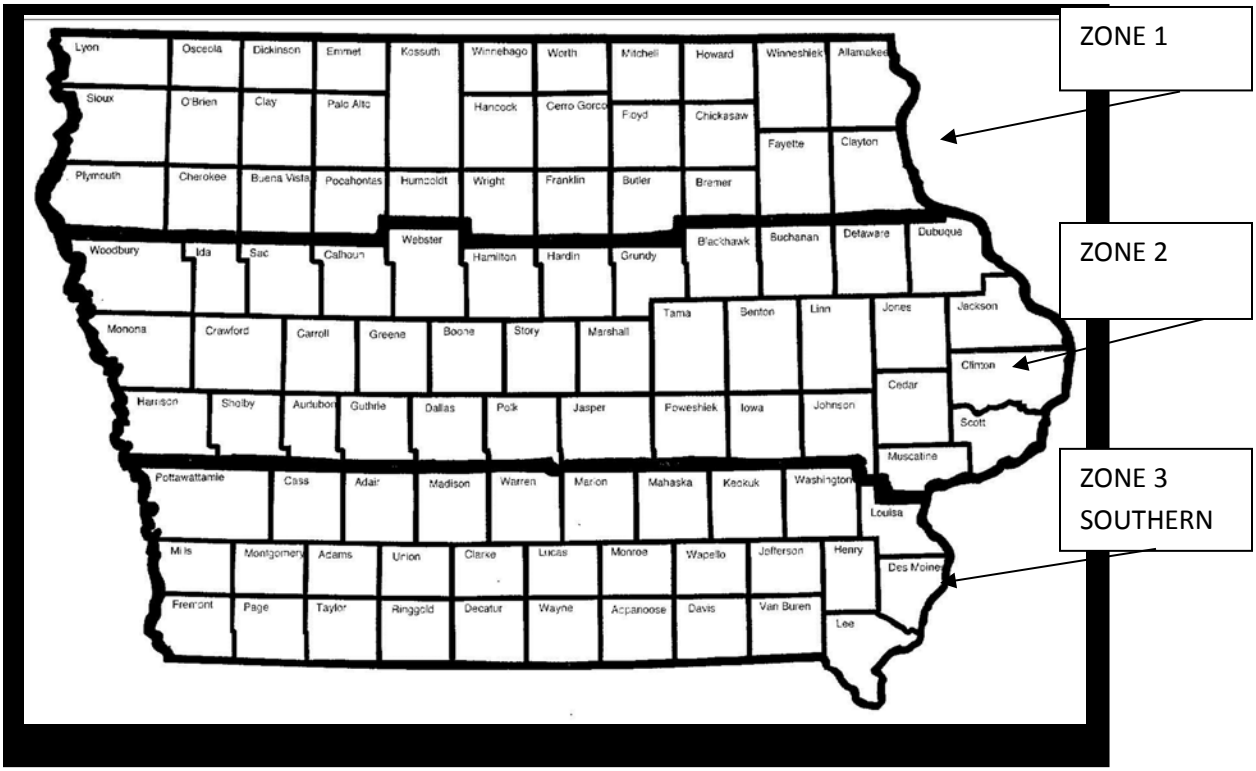
2011-2012-2013

The Iowa Ecotype study is considered finalized. Releases from this study will be maintained by the Tallgrass Prairie Center in Cedar Falls, Iowa and when needed at the Plant Materials Center. This study is discontinued and no other data or conclusions will be presented.

Study: 29I124G – Native Iowa Ecotypes **TABLE #1**

Ecotype Species		**Iowa Geographic Zones – Year of Release**		
Common Name	**Scientific Name**	**Northern**	**Central**	**Southern**
Pale Purple Coneflower	*Echinacea pallida*	2002	2006	2002
Purple Prairie Clover	*Dalea purpurea*	2003	1998	***TBD***
Switchgrass	*Panicum virgatum*	***TBD***	2003	***TBD***
Junegrass	*Koeleria macanthra*	2003	2003	***TBD***
Horsemint	*Monarda fistulosa*	2007	2007	2003
Rough Blazing Star	*Liatris aspera*	2003	2003	2003
New England Aster	*Aster novae-angliae*	2002	2002	2002
Tall Dropseed	*Sporobolus compositus*	2002	1996	2002
Stiff Goldenrod	*Oligneuron rigidum*	1998	2002	2002
Big Bluestem	*Andropogon gerardii*	2000	1998	2000
Prairie Blazing Star	*Liatris pycnostachya*	1999	1999	2000
Bushclover	*Lespedeza capitata*	2000	1996	1997
Little Bluestem	*Schizachrium scoparium*	1999	1997	1999
Rattlesnake Master	*Eryngium yuccifolium*	1998	1999	1999
Indiangrass	*Sorghastrum nutans*	1996	1996	1998
Canada Wild Rye	*Elymus canadesis*	1995	1995	1997
Oxeye False Sunflower	*Heliopsis helianthoides*	1996	1995	1997
Sideoats gramma	*Bouteloua curtipendula*	1995	1995	1995

IOWA ECOTYPE ZONE MAP



Wetland/Riparian Propagation, Establishment, and Demonstration

Study No. 29A137O

National Project(s): Critical Area 1.1; Water Quality 1.1, 2.1, 3.1, and 4.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager and Jerry Kaiser, PM Specialist

Introduction: There is a growing interest in wetland restoration throughout the conservation community. Government programs, such as USDA-Wetland Reserve Program, the USFWS Partners for Wildlife, Wetland Restoration Program, the Missouri Department of Conservation (MDC) Private Lands Wetland Program, and private programs sponsored by Ducks Unlimited and Waterfowl USA have all focused on the need for a suitable supply of plants in wetland restoration efforts.

The increasing use of wetlands as filters in agricultural waste management and the control of non-point source pollution also indicate the need for a greater knowledge base for proper plant selection.

Understanding wetland ecosystems will require improved and increased quality of information on wetland plants and ecosystems. Innovative approaches to field management and additional training of personnel in wetland conservation and management will also be needed. Intra- and interagency coordination and information exchange among state and federal agencies will help standardize monitoring and management strategies.

Information is largely unavailable related to the propagation, adaptation, and potential use of many of the wetland species found in the Midwest. Wetland plants of interest often have multi-use potential providing wildlife benefits, shoreline stabilization, water quality improvement, and/or aesthetic benefits. They are also needed to fulfill conservation needs resulting from increased demands in wetland development and water treatment. The ability to document this information or to observe the interaction of selected species is restricted by the availability of plants and plant communities especially under controlled conditions. Proper use of species to address conservation problems is limited by specific knowledge and technology for using these plants.

Objective: The objectives of the Elsberry PMC wetland study are to:

1. Provide a demonstration of various plant materials for wetland conservation and aesthetic values.
2. Provide an area for interagency research on the biology of selected wetland plants.

Potential Products: Information Technology, cultivar release, FOTG standards

Progress or Status:

1994 – 1999
A large wetland was constructed in Field #4 on the Plant Materials Center in July 1994. Selected plant materials were planted with the intent of evaluating these plants for flood tolerance. The PMC has been working with a flood tolerant switchgrass since 1991. As a result, it was placed in this wetland for further testing along with six accessions of eastern gamagrass which were found growing in wet conditions: accessions 9078842, 9078844 and 9078843 were collected in Atchison County, Missouri, 9078845 collected in Holt County, Missouri, 9078840 collected in Chariton County, Missouri and 9078846 was collected in Clinton County, Missouri. Local collections of bermudagrass and swamp milkweed were planted in the spring of 1998. Two collections of prairie cordgrass (Cuivre Island and Lost Creek) were also planted in this wetland. The switchgrass, eastern gamagrass and the prairie cordgrass were planted in 1997. All plants in this wetland were given time to establish prior to the beginning of the flooding operation which took place in October 1999. The wetland was flooded to a depth of 40 inches. This water

remained in the wetland until early spring of 2000. Once the water is drained out of the wetland and enough time elapses for plant regrowth, evaluations on survival will take place.
The following Tables #1, #2, #3 and #4 reflect the plants' performance.

2000
Water was drained out of the wetland in segments because the drainpipe was not functioning properly. This operation started on March 21, 2000 and ended on March 30, 2000. The prairie cordgrass were the first plants to begin green up (March 30) followed by the bermudagrass planting. 'Cave-In-Rock' switchgrass sod (23 plugs) was planted on the west side of the flood tolerant switchgrass (sod) for comparison with other plant species in the wetland. On June 1, 2000, flood tolerant switchgrass was seeded in a plot 50 feet long and three feet wide. On August 9 an evaluation of the seeded flood tolerant switchgrass revealed no germination had taken place in the plot seeded on June 1. Poor germination has been experienced with this selection since 1998. There was no flooding of the wetland this fall to allow the Cave-In-Rock to get fully established. The following is a listing of percent survival of plants included in this study. The best performing plants in this study are Cuivre Island and Lost Creek collection of *Spartina pectinata*, *Tripsacum dactyloides* accessions 9078843, 9078845, and 'Pete'; and *Cynodon dactylon.* The following tables reflect the different plants' performance before and after a flooding event.

2001
The objective of the flooding was to parallel flood events that were occurring on the Mississippi River during that same time event. Began pumping turbid water into wetland on April 24, 2001 to flood the wetland to a depth of approximately 32 inches of water, which was achieved by April 27, 2001. The water was allowed to remain in the wetland for seven days. Water was then allowed to drain out of the wetland starting on April 30, 2001. All the water was drained out of the wetland by May 1, 2001. On May 8 evaluations were conducted to document re-growth after flooding. Again on June 11 a quick flooding scenario was conducted in the wetland to simulate a flash flooding event, similar to what was occurring on the Mississippi River. Thirty-four inches of turbid water was pumped into the wetland. The PMC began draining the water out of the wetland on June 15. The process of draining the water out of the wetland was completed on June 19.

The following is a listing of plant vigor ratings for each accession/variety included in this study. Plant evaluations for vigor were taken on June 21 and 26, 2001.

2002-2003
Plant performance evaluations were performed on April 24, 2002 and May 27, 2003. The wetland was not burned in 2002; however it was burned in 2003 and in previous years to remove accumulated vegetation. Flooding of the wetland began on April 29, 2002 and June 10, 2003. A total of 45 inches of water was pumped into the wetland (2002) and 42 inches in 2003 before the de-watering process began. All water was drained out of the wetland by May 17, 2002 and July 7, 2003. The plants were under water for 17 days in 2002 and 22 days in 2003. Once all the water was drained out of the wetland, follow-up evaluations took place on June 2002 and August 2003. The flood event in 2003 was to inundate the site for more than 20 days to test the switchgrass, *Panicum virgatum.* Table #4 reflects the plant performances during 2003 before and after the flood event. Previous years' plant performances can be found on Tables #1 - #3.

2003-2004
Switchgrass, *Panicum virgatum,* accessions 9062193, 9062235, 9083170 were compared to Cave-In-Rock. The percent was 76%, 77%, and 78% survival compared to Cave-In-Rock at 65%. The composite 9083170 Flood Tolerant switchgrass is the next generation of the three accessions 9062193, 9062235, and 9083170 which did perform from seed that was planted in 2000. Vigor was slow with only 20% stand the first growing season. Flood events occurred in 2001, 2002, and 2003 with the stand increasing in density to 85% by spring of 2004.

Prairie cordgrass, *Spartina pectina,* accessions 9083166 Cuivre Island and 9083167 Lost Creek planted on the 3'X 3' grid was a solid block in two growing seasons. The cordgrass planted on the 10'x 10' grid was a solid block in six growing seasons. The vegetative spread averaged 1.5 feet during a growing season. The flooding events did enhance the plants' ability to flourish and produce seed that spread seedlings in the wetland cell.

Virginia wildrye, *Elymus virginicus,* accession 9083169 Cuivre River was vegetatively transplanted in 2001. In the flood event of early spring 2002 there was 100% survival of the plants; however the flood event of 2003 late spring to early summer did result in a decline in the plants with 47% survival by spring 2004. Many seedlings were observed that came from seed in the soil that developed fall 2003 and spring 2004.

2004
The wetland cell was not burned and there was no flooding in 2004. A new block was added to the wetland for evaluation. The block contained 16 plants of low growing switchgrass, *Panicum virgatum*, erect big bluestem, and short growing big bluestem, *Andropogon gerardii*. 'Cave-In-Rock' switchgrass was added to the block as a check. The plants were transplanted from plugs grown in the greenhouse in order to get good established plants. They were evaluated for survival in October and only the low growing and 'Cave-in-Rock' switchgrasses were needed; three and four plants respectfully. The block will be flooded in late April to June of 2005 and the entire wetland planting will be evaluated.

2005
In 2005 there was no activity with this study. The warm season grasses, erect big bluestem, 9083274 and short-growing known as Refuge, 9078832, and low growing switchgrass, 9083172, and Cave-in-Rock, 469228, were allowed to establish. Then control of broadleaf weeds was addressed. The flooding sequences are again planned for 2006, but with lack of help may be put off indefinitely.

2006
A re-evaluation of this study was done and a determination was made to evaluate the warm season grasses and other plants in the wetland cell if time and labor is available. A survival evaluation was done on the warm season grasses (bluestems and switchgrasses). Those plants that have died were replaced.

2007
The wetland cell was mowed and the eastern side of the cell has been cleaned and made available for new specie evaluations. There were no flooding sequences in 2007 and plants that are in the wetland cell have been maintained. Plans are to flood the cell in 2008 and simulate the flooding sequence of the Mississippi River in 2007. Evaluations will be taken for survival and regrowth after the flooding event. Potentially new flood tolerant species may be added to the study in 2008.

2008
The warm season grasses, erect (commonly called Epic) big bluestem, 9083274 and Refuge, 9078832, and low growing switchgrass, 9083172, and Cave-in-Rock, 469228, were flooded in April as the plants began to emerge. The height of each plant was between 1/2 to 3 inches. The big bluestems did not progress and the switchgrasses were slow, showing very little growth. After 14 days of inundation the water was dropped and the switchgrasses flourished. Both big bluestems were very slow to recover and did not become full plants as they had in 2007. They were very spindly. The switchgrass plants performed very well after the water was drained. Based on observations from this study, the selected big bluestem accessions would not be a beneficial plant for use in frequently flooded or wetland situations.

2009

There were no evaluations performed in this study in 2009. Information for several different sedges in frequently flooded areas is of growing interest. Different sedge species from the ongoing sedge study could be a possibility for evaluation. This study will stay active on an “as needed” basis.

2010
There were no evaluations performed for this study in 2010. This study will stay active on an “as needed” basis.

2011-2012-2013
There were no evaluations performed for this study in 2011, 2012 and 2013.

This study is discontinued and no other data or conclusions will be presented.

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC							Table #1
Plugs Planted 5-2-97 (Eastern Gamagrass)							
2002 Data	**Began Flooding on 4/24/02**						
2003 Data	**Began Flooding on 6-10-03**						
	Total # Planted	**Active Growing**	**Weed Comp.**	**Disease/ Insect**	**Developed Seed Head**	**Vigor**	**Ave. Ht.**
Eastern Gamagrass 9078840 Chariton, Missouri. 5' spacing, planted 5/2/97.							
						25 plants planted	
Dates Evaluated							
7/9/1998	20	20	severe	moderate	yes	good	2'5"
9/29/1999	20	20	moderate	light rust	yes	good/exc	3'5"
5/11/2000	19	17	moderate	moderate	none	poor	6"
9/19/2000	13	13	mod/sev	light rust	none	good	2'5"
6/26/2001	20	20	light	none	yes	good	3'4"
4/24/02 (BFE)	18	18	light	none	none	good	8"
6/17/02 (AFE)	15	15	light	none	yes	exc	2'
5/27/03 (BFE)	**15**	**15**	**light**	**none**	**yes**	**exc.**	**2'**
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 75%							
Eastern Gamagrass 9078844 Atchison, Missouri. 7' spacing, planted 5/2/97.							
						18 plants planted	
Dates Evaluated							
7/9/1998	12	12	severe	moderate rust	yes	poor	2'5"
9/29/1999	12	12	moderate	moderate rust	yes	fair	2'5"
5/11/2000	12	10	moderate	moderate	none	poor	6"
9/19/2000	12	13	severe	light rust	Yes	fair	2'
6/26/2001	12	9	light	light rust	yes	fair	2'10"
4/24/02 (BFE)	9	9	light	none	none	fair	7"
6/17/02 (AFE)	9	9	light	none	none	exc.	2'
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 75%							
Eastern Gamagrass 9078842 Atchison, Missouri. 15' spacing, planted 5/2/97.							
						9 plants planted	
Dates Evaluated							
7/9/1998	5	5	severe	none	yes	fair	2'
9/29/1999	5	5	severe	none	yes	fair	2'5"
5/11/2000	5	3		none	0	poor	6"
9/19/2000	5	4	severe	none	none	fair	1'8"
6/26/2001	3	3	light	none	yes	fair	2'2"
4/24/02 (BFE)	4	4	light	none	none	fair	7"
6/17/02 (AFE)	4	4	light	none	none	exc.	2'
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 44%							
Rating for Vigor: 1=Excellent; 9=Poor							
Rating for Weed Competition and Dis/Insect: 1=Excellent; 9=Severe							
*** = Cannot determine rows of plants**							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC						Table #1-continued	
	Total # Planted	Active Growing	Weed Comp.	Disease/ Insect	Developed Seed Head	Vigor	Ave. Ht.
Eastern Gamagrass 9078846 Clinton, Missouri. 8' spacing, total planted 5/2/97.							
						16 plants planted	
Dates Evaluated							
7/9/1998	11	11	severe	none	yes	good	2'
9/29/1999	11	11	moderate	none	yes	good	2'5"
5/11/2000	8	8	moderate	none	none	poor	7"
9/19/2000	10	10	severe	light rust	none	fair	2'
6/26/2001	8	8	light	light rust	yes	good	3'2"
4/24/02 (BFE)	10	10	light	none	none	good	8"
6/17/02 (AFE)	10	10	light	none	yes	exc.	2'6"
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 63%							
Eastern Gamagrass 9078843 Atchison, Missouri. 15' spacing, planted 5/2/97.							
						9 plants planted	
Dates Evaluated							
7/9/1998	13	13	severe	none	yes	poor	2'5"
9/29/1999	13	13	moderate	none	yes	moderate	3'
5/11/2000	5	5		none	none	poor	7"
9/19/2000	10	10	severe	slight rust	none	fair	2'
6/26/2001	4	4	light	light	none	fair	2'6"
4/24/02 (BFE)	4	4	light	light	none	fair	8"
6/17/02 (AFE)	4	4	light	light	none	good	2'
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 44%							
Eastern Gamagrass 9078845 Holt, Missouri. 8' spacing, planted 5/2/97.							
						16 plants planted	
Dates Evaluated							
7/9/1998	12	12	severe	none	yes	good	3'5"
9/29/1999	12	12	severe	none	yes	good	3'
5/22/2000	12	9	severe	none	none		8"
9/19/2000	16	16	severe	slight rust	yes	good	2'5"
6/26/2001	10	10	light	none	yes	good	3'2"
4/24/02 (BFE)	10	10	light	none	none	good	8"
6/17/02 (AFE)	10	10	light	none	none	exc.	2'6"
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 63%							
Rating for Vigor: 1=Excellent; 9=Poor							
Rating for Weed Competition and Dis/Insect: 1=Excellent; 9=Severe							
BFE - Before Flooding Event							
AFE - After Flooding Event							
*** = Cannot determine rows of plants**							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC						Table #1-continued	
Eastern Gamagrass 9078845 Holt, Missouri 8' spacing, planted 5/2/97							
	Total Plant #	**Active Growing**	**Weed Comp.**	**Disease/ Insect**	**Developed Seed Head**	**Vigor**	**Ave. Ht.**
Pete Eastern Gamagrass 5' spacing, 25 total planted 5/2/97.							
						25 plants planted	
Dates Evaluated							
7/9/1998	21	21	severe	light	21/21	good	3' 5"
9/29/1999	21	21	severe	light	21/21	good	3'
5/11/2000	21	20		light		fair	10"
9/19/2000	21	21	severe	light rust	17/21	exc.	3'
6/26/2001	19	19	light	none	none	exc.	4'4"
4/24/02 (BFE)	19	19	light	none	none	exc.	8"
6/17/02 (AFE)	14	14	light	none	yes	exc.	2'
5/27/03 (BFE)	*						
8/5/03 (AFE)	*						
Percent surviving as of 6/17/02 was 56%							
BFE - Before Flooding Event							
AFE - After Flooding Event							
Rating for Vigor: 1=Excellent; 9=Poor							
Rating for Weed Competition and Dis/Insect: 1=Excellent; 9=Severe							
*** = Cannot determine rows of plants**							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC							Table #2
Plugs Planted 6-24-97 (Flood Tolerant Switchgrass)							
2002 Data: Flood Event from 4/29/02 to 5/17/02							
2003 Data: Flooding began 6/10/03							
	% Cover/ Plant #	Active Growing	Weed Comp.	Disease/ Insect	Developed Seed Head	Vigor	Ave. Ht.
Switchgrass 9062213 3' spacing, 41 total planted (plugs) 6/24/97.							
Dates Evaluated							
7/9/1998		35 plants	moderate	none	all plants	poor/fair	2'
9/29/1999		35 plants	moderate	none	all plants	fair	2' 5"
4/26/2000		35 plants	moderate	none	none	exc.	5" regrowth
9/19/2000	85% row	35 plants	moderate	none	all plants	exc.	4'5"
6/26/2001		33 plants	light	none	none	exc.	3' 4"
4/24/02 (BFE)		31 plants	light	none	none	good	6"
6/17/02 (AFE)		31plants	light	none	none	exc.	2' 6"
5/27/03 (BFE)		**32 plants**	**light**	**none**	**none**	**exc.**	**1' 7"**
8/5/03 (AFE		**32 plants**	**light**	**none**	**none**	**good**	**2' 5"**
Percent surviving as of 6/17/02 was 76%							
Switchgrass 9062235 4' spacing, 31 total planted (plugs) 6/24/97.							
Dates Evaluated							
7/9/1998		22 plants	moderate	none	all plants	poor/fair	5' 5"
9/29/1999		22 plants	moderate	none	all plants	fair	5'
4/26/2000		26 plants	moderate	none	none	exc.	6' 5"
9/19/2000		26 plants	moderate	none	All plants	exc.	4' 5"
6/26/2001		24 plants	light	none	none	exc.	2' 9"
4/24/02 (BFE)		20 plants	light	none	none	good	6"
6/17/02 (AFE)		20 plants	light	none	none	good	2'
5/27/03 (BFE)		**23 plants**	**light**	**none**	**none**	**exc.**	**1' 8"**
8/5/03 (AFE)		**23 plants**	**light**	**none**	**none**	**good**	**2' 9"**
Percent surviving as of 6/17/02 was 65%							
Switchgrass 9062193 5' spacing; 25 total planted (plugs) 6/24/97.							
Dates Evaluated							
7/9/1998		17 plants	moderate	none	all plants	fair	3' 5"
9/29/1999		17 plants	moderate	none	all plants	good	4' 5"
4/26/2000		21 plants	moderate	none	all plants	exc.	6' 5"
9/19/2000		21 plants	moderate	none	all plants	exc.	5'
6/26/2001		20 plants	light	none	none	exc.	3' 6"
4/24/02 (BFE)		16 plants	light	none	none	good	5"
6/17/02 (AFE)		14 plants	light	none	none	exc.	2' 6"
5/27/03 (BFE)		**19 plants**	**light**	**none**	**none**	**exc.**	**1' 5"**
8/5/03 (AFE)		**19 plants**	**light**	**none**	**none**	**good**	**2' 8"**
Percent surviving as of 6/17/02 was 56%							
BFE - Before Flooding Event							
AFE - After Flooding Event							
* = Cannot determine rows of plants							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC						Table #2 - continued	
	% Cover/ Plant #	Active Growing	Weed Comp.	Disease/ Insect	Developed Seed Head	Vigor	Ave. Ht.
Evaluation Dates:		4/24/02 & 6/17/02					
Cave-In-Rock Switchgrass 23 plants planted.							
Dates Evaluation							
4/18/2000	23	23	severe	none	none	good	5"
9/19/2000	9	growing weak	severe	none	yes	poor	2'
6/21/2001	21	21	light	light	none	good	2' 6"
4/24/02 (BFE)	10	10	light	none	none	good	8"
6/17/02 (AFE)	12	12	light	light	none	good	2' 6"
5/27/03 (BFE)	**16**	**16**	**light**	**light**	**none**	**good**	**1' 5"**
8/5/03 (AFE)	**16**	**16**	**light**	**light**	**none**	**fair**	**2' 6"**
Percent surviving as of 6/17/02 was 52%							
Flood Tolerant Switchgrass, seeded 50' row plus 3' wide.							
Dates Evaluated							
Seeded 6/1/00 50' x 40" plot - .0038 ac. Rate 6# PLS/ac.							
9/19/2000	15%-20% of 50' row	fair	moderate	none	6/5 5%	good	8"
6/21/2001	22	22	light	none	none	exc.	3'
4/24/02 (BFE)	16	16	light	none	none	good	5"
6/17/02 (AFE)	33	33	light	none	none	good	1' 6"
5/27/03 (BFE)	**45%**	**45%**	**light**	**none**	**none**	**good**	**1' 6"**
8/5/03 (AFE)	**45%**	**45%**	**light**	**none**	**none**	**good**	**2' 5"**
Flood tolerant switchgrass plugs block, 63 plants planted 5/25/99.							
Dates Evaluated							
4/26/2000	92%	58 plants	none	none	6/5 100%	exc.	6' 5"
9/19/2000	95%	95%	none	none	6/5 100%	exc.	4' 5"
6/21/2001	80%	66 plants	light	none	none	exc.	3'
4/24/02 (BFE)	85%	66 plants	light	none	none	good	6"
6/17/02 (AFE)	85%	66 plants	light	none	none	good	2'
5/27/03 (BFE)	**85%**	**66 plants**	**light**	**none**	**none**	**good**	**1' 3"**
8/5/03 (AFE)	**85%**	**66 plants**	**light**	**none**	**none**	**fair**	**2' 2"**
Bermudagrass block plugs, planted 5/25/99.							
Dates Evaluated							
9/28/1999	35%	100%	light	none	50%	exc.	3"
4/26/2000		100%	light	none	none	exc.	3-5"
9/19/2000	100%	100%	light	none	100%	exc.	9"
6/21/2001	100%	100%	none	none	none	exc.	6"
4/24/02 (BFE)	100%	50%	none	none	none	good	2"
6/17/02 (AFE)	90%	90%	none	none	none	good	3"
5/27/03 (BFE)	**100%**	**100%**	**none**	**none**	**none**	**fair**	**1"**
8/5/03 (AFE)	**100%**	**100%**	**none**	**none**	**none**	**fair**	**1"**
BFE = Before Flood Event							
AFE = After Flood Event							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC						Table #2 - continued	
	% Cover/ Plant #	Active Growing	Weed Comp.	Disease/ Insect	Developed Seed Head	Vigor	Ave. Ht.
Swamp milkweed block 8 rows plugs, 1' center planted 5/25/99.							
Dates Evaluated							
9/28/99	8 plants		severe foxtail	none	none	poor	9"
5/11/2000	46 plants		moderate	none	none	poor	8"
9/19/2000	30%	30%	moderate	none	30%	fair	1' 2"
6/26/2001	54	54	light	none	none	good	2' 2"
4/24/02 (BFE)	No plants observed; heavy mulch cover of weeds						
6/17/02 (AFE)	41	41	light	none	none	good	1'
5/27/03 (BFE)	**50**	**50**	**light**	**none**	**none**	**good**	**1' 3"**
8/5/03 (AFE)	**50**	**50**	**light**	**none**	**none**	**fair**	**1' 7"**
Cardinal flower, planted 8 plants on 4/17/01 and on 5/1/01							
4/24/2001	BFE		8	none	8	good	2"
5/8/2001	AFE		8	none	8	good	3"
6/11/2001	BFE		16	none	16	good	10"
6/26/2001		7	moderate	none	none	poor	10"
4/24/02 (BFE)		19	none	none	none	exc.	1' 1"
6/17/02 (AFE)		19	none	none	none	good	2'
5/27/03 (BFE)		**11**	**light**	**none**	**none**	**good**	**7"**
8/5/03 (AFE)		**8**	**light**	**none**	**none**	**poor**	**1' 6"**
BFE - Before Flooding Event							
AFE - After Flooding Event							

Study 29A1370 - Wetland Species in Wetland at Elsberry PMC							**Table #3**	
Prairie Cordgrass								
2002 Data: Flood Event from 4/29/02 to 5/17/02								
2003 Data: Flooding Began 6/10/03								
	Total # Planted	**Active Growing Spreading**	**Weed Comp.**	**Disease/ Insect**	**Developed Seed Head**	**Vigor**	**Ave. Ht. Seed Head**	**Average Forage Height**
							10' x 10'	
Prairie Cordgrass Collection, planted 9/29/97							3 | 2 | 1	
East →							6 | 5 | 4	
							9 | 8 | 7	
7/9/1998	9	6" average	severe	none	NA	exc.	-	-
8/1/1999	9	30" average	moderate	none	9/9	good	-	-
9/19/2000	9	4'.5" ave.	none	none	9/9	exc.	6'.5"	5'.0 forage
6/21/2001	9	6'	light	none	none	exc.	6'	45"
4/24/02 (BFE)	9	7.5'	light	none	none	exc.	none	17"
6/17/02 (AFE)	9	8'	light	none	none	exc.	none	36"
5/27/03 (BFE)	**9**	**8.5'**	**light**	**none**	**none**	**exc.**	**none**	**30"**
8/5/03 (AFE)	**9**	**8.5'**	**light**	**none**	**none**	**exc.**	**6.5'**	**40"**
Percent surviving as of 6/17/02 was 100%								
Cuivre Island Prairie Cordgrass Collection, planted 5/15/98					↑		3' x 3'	
					North		4 |3 | 2| 1	
							8 | 7| 6| 5	
7/9/1998	8	5.'5"	severe	none	6 plants	good/exc	4'.0"	4'.0"
5/25/1999	8	1'.5" each	moderate	none	none	exc.	none	
		direction						
Lost Creek Prairie Cordgrass Collection, planted 5/15/98							3'x3'	
							12|11|10|9	
							16|15|14|13	
7/9/1998	8	6"	severe	none	4 plants	good/exc	4'.0"	4'.0"
5/25/1999	8	1'.5" each	moderate	none	none	exc.	none	
		direction						
9/19/2000								
Total block for both collections			none	none	35%	exc.	6' 0"	5' 0"
								More lodging Cuivre
								Island collection
9/19/2000								
14' x 13'5" total spread of blocks			none	none	35%	exc.	6'.0"	More lodging Cuivre
								Island collection
9/19/2000								
3' x 3' block is filled in total								
prairie cordgrass			none	none	35%	exc.	6'.0"	More lodging Cuivre
								Island collection
6/26/2001		solid	none	none	none	exc.	6',0"	50"
4/24/02 (BFE)		80%	none	none	none	exc,	15"	
6/17/02 (AFE)		solid block	none	none	none	exc.	48"	
5/27/03 (BFE)		**solid block**	**none**	**none**	**none**	**exc.**	**none**	**29"**
8/5/03 (AFE)		**solid block**	**none**	**none**	**none**	**exc.**	**6.5'**	**42"**
BFE - Before Flooding Event								
AFE - After Flooding Event								

Study: 29A1370 - Wetland/Riparian Propagation, Establishment, and Demonstration

Table #4

Genus/Species	Common Name	Accession No.	Vigor Rating BFE	Vigor Rating AFE	Date of Rating BFE	Date of Rating AFE
Tripsacum dactyloides	Eastern gamagrass	9098840	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	9078844	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	9078842	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	9078846	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	9078843	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	9078845	*	*	5/27/03	8/5/03
Tripsacum dactyloides	Eastern gamagrass	Pete	*	*	5/27/03	8/5/03
Panicum virgatum	Switchgrass	9062193	Exc.	Good	5/27/03	8/5/03
Panicum virgatum	Switchgrass	9062235	Exc.	Good	5/27/03	8/5/03
Panicum virgatum	Switchgrass	9062213	Exc.	Good	5/27/03	8/5/03
Panicum virgatum	Switchgrass	C-I-R	Good	Fair	5/27/03	8/5/03
Panicum virgatum	Switchgrass Direct Seeded 2001	9083170 Flood-Tolerant	Exc.	Good	5/27/03	8/5/03
Spartina pectinata	Prairie cordgrass	Cuivre Island	Exc.	Exc.	5/27/03	7/5/03
Spartina pectinata	Prairie cordgrass	Lost Creek	Exc.	Exc.	5/27/03	7/5/03
Cynondon dactylon	Bermuda grass	Elsberry	Fair	Fair	5/27/03	7/5/03
Asclepias incarnata	Swamp milkweed	Iowa	Good	Fair	5/27/03	7/5/03
Lobelia cardinalis	Cardinal flower	Forrest Keeling	Good	Poor		7/5/03
Carex scoparia	Broomsedge	MDC	Died			7/5/03
Elymus virginicus	Virginia Wildrye	Cuivre River	Fair	Top Growth Died	5/27/03	7/5/03
Spartina pectinata	Prairie cordgrass Seedlings		Exc.	Exc.	5/27/03	7/5/03
Panicum virgatum	Plugs of switchgrass	9062213 9062235 9062193	Good	Fair	5/27/03	7/5/03

BFE = Before Flood Event AFE = After Flood Event

- **= Cannot determine rows from plants/seed that germinated**

Study: 29A1370 - Wetland/Riparian Propagation, Establishment, and Demonstration

Table #5

Genus/Species	Common Name	Accession No.	Vigor Rating BFE	Vigor Rating AFE	Date of Rating BFE	Date of Rating AFE
Andropogon gerardii	**Epic Big Bluestem**	9083274	Exc.	Fair	4/14/08	5/5/08
Andropogon gerardii	**Refuge Big Bluestem**	9078832	Exc.	Fair	4/14/08	5/5/08
Panicum virgatum	**Low Growing Switchgrass**	9083172	Exc.	Exc.	4/14/08	5/5/08
Panicum virgatum	**Cave-in-Rock Switchgrass**	469228	Exc.	Exc.	4/14/08	5/5/08

BFE = Before Flood Event AFE = After Flood Event

- **= Cannot determine rows from plants/seed that germinated**

Assembly and Evaluation of Little Bluestem (*Schizachyrium scoparium* Nichx.)

Study No. 29I141G

National Project(s): Critical Area 1.1; Cropland 2.1 and 4.1; Pasture/Hayland 2.1; Rangeland 1.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Little bluestem is a native warm season prairie grass. It was a major component making up as much as 50 percent of the tall grass prairie that was native to much of the Elsberry PMC service area. It can also be a major component of glade areas and mixed grass prairies. Little bluestem can be found in prairies, open woods, dry hills, and fields, from Quebec and Maine to Alberta and Idaho, south to Florida and Arizona.

There are no current varieties of little bluestem on the market that have an origin within the three-state service area. Available varieties do not always perform as well as expected. There is a need for an adapted and improved variety of little bluestem for pasture and range seedings, surface mine reclamation, critical area planting, wildlife plantings, recreational area development and other conservation uses in Missouri, Iowa, and Illinois.

Objective: The objective is to assemble, evaluate, develop and cooperatively release an adapted variety and/or varieties of tested class of little bluestem for conservation use in Missouri, Iowa, and Illinois.

Procedure: Vegetative material from native ecotypes was collected throughout the states of Missouri, Iowa, and Illinois. A minimum of three collections per Major Land Resource Area/state was requested. (Approximately 60 collections total.) Field selection of collected plant material was based on forage quantity and plant vigor.

Each collection (accession) was one individual plant. A collection was made up of more than one plant if they were in the same immediate area (within five feet) and appeared to be clones of each other.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

1996
The study was approved in July 1996. Collection instructions were sent out and plants were dug in October and November. The samples were picked up shortly after collection and stored in the packing shed at the Plant Materials Center. At this time we received 113 collections from the three-state area. There are a few additional collections expected.

1997 - 1998
The collections were vegetatively propagated in containers in January and grown out in the greenhouse until April. These plants were then transplanted in Field #1 on the PMC April 22-24, 1997 in a randomized complete block with four replications (see Table #2 for map of plot layout). Thirteen additional collections were made in the summer of 1997 and planted into the replications August 14-15, 1997. This brought the total accessions represented to 130: 79 from Missouri, 20 from Illinois, 27 from Iowa, and four standards of comparison. A list of collectors can be seen in Table #1. First year evaluation consisted of survival. The second year evaluations consisted of survival, height, late dormancy, and form.

1999
The assembly was evaluated in 1999 for forage amount and vigor (Tables #3 and #4). The higher rated plants will have forage quality samples taken in 2000.

2000
The assembly was evaluated for mid-season forage production, quality and vigor on June 27, 2000. The entire planting was then clipped to a height of six inches on June 28, 2000. The assembly was evaluated for amount of regrowth and vigor on July 25, 2000 and forage quality samples were taken on August 1, 2000. The assembly was clipped the second time on August 2, 2000 and evaluations for regrowth amount and vigor were taken October 24, 2000.

2001
Evaluations from previous years were correlated and the best plants from the top 10-20 percent of the total accessions were propagated in the greenhouse from clonal material from each individual plant. Plants were then isolated in two locations. A northern region was established containing plants from Iowa, northern Missouri, and northern Illinois. A southern region was established containing plants from southern Missouri and central and southern Illinois. These isolation blocks will receive additional evaluation to remove unwanted plants and the remaining plants will be allowed to produce seed. Plants from this seed will be selected for the next evaluation nursery. After further evaluation, plants from the nursery planted in 2003 will be used as a breeder's block for improved selections. Plants selected for each region can be found in Table #5.

2002
The south region crossing block did very well in 2002. Very few plants were rouged out and seed was harvested from each accession in the block. This seed will be used to establish the next evaluation nursery scheduled for 2003.

The north region crossing block did not do well in 2002. Weed control became a problem and many of the plants were reestablished and did not make seed. Filling in additional plants is scheduled for 2002 and also seed production from this crossing block.

2003
Seed from the south region crossing block was evaluated for quick establishment and plants were grown in the greenhouse for establishment of the recurrent selection evaluation nursery. Approximately 500 plants were transplanted on three foot centers in this evaluation block.

The plants will be allowed to develop and be evaluated for forage. Plants in the north region crossing block were not all equally matured and no seed was harvested from this block.

2004
The plants in the southern region evaluation block were given 2004 to develop and mature. Evaluation of this block will begin in 2005.

Seed was harvested from the northern region crossing block, cleaned, and planted in the greenhouse. These plants were evaluated for quick establishment and seedling vigor. Selected plants will be transplanted into an evaluation nursery.

2005
The plants in the southern region nursery were evaluated based on vigor, amount of forage production, leafiness, drought resistance, disease and insect resistance, and late maturity. Of

312 plants 195 plants were selected (62.5%) and allowed to cross pollinate. Seed was collected from the selected plants to establish a foundation field next year. This south region selection was given the accession number 9083271.

Greenhouse plants selected for seedling vigor from seed harvested from the northern crossing block were transplanted into an evaluation nursery.

2006
A .75 acre foundation field (G1) of southern region selection (accession 9083271) was planted in field #12 on the PMC. Establishment was good but no seed was harvested the first year. Some plants did produce seed but there was not enough to justify a harvest.

The northern region crossing block was evaluated for survival and missing plants were reestablished with greenhouse plants selected for seedling vigor. This evaluation nursery had no further evaluation or selection.

2007
The southern region selection (accession 9083271) G0 block (field 11) was harvested in 2007 but seed was very limited. This seed was used to expand the foundation (G1) field (Field 12). The small expanded portion of the field established poorly. The larger part of the G1 field produced 58.9 pounds bulk seed from approximately 0.60 acre. This seed will be used for field plantings for additional testing.

The northern region crossing block was evaluated for forage production, seed production and late maturity. This block started with 506 plants with a survival of over 95%. There were 159 of these selected and allowed to cross pollinate. Seed was harvested individually from the 159 and will be placed in the germinator and plants germinating the quickest will go to the next evaluation block.

2008
The southern region selection (accession 9083271) of little bluestem, G0 block (field 11) was harvested in 2008 and produced 11.1# bulk seed. Seed was very limited. This seed will be used to establish a new foundation (G1) plot in field 7 because the original increase plot in field 12 has to much indiangrass contamination from the adjoining plot. The G1 plot in field 12 produced 107.6 pounds bulk seed from approximately 0.60 acre. This seed will be used for field plantings for additional testing.

The northern region crossing block (Cycle 2) of little bluestem was again evaluated for forage production, seed production and late maturity. The top 20 individual plants were selected and allowed to cross pollinate. Seed was harvested individually from the 20 plants and placed in the germinator and the plants that germinated the quickest were added to the next block (Cycle 3, Breeders Block at FKN).

2009
The southern region selection (accession 9083271) of little bluestem, G0 block (field 11) was harvested in 2009 and produced 16.4# bulk seed. This seed will be used to enlarge the foundation (G1) plot in field 7 that was planted in 2009 but did not produce seed the first year. The G1 plot in field 12 produced 58.1# bulk seed from approximately 0.60 acre. This seed will be allocated to seed growers interested in producing the new release in 2010.

The northern region crossing block (Cycle 2) of little bluestem was again narrowed to the top 20 plants again and allowed to cross pollinate. Seed was harvested individually from the 20 selections and placed in the germinator and the plants that germinated the quickest were added to the Cycle 3, Breeders Block at FKN. Undesirable plants in this block were rouged out.

2010

Southern region selection (9083271) was released as a selected class release in 2010. The new release name is Ozark Germplasm. A few growers have already picked up the release and it should be available on the commercial market in 2011. The Elsberry PMC harvested over 300 bulk pounds of seed from just over an acre. Seed for this release is currently available to other interested growers.

The northern region (cycle 3 – breeders block) SG0 plot was completed on the FKN property and will be harvested in 2011. Seed from this plot will be used to establish an SG1 (foundation) field. Field testing will begin once seed has been harvested from the SG1 field.

2011-2012-2013

The northern region little bluestem seed from the breeders block located on FKN was collected in 2011, 2012 and 2013. The seed will be used to plant a SG1 block in the spring of 2014. Also seed will be offered out for field plantings to capture field evaluation data compared to other varieties such as ‘Aldous’ and Ozark Germplasm once seed has been harvested off the SG1 plot. Information gathered will be used to finalize the release of this selection.

Study 29I141G - Assembly and Evaulation of Little Bluestem, *Schizachyrium scoparium* , Nichx.

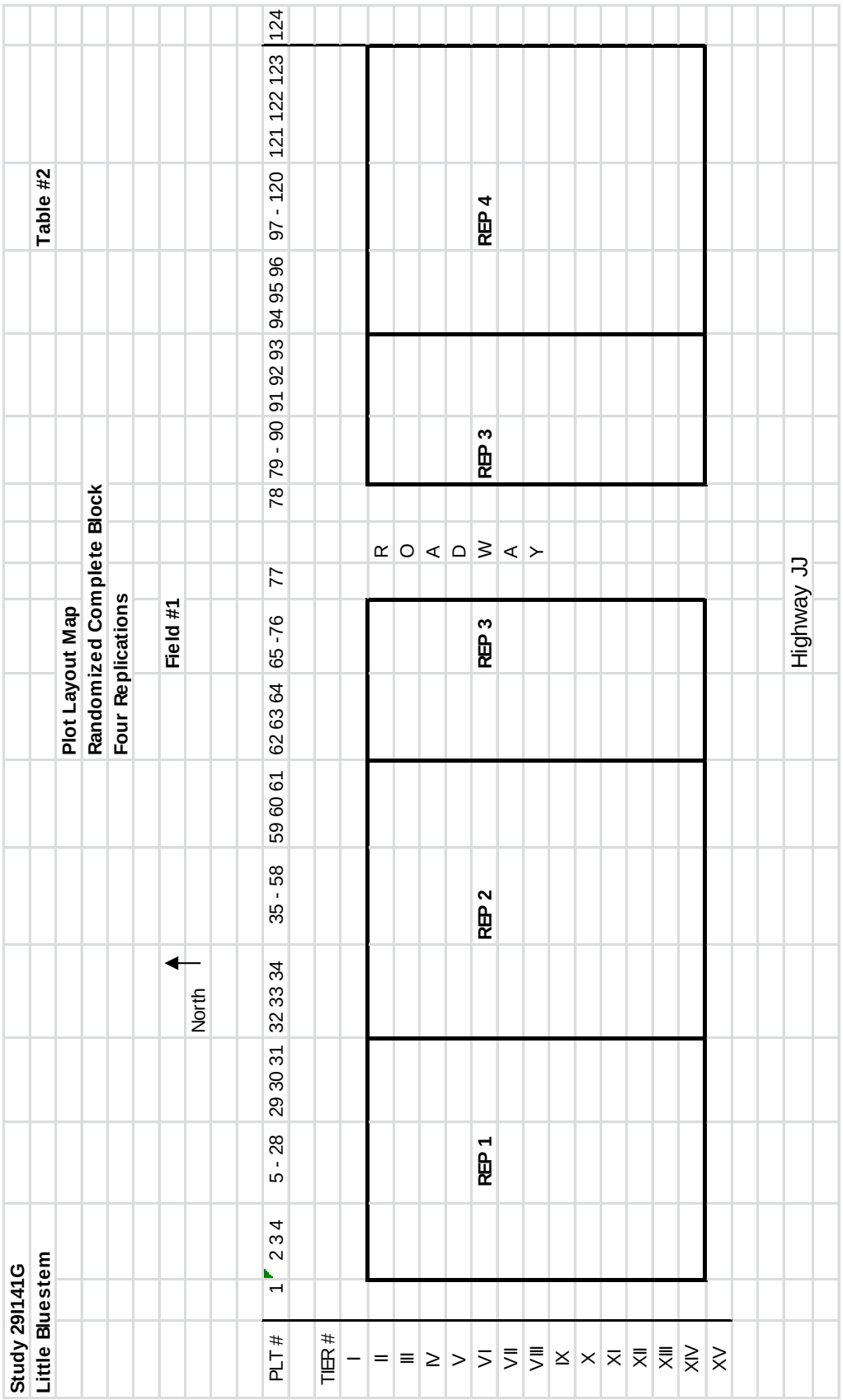
Little Bluestem **Table #1**

ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
9078894	MO-1	Robert S. Crowder	M115	Chariton	Missouri
9078951	MO-2	Robert J. Crowder/	109	Chariton	Missouri
		George L. Pollard			
9078895	MO-3	Joe Tousignant	N116B	Cape Girardeau	Missouri
9078896	MO-4	Douglas Rainey	M115	Clark	Missouri
9078897	MO-5	David S. Mackey	113	Knox	Missouri
9078898	MO-6	Larry R. Brewer	M109	Putnam	Missouri
9078899	MO-7	Tommy Robins/	116	Ripley	Missouri
		Jim Hoefer			
9078900	MO-8	Grant P. Butler	N116B	Jefferson	Missouri
9078901	MO-9			Iron	Missouri
9078902	MO-10	Tommy Robins/	116	Carter	Missouri
		Jim Hoefer			
9078903	MO-11	Arch J. Mueller	M115	Ste. Genevieve	Missouri
9078904	MO-12			St. Francois	Missouri
9078905	MO-13	J. Mark Mitchell		Butler	Missouri
9078906	MO-14	Randy C. Miller	N116A	Shannon	Missouri
9078907	MO-15	Tom Johnson	N116B	Bollinger	Missouri
9078908	MO-16	Tom Johnson	N116A	Bollinger	Missouri
9078909	MO-17	Randy C. Miller	N116B	Reynolds	Missouri
9078910	MO-18			Franklin	Missouri
9078911	MO-19	Tom Johnson	N116A	Wayne	Missouri
9078912	MO-20	Mark E.Nussbaum	N116B	Cape Girardeau	Missouri
9078913	MO-21	Frank Oberle	115	Adair	Missouri
9078914	MO-22	David S. Mackey	113	Knox	Missouri
9078915	MO-23	Claude F. Peifer	116B	Perry	Missouri
9078916	MO-24	Grant P. Butler/	N116A	Washington	Missouri
		Bryan L. Westfall			
9078917	MO-25	John E. Turner	113/115	Monroe	Missouri
9078918	MO-26	David S. Mackey	113	Knox	Missouri
9078919	MO-27	Douglas Rainey	M115	Clark	Missouri
9078920	MO-28	Frank Oberle	115	Adair	Missouri
9078921	MO-29		M115	Montgomery	Missouri
9078922	MO-30	David S. Mackey	113	Knox	Missouri
9078923	MO-31	Curtis W. Walker	109	Clinton	Missouri
9078924	MO-32	James A. Mayberry	109	Carroll	Missouri
9078925	MO-33	Gary J. Barker	M109	Gentry	Missouri
9078926	MO-34			Vernon	Missouri
9078927	MO-35	Louis Byford		Atchison	Missouri
9078928	MO-36	Todd E. Mason	M109	Worth	Missouri
9078929	MO-37	Louis Byford		Atchison	Missouri
9078930	MO-38	Louis Byford		Atchison	Missouri
9078931	MO-39	Ronald L. Musick	M109	Harrison	Missouri

Study 29I141G - Little Bluestem				Table #1 - continued	
ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
9078932	MO-40	Gary J. Barker	M109	Gentry	Missouri
9078933	MO-41	Curtis Walker	109	Gentry	Missouri
9078934	MO-42	Curtis Walker	107	Buchanan	Missouri
9078935	MO-43	Louis Byford		Atchison	Missouri
9078936	MO-44	Ronald L. Musick	M109	Harrison	Missouri
9078937	MO-45	Louis Byford		Atchison	Missouri
9078938	MO-46	Louis Byford		Atchison	Missouri
9078939	MO-47	Bob Sipec		Holt	Missouri
9078940	MO-48	Bib Sipec		Holt	Missouri
9078941	MO-49	Bob Sipec		Holt	Missouri
9078942	MO-50	Ian S. Kurtz	116A	Taney	Missouri
9078943	MO-52	Dennis Shirk/	115	Gasconade	Missouri
		Ed Gillmore			
9078944	MO-53	Dennis Shirk/	116	Osage	Missouri
		Ed Gillmore			
9078945	MO-54	Raleigh Redman	112	Henry	Missouri
9078946	MO-55	Dennis Shirk/	116	Maries	Missouri
		Ed Gillmore			
9078947	MO-56	Jerry Cloyed	M112	Barton	Missouri
9078948	MO-57	Ian S. Kurtz	116A	Taney	Missouri
9078949	MO-58	Ben A. Reed	M112	Barton	Missouri
9078950	MO-59	Jerry Cloyed	M112	Barton	Missouri
9078952	MO-60	M. Denise Brown	N116A	Miller	Missouri
9078953	MO-61	M. Denise Brown	N116B	Miller	Missouri
9078954	MO-62	Howard L. Coambes	N116B	Cedar	Missouri
9078955	MO-63	Howard L. Coambes	N116B	Cedar	Missouri
9078956	MO-64	Douglas G. Newman		Shannon	Missouri
9078957	MO-65	Tom E. Toney		Wayne	Missouri
9078958	MO-66	Rod Doolen		Wayne	Missouri
9078959	MO-67	Rod Doolen		Wayne	Missouri
9078960	MO-68	Kenneth L. Dalrymple		Pike	Missouri
9078963	MO-69	Maurice Davis/		Pettis	Missouri
		Steve Clubine			
	MO-70	Maurice Davis/		Benton	Missouri
		Steve Clubine			
	MO-71	Maurice Davis/		St. Clair	Missouri
		Steve Clubine			
	MO-72	Maurice Davis/		Benton	Missouri
		Steve Clubine			
9078964	MO-73	Maurice Davis/		Pettis	Missouri
		Steve Clubine			
9078965	MO-74	Maurice Davis/		Pettis	Missouri
		Steve Clubine			

Study 29I141G - Little Bluestem				Table #1 - continued	
ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
	MO-75	Maurice Davis/		Pettis	Missouri
		Steve Clubine			
	MO-76	Maurice Davis/		Benton	Missouri
		Steve Clubine			
9078966	MO-77	Maurice Davis/		Maries	Missouri
		Steve Clubine			
9078967	MO-78	Dennis Shirk		Maries	Missouri
9078968	MO-79	Steve Clubine		Maries	Missouri
9078969	MO-80	Maurice Davis		Maries	Missouri
9078970	MO-81			Lawrence	Missouri
9078961	IA-27	Robert R. Bryant/	108	Scott	Iowa
		Shawn Dettman			
9078847	IA-1	Curt Donohue	109	Clarke	Iowa
9078848	IA-2	Curt Donohue	109	Clarke	Iowa
9078849	IA-3	Janet M. Thomas/	107	Cherokee	Iowa
		John P. Vogel			
9078850	IA-4	John P. Vogel	107	Woodbury	Iowa
9078851	IA-5	Henry D. Tordoff	107	West	Iowa
				Pottawattamie	Iowa
9078852	IA-6	Henry D. Tordoff/	107	West	Iowa
		Galen Barrett		Pottawattamie	Iowa
9078853	IA-7	John P. Vogel	107	Woodbury	Iowa
9078854	IA-8	Henry D. Tordoff	107	West	Iowa
				Pottawattamie	Iowa
9078855	IA-9	John P. Vogel	107	Plymouth	Iowa
9078856	IA-10	Henry D. Tordoff	107	West	Iowa
				Pottawattamie	Iowa
9078857	IA-11	Julie K. Watkins/	108	Franklin	Iowa
		Charlie E. Kiepe			
9078858	IA-12	Brad Harrison	103	Dallas	Iowa
9078859	IA-13	Shawn A. Dettman	108	Muscatine	Iowa
9078860	IA-14	Jim Ranum	105	Allamakee	Iowa
9078861	IA-15	Rick Cordes	104	Howard	Iowa
9078862	IA-16	James Ranum	105	Allamakee	Iowa
9078863	IA-17	Jay E. Ford	107	Crawford	Iowa
9078864	IA-18	Steve Maternack	103	Polk	Iowa
9078865	IA-19	Jay E. Ford	107	Crawford	Iowa
9078866	IA-20	Jay E. Ford	107	Crawford	Iowa
9078867	IA-21	Al Ehley	104	Cerro Gordo	Iowa
9078868	IA-22	Al Ehley	104	Cerro Gordo	Iowa
9078869	IA-23	John P. Vogel	102	Lyon	Iowa
9078870	IA-24	Jay E. Ford	107	Crawford	Iowa

Study 29I141G - Little Bluestem				Table #1 - continued	
ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
9078871	IA-25	Jay E. Ford	107	Crawford	Iowa
9078872	IA-26	John Vogel	102	Lyon	Iowa
9078962	IA-28		105		Minnesota
9078873	IL-1	Barbara Sheffer	95B	Kane	Illinois
9078874	IL-2	David J. Harrison/	105	Whiteside	Illinois
		Mark Kaiser			
9078875	IL-3	Barbara Sheffer	95B	Kane	Illinois
9078876	IL-4	Timothy Dring	115	Pike	Illinois
9078877	IL-5	Jim Ritterbusch		Stephenson	Illinois
9078878	IL-6	Jim Ritterbusch		Stephenson	Illinois
9078879	IL-7	Dennis D. Clancy	113	Jasper	Illinois
9078880	IL-8	Bob Jankowski/	110	Will	Illinois
		Steve Hollister			
9078881	IL-9	Barbara Sheffer	95B	Kane	Illinois
9078882	IL-10	Timothy P. Dring	108	Henderson	Illinois
9078883	IL-11	John D. Lundquist	105	Carroll	Illinois
9078884	IL-12	Bill Kleiman		Lee	Illinois
9078885	IL-13	Laura S. Dufford	105	Jo Daviess	Illinois
9078886	IL-14	David J. Harrison/	108	Whiteside	Illinois
		Mark Kaiser			
9078887	IL-15	Timothy P. Dring	108	Mason	Illinois
9078888	IL-16	W. Burke Davies	113	Marion	Illinois
9078889	IL-17	Michael Stanfill/	115	Monroe	Illinois
		Marty Kemper			
9078890	IL-18	Kenton L. Macy	114	Cumberland	Illinois
9078891	IL-19	Martha E. Sheppard	115	Calhoun	Illinois
9078892	IL-20	Michael Stanfill/	113	Washington	Illinois
		Marty Kemper			
9078893	IL-21	Remington T. Irwin	114	Wayne	Illinois


Study 29l141G
Little Bluestem
Plot Layout Map
Randomized Complete Block
Four Replications
Table #2
Field #1
North
PLT # 1 2 3 4 5 - 28 29 30 31 32 33 34 35 - 58 59 60 61 62 63 64 65 -76 77 78 79 - 90 91 92 93 94 95 96 97 - 120 121 122 123 124
TIER #
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV
XV
REP 1
REP 2
REP 3
REP 3
REP 4
ROADWAY
Highway JJ

Study 29I141G		Little Bluestem													Field #1				Table #2 - continued				Rep #1
PLT #	1	2 3 4	5 6 7	8 9 10	11 12 13	14 15 16	17 18 19	20 21 22	23 24 25	26 27 28	29 30 31												NORTH
TIER #																							
I	j	V V X	X j X	X X X	j X X	j X X	X j X	X W W	W W W	W W W	W W W	I											
II	V	MO-9	IA-11	MO-30	MO-45	MO-31	MO-78	MO-47	IL-8	IA-25	MO-63	II											
III	V	MO-55	IL-21	MO-10	IL-13	MO-6	MO-60	MO-28	MO-36	MO-24	IL-15	III											
IV	V	IA-12	MO-74	MO-51	MO-40	MO-27	MO-57	MO-58	MO-15	IA-17	MO-1	IV											
V	V	MO-42	IA-26	IL-3	MO-77	MO-67	ALDOUS	IA-15	MO-28	MO-50	IA-19	V											
VI	V	IA-7	MO-52	MO-39	MO-35	IL-4	IA-5	MO-23	IA-16	MO-21	MO-33	VI											
VII	i	MO-14	IL-17	MO-13	IA-3	IA-23	MO-65	IA-18	MO-61	IA-24	MO-48	VII											
VIII	V	MO-56	MO-26	MO-69	IL-5	MO-46	IL-20	MO-80	MO-5	MO-7	IL-10	VIII											
IX	i	MO-34	PASTURA	IL-11	MO-4	IL-16	MO-16	MO-37	MO-32	MO-59	IA-22	IX											
X	V	IL-2	MO-8	MO-29	MO-49	MO-81	IA-1	IL-7	IA-27	MO-25	CAMPER	X											
XI	i	IA-10	MO-64	MO-20	MO-66	IA-4	MO-12	MO-22	IL-1	IA-2	MO-54	XI											
XII	V	MO-71	MO-17	IL-14	MO-73	MO-44	CIMMERON	MO-18	MO-53	MO-79	MO-72	XII											
XIII	V	IL-12	MO-41	IA-8	IL-19	IA-20	MO-62	IA-6	MO-68	MO-11	IA-21	XIII											
XIV	T	MO-38	IA-13	MO-43	IA-9	IL-9	IL-6	MO-19	MO-3	IA-14	IL-18	XIV											
XV	T	T T j	j T T	T T T	T j j	T T Y	Y Y Y	Y Y Y	Y Y Y	Y Y Y	Y Y Y	XV											
MO-57 ONLY ONE PLANT					3 PLANTS/PLOT (MO-9)																		
IL-8 ONLY ONE PLANT					LETTERS (V, j, ETC..) ARE SINGLE PLANT BORDER ROWS																		

PLT #	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	Rep #2
TIER #																															
I	?	?	?	W	W	W	W	W	W	W	W	b	b	b	b	b	b	b	b	b	b	b	b	b	R	R	R	R	R	R	I
II	MO-34			IL-18			IA-7			MO-31			MO-6			MO-53			MO-2			IA-18			MO-22			MO-48			II
III	MO-71			MO-24			MO-35			IA-14			IA-23			IA-2			MO-74			MO-28			CAMPER			MO-57			III
IV	MO-8			MO-42			MO-67			IL-1			MO-60			MO-33			MO-37			MO-26			IL-21			IL-7			III
V	IA-13			IA-3			MO-9			MO-39			IL-16			IA-8			MO-15			MO-69			MO-14			MO-25			IV
VI	MO-50			CIMMERON			IL-4			MO-59			MO-52			MO-40			MO-51			IA-27			MO-81			IA-16			VI
VII	IA-17			MO-63			MO-66			IL-20			MO-72			IL-19			MO-19			MO-23			IL-11			IL-10			VII
VIII	MO-32			IA-6			MO-4			IA-11			IL-2			MO-54			IA-26			IL-8			MO-41			IA-4			VIII
IX	IA-10			MO-77			IL-5			MO-46			MO-56			MO-64			MO-1			MO-21			MO-65			MO-10			IX
X	IL-14			MO-38			MO-49			MO-27			IL-12			MO-79			IA-19			MO-68			IA-1			ALDOUS			X
XI	MO-61			IA-9			MO-55			IL-15			IA-25			MO-17			MO-7			IA-5			IL-9			IL-3			XI
XII	IA-24			MO-47			MO-78			MO-43			PASTURA			MO-20			MO-73			MO-12			IA-20			MO-13			XII
XIII	MO-30			MO-18			MO-11			IL-6			MO-3			IL-13			IA-12			IA-22			MO-29			MO-44			XIII
XIV	MO-45			MO-62			MO-58			MO-5			IL-17			IA-21			MO-80			MO-16			MO-36			IA-15			XIV
XV	Y	Y	S	i	S	S	S	S	S	S	S	S	S	S	S	S	S	S	h	S	S	Y	h	Y	Y	Y	Y	h	J	J	XV

Study 29I141G **Little Bluestem** **Table #2 - continued** **Rep #3** **North** ←

PLT #	62 63 64	65 66 6	68 69 70	71 72 73	74 75 76	77	78	79 80 81	82 83 84	85 86 87	88 89 90	91 92 93	
TIER #	R R R	R R R	R c c	c c c	c c c	c	a	a a a	a b b	j b b	j j j	R R R	I
I	MO-45	IL-6	MO-71	IA-13	MO-31	B	a	IL-4	MO-63	MO-11	IL-8	IL-11	II
II	MO-61	MO-19	MO-43	MO-50	MO-40	B ***R*** a		IA-21	IL-13	IL-17	MO-68	MO-29	III
III	IA-9	MO-51	MO-58	IA-17	MO-55	E ***O*** a		MO-47	MO-56	MO-2	MO-13	IL-11	IV
IV	MO-35	MO-1	MO-23	IA-24	MO-24	E ***A*** a		IL-5	CAMPER	MO-69	IL-12	MO-25	V
V	MO-39	MO-28	MO-36	MO-42	MO-53	E ***D*** a		MO-54	IA-26	IA-14	IA-5	IA-15	VI
VI	MO-77	IA-19	CIMMERON	IA-18	MO-64	C ***W*** a		MO-6	MO-33	MO-73	MO-16	IL-3	VII
VII	MO-9	MO-7	IA-23	IL-20	IA-4	C ***A*** i		MO-32	IA-26	MO-52	MO-22	MO-44	VIII
VIII	IA-6	MO-80	IL-2	IA-10	MO-5	G ***Y*** a		IA-7	MO-20	IL-16	MO-48	IA-16	IX
IX	MO-8	IA-12	MO-78	MO-30	IA-25	G a		MO-79	MO-17	MO-59	MO-14	IL-7	X
X	MO-34	MO-12	MO-46	IA-8	MO-18	I a		IA-11	IL-21	MO-72	IA-22	PASTURA	XI
XI	IL-14	MO-26	MO-4	IL-19	MO-38	I a		MO-74	MO-33	MO-21	MO-65	IL-9	XII
XII	IL-18	IA-27	MO-66	ALDOUS	MO-67	O a		IA-3	MO-27	MO-81	MO-41	IA-20	XIII
XIII	MO-60	MO-10	MO-37	MO-15	MO-62	O a		MO-49	IL-15	MO-57	IA-1	IL-10	XIV
XIV													XV
XV	H H A	A K K	F F D	D L L	M M N	N a		a c c	c c c	c c c	c c c	h c c	

IL-8 only one planted

PLT #	94 95 96	97 98 99	100 101102	103 104 105	106 107 108	109 110	111 112 113 114	115 116 11	118 119 120	121 122 123	124	
TIER #	R i R	a a a	X X X	X X U	i U U	U U U	U U U	W W W	W W W	W W W		I
I	IA-9	IL-18	MO-8	MO-74	MO-40	IA-25	MO-5	MO-42	IA-4	IA-20		d II
II	MO-58	IA-19	MO-28	IL-17	MO-53	IL-8	PASTURA	MO-37	IL-10	MO-77		d III
III	ALDOUS	MO-80	IA-21	MO-2	IA-8	MO-26	IA-26	MO-68	MO-14	MO-52		d IV
IV	MO-51	IA-18	MO-20	MO-46	IL-1	MO-1	MO-62	MO-44	MO-9	MO-34		d V
V	IA-17	IA-10	MO-33	IA-24	MO-43	IL-12	IA-5	MO-81	CIMMERON	MO-19		d VI
VI	MO-64	IA-10	CAMPER	MO-3	MO-69	MO-61	IA-16	IL-4	MO-35	MO-21		d VII
VII	IA-27	MO-39	IL-19	MO-57	IL-6	MO-38	MO-67	MO-25	MO-48	IL-14		e IX
VIII	MO-60	MO-15	MO-63	IA-7	MO-36	IL-15	MO-49	IA-13	MO-29	MO-30		e X
IX	MO-12	MO-41	MO-32	MO-55	IA-12	MO-47	IA-26	IL-21	MO-65	IL-9		e XI
X	IL-20	IA-23	IA-11	MO-46	MO-17	IL-2	IL-13	MO-45	IL-11	IA-22		f XII
XI	MO-50	MO-6	MO-59	IA-14	MO-31	MO-54	MO-79	IA-3	MO-16	IL-7		f XIII
XII	MO-71	MO-78	MO-27	MO-73	MO-18	IA-15	MO-66	MO-72	MO-22	MO-10		f XIV
XIII	MO-7	MO-11	IL-16	MO-23	IA-1	IL-5	IA-6	MO-13	IL-3	MO-56		f XV
XIV	MO-24	R h R	R S h	h S S	S S T	h h h	T V V	V h g	g g g			g
XV	c R R											

Study 29I141G							Forage Rating: 8/9/99									Table #3	
Little Bluestem																	
			1 = High				9 = Low										
Local Number	Rep 1			Rep 2			Rep 3			Rep 4			Percent Survival	Ave. Living Plants	Best Plant	Locations
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12				
MO-7	2	3	1	3	3	2	2	1	2	5	1	3	100	2.33	1	P 1, 8, 11
MO-12	1	2	1	3	2	2	3	2	2	1	1	1	100	1.75	1	P 1, 3, 12, 11, 12
MO-21	1	2	2	6	2	3	4	3	3	4	4	5	100	3.25	1	P 1
MO-74	3	3	5	4	4	4	5	5	4	1	2	1	100	3.42	1	P 10, 12
MO-80	3	3	x	4	5	5	4	4	2	1	4	3	92	3.45	1	P 10
MO-4	x	5	5	4	8	2	3	4	4	6	x	x	83	4.10	2	P 6
MO-9	4	4	4	3	4	4	3	4	3	2	3	3	100	3.42	2	P 10
MO-14	4	4	3	4	4	4	5	2	2	4	4	3	100	3.58	2	P 8, 9
MO-15	3	2	3	5	4	3	6	4	5	4	3	5	100	3.92	2	P 2
MO-22	4	5	5	3	4	2	5	5	6	x	8	x	83	4.70	2	P 6
MO-23	3	5	6	2	6	8	5	4	5	8	8	3	100	5.73	2	P 4
MO-24	3	x	2	x	4	4	3	4	3	3	4	5	83	3.18	2	P 3
MO-32	4	x	8	6	7	3	3	4	5	2	5	6	92	4.82	2	P 10
MO-34	4	4	4	3	4	3	x	x	4	2	x	5	75	3.00	2	P 10
MO-37	2	4	3	7	5	4	x	5	4	3	4	3	92	3.67	2	P 1
MO-42	5	5	6	4	5	2	4	4	4	5	5	7	100	4.67	2	P 6
MO-50	3	3	4	2	2	2	3	4	6	2	3	4	100	3.17	2	P 4, 5, 6, 10
MO-51	3	3	3	3	4	4	4	6	3	4	3	2	100	3.50	2	P 12
MO-53	4	4	5	5	5	5	2	4	5	5	6	7	100	4.75	2	P 7
MO-56	3	3	2	2	5	4	5	3	3	3	3	3	100	3.25	2	P 3, 4
MO-58	3	3	3	5	4	5	5	5	5	2	2	4	100	3.83	2	P 10, 11
MO-59	2	3	4	4	4	5	3	3	3	3	4	4	100	3.50	2	P 1
MO-66	3	3	x	3	3	3	3	2	4	4	5	5	92	3.45	2	P 8
MO-73	7	4	4	3	3	2	4	5	5	7	8	6	100	4.83	2	P 6
MO-79	2	3	2	5	3	5	3	8	5	4	4	3	100	3.92	2	P 1, 3
MO-2	4	5	3	5	5	5	5	3	3	3	4	3	100	4.00	3	P 3, 8, 9, 10, 12
MO-5	7	3	3	5	5	5	6	8	4	4	5	4	100	4.92	3	P 2, 3
MO-8	6	x	5	5	4	5	7	4	8	3	3	4	92	4.91	3	P 10, 11
MO-10	4	5	5	3	3	5	5	5	5	7	5	4	100	4.67	3	P 4, 12
MO-11	x	7	x	4	5	6	6	6	5	3	3	6	83	4.25	3	P 10, 11
MO-13	5	8	5	5	x	5	4	4	3	6	4	6	100	4.58	3	P 9
MO-16	4	3	8	6	6	54	5	6	4	4	5	100	75	3.00	3	P 2
MO-17	4	4	3	4	3	7	8	6	5	4	5	5	100	4.83	3	P 3, 5
MO-18	3	4	3	7	7	8	x	x	x	5	5	5	75	3.92	3	P 1, 3
MO-19	3	5	5	3	4	3	4	6	5	3	5	4	100	4.17	3	P 1, 4, 6, 10
MO-20	8	7	6	7	6	5	3	4	5	4	8	3	100	6.60	3	P 7, 12
MO-25	3	3	x	5	5	5	5	4	6	5	5	6	92	4.33	3	P 1, 2
MO-26	3	4	4	5	x	4	3	4	4	3	4	5	92	4.30	3	P 1, 7, 10
MO-27	5	6	3	4	5	4	6	5	4	5	5	7	100	5.36	3	P 3
MO-29	4	3	x	4	5	4	4	6	3	3	5	8	92	4.45	3	P 2, 9, 10
MO-30	3	4	5	7	7	x	4	4	7	4	3	4	92	4.73	3	P 1, 11
MO-31	7	3	4	4	4	6	7	8	x	5	5	5	92	5.27	3	P 2

Study 29I141G							Forage Rating: 8/9/99									Table #3 - continued
Little Bluestem																
			1 = High				9 = Low									
Local Number	Rep 1 P1	P2	P3	Rep 2 P4	P5	P6	Rep 3 P7	P8	P9	Rep 4 P10	P11	P12	Percent Survival	Ave. Living Plants	Best Plant	Locations
MO-33	3	x	3	5	5	3	4	5	5	8	8	4	92	5.89	3	P 1, 3, 6
MO-35	4	7	8	5	6	7	5	3	6	5	4	x	92	5.45	3	P 8
MO-38	6	6	5	3	3	4	4	6	7	3	3	4	100	5.40	3	P 4, 5, 10 ,11
MO-41	5	6	5	4	4	7	6	x	4	3	x	5	83	4.90	3	P 10
MO-43	4	4	x	5	5	5	5	6	5	4	3	4	92	4.55	3	P 11
MO-46	4	x	4	4	3	3	3	5	5	4	4	4	92	3.91	3	P 5, 6, 7
MO-47	5	6	6	6	5	4	3	4	5	5	8	4	100	5.08	3	P 7
MO-48	3	7	8	5	5	6	4	4	6	4	5	5	100	5.17	3	P 1
MO-52	3	3	3	4	3	3	4	5	4	4	3	4	100	3.58	3	P 1, 2, 3, 5, 6, 11
MO-54	x	x	x	5	5	5	4	5	5	6	4	3	75	4.67	3	P 12
MO-57	4	4	x	3	5	x	4	4	x	5	4	3	92	3.27	3	P 4, 12
MO-60	7	4	6	4	6	3	6	4	6	5	5	4	100	5.00	3	P 6
MO-61	5	8	6	x	4	5	x	8	8	3	7	5	83	5.90	3	P 10
MO-65	4	5	6	7	x	x	4	5	3	4	6	6	83	5.00	3	P 9
MO-67	3	3	3	3	3	3	6	5	x	3	3	3	92	3.45	3	P 1, 2, 3, 4, 5, 6, 10, 11, 12
MO-69	4	5	4	3	3	5	4	5	4	7	4	5	100	4.42	3	P 3, 4
MO-71	x	5	5	4	3	5	4	4	5	4	5	3	92	4.27	3	P 5, 12
MO-77	6	x	6	4	6	4	3	4	5	6	6	5	92	5.00	3	P 7
MO-78	5	6	5	5	3	5	3	5	6	4	3	3	100	4.42	3	P 5, 7, 11, 12
MO-1	4	5	4	4	4	6	4	7	5	4	5	5	100	4.75	4	
MO-3	4	7	4	5	4	4	4	4	4	5	4	5	100	4.50	4	
MO-6	7	7	7	7	7	5	x	8	7	4	4	4	92	6.09	4	
MO-28	6	5	6	6	7	5	4	7	7	4	x	x	83	4.75	4	
MO-36	4	4	5	6	6	6	x	5	5	5	6	5	92	5.18	4	
MO-39	4	6	7	4	6	4	6	5	x	6	5	x	83	5.89	4	
MO-40	7	6	7	5	4	4	x	6	5	5	5	5	92	5.36	4	
MO-44	7	4	5	5	6	7	7	x	6	5	4	6	92	5.64	4	
MO-45	4	4	4	5	6	6	5	6	5	4	4	4	100	4.75	4	
MO-49	6	5	6	6	5	x	5	5	4	7	5	6	92	5.45	4	
MO-55	x	6	x	4	4	5	4	5	x	8	x	5	67	5.13	4	
MO-62	4	4	5	5	4	5	5	7	6	5	5	6	100	5.08	4	
MO-63	5	6	5	5	4	4	8	4	6	4	5	5	100	5.08	4	
MO-68	7	6	6	6	8	4	5	6	5	4	4	4	100	5.42	4	
MO-72	5	6	5	5	6	5	4	6	6	5	4	4	100	5.08	4	
MO-81	x	4	5	5	4	6	x	x	x	6	x	8	58	5.43	4	
MO-64	x	7	6	7	6	6	6	5	8	x	7	5	92	5.73	5	
MO-70																
MO-75																
MO-76																

Study 29I141G							Forage Rating: 8/9/99										Table #3 - continued
Little Bluestem																	
			1 = High				9 = Low										
Local Number	Rep 1 P1	P2	P3	Rep 2 P4	P5	P6	Rep 3 P7	P8	P9	Rep 4 P10	P11	P12	Percent Survival	Ave. Living Plants	Best Plant	Locations
IA-16	x	x	4	3	6	5	3	x	1	x	5	5	75	3.56	1	P 9
IA-27	1	1	3	3	4	5	5	5	4	5	4	2	100	3.50	1	P 1, 2
IA-6	4	5	6	5	2	4	3	4	3	7	4	5	100	4.33	2	P 5, 6
IA-8	5	6	3	5	3	5	5	5	5	5	3	2	100	4.33	2	P 12
IA-12	7	5	7	x	4	5	4	3	2	4	5	5	92	4.64	2	P 9
IA-15	5	4	5	x	x	x	2	x	5	5	5	6	67	4.63	2	P 7
IA-23	6	5	5	8	8	6	5	4	x	2	4	6	92	5.36	2	P 10
IA-1	8	5	5	5	4	4	4	5	x	3	7	3	92	4.82	3	P 10, 12
IA-2	4	4	4	3	4	4	6	5	5	4	x	6	92	4.45	3	P 4
IA-3	x	x	8	x	3	3	4	5	4	4	5	4	75	4.44	3	P 5, 6
IA-4	5	8	4	3	x	3	4	7	5	4	7	5	92	5.00	3	P 4, 6
IA-5	4	5	4	3	6	8	6	4	4	3	5	x	92	4.73	3	P 4, 10
IA-7	5	3	3	5	5	5	4	4	6	5	5	5	100	4.58	3	P 2, 3
IA-9	4	6	7	6	6	6	8	6	6	4	3	4	100	5.50	3	P 11
IA-11	6	5	6	5	7	3	5	5	6	4	x	5	92	5.18	3	P 6
IA-13	4	4	6	4	7	x	5	4	x	3	4	3	83	4.40	3	P 10, 12
IA-17	3	7	4	5	x	4	6	x	6	4	6	5	83	5.00	3	P 1
IA-19	6	x	x	6	3	3	x	4	4	x	x	x	50	4.33	3	P 5, 6
IA-20	x	4	x	7	5	5	4	x	4	6	7	3	75	5.00	3	P 12
IA-24	4	5	3	5	4	4	4	4	5	5	5	4	100	4.33	3	P 3
IA-25	4	5	6	6	5	6	6	4	5	3	5	3	100	4.83	3	P 10, 12
IA-26	x	3	4	3	3	6	x	x	4	5	6	x	67	4.25	3	P 2, 4, 5
IA-10	6	7	7	4	5	5	5	6	7	6	4	x	92	5.64	4	
IA-14	4	6	4	5	5	6	4	5	5	5	7	5	100	5.08	4	
IA-18	5	6	5	6	5	6	5	4	5	4	5	5	100	5.08	4	
IA-21	4	5	4	4	x	6	x	x	6	-	4	5	67	4.75	4	
IA-22	x	x	x	7	x	x	7	6	6	5	8	8	58	6.71	5	
IL-12	8	7	5	3	8	4	5	5	4	4	2	x	92	5.00	2	P 11
IL-17	3	4	3	2	3	5	3	4	2	2	3	3	100	3.08	2	P 4, 9, 10
IL-18	5	4	6	3	3	3	5	6	4	3	2	4	100	4.00	2	P 11
IL-2	6	6	6	4	5	6	5	3	5	4	5	3	100		3	P 8
IL-5	6	5	7	4	8	3	4	5	5	5	4	5	100	5.08	3	P 6
IL-7	4	4	3	4	7	6	8	6	8	6	8	8	100	6.00	3	P 3
IL-8	x	x	5	4	x	8	x	6	4	x	4	3	58	4.86	3	P 12
IL-11	x	x	3	x	4	x	5	x	6	x	x	x	33	4.50	3	P 3
IL-14	4	5	x	3	5	x	6	4	7	6	5	6	83	5.10	3	P 4
IL-16	5	5	4	4	3	3	4	x	3	7	6	4	92	4.36	3	P 5, 6, 9
IL-19	5	6	7	3	3	3	4	3	4	3	4	3	100	4.00	3	P 4, 5, 6, 8, 12

Study 29I141G							Forage Rating: 8/9/99										Table #3 - continued
Little Bluestem																	
			1 = High				9 = Low										
	Rep 1			Rep 2			Rep 3			Rep 4					Ave.		
Local Number	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Percent Survival	Living Plants	Best Plant	Locations
IL-20	5	3	3	x	6	5	4	4	4	3	5	3	92	4.09	3	P 2, 3, 10, 12
IL-21	5	5	4	3	4	4	5	4	4	5	4	4	100	4.25	3	P 4
IL-1	4	x	4	6	7	6	4	7	7	5	6	5	92	5.55	4	
IL-6	7	7	4	6	5	7	x	x	x	6	5	5	75	5.78	4	
IL-9	6	x	6	x	5	7	6	5	4	4	4	7	83	5.40	4	
IL-10	x	x	x	4	6	7	x	x	7	x	5	7	50	6.00	4	
IL-13	x	7	x	5	7	4	6	6	7	x	8	6	83	5.60	4	
IL-15	8	8	x	x	7	6	4	5	5	5	4	5	83	5.70	4	
IL-3	5	4	x	7	x	x	8	7	6	5	x	x	58	6.00	5	
IL-4	6	7	4	4	6	5	6	5	5	5	5	5	100	5.25	5	
IL-22																
Aldous	2	3	3	3	3	3	5	4	5	3	2	2	100	3.17	2	P 1, 11, 12
Cimmeron	2	3	2	4	2	3	3	2	5	3	5	3	100	3.08	2	P 1, 3, 5, 8
Camper	3	4	5	4	5	6	5	4	5	x	3	5	92	4.45	3	P 1, 11, 12
Pastura	x	x	5	6	x	6	6	6	x	3	3	x	58	5.00	3	P 10, 11

Study 29I141G							Vigor Rating: 8/9/99										Table #4
Little Bluestem																	
			1 = High				9 = Low										
Local	Rep 1			Rep 2			Rep 3			Rep 4			Percent	Living	Best	
Number	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Survival	Plants	Plant	Location/s
														Ave.		
MO-4	x	3	4	4	6	2	4	5	5	3	x	x	75	4.00	2	P 6
MO-7	2	3	2	3	3	3	5	2	2	5	2	2	100	2.83	2	P 1, 3, 8, 9, 11, 12
MO-12	3	3	3	4	2	2	4	4	3	3	3	3	100	3.08	2	P 5, 6
MO-16	3	2	6	6	4	3	4	5	6	4	5	3	100	4.25	2	P 2
MO-24	5	x	5	x	5	3	5	5	5	2	4	6	83	4.50	2	P 10
MO-25	2	3	x	5	4	3	5	4	4	5	6	6	92	4.27	2	P 1
MO-32	3	x	6	5	5	3	4	6	4	2	4	6	92	4.36	2	P 10
MO-35	2	6	7	2	4	5	6	6	3	5	4	x	92	4.55	2	P 1, 4
MO-42	5	4	5	3	4	2	4	4	6	4	5	6	100	4.33	2	P 6
MO-47	4	5	6	4	5	4	2	2	3	4	6	3	100	4.00	2	P 7, 8
MO-56	3	4	3	3	3	2	4	4	4	4	3	3	100	3.33	2	P 6
MO-61	5	5	4	x	3	4	x	7	7	2	5	4	83	4.60	2	P 10
MO-67	3	3	3	2	3	3	5	4	x	4	5	5	92	3.64	2	P 4
MO-69	4	5	6	3	3	4	2	3	5	8	4	5	100	4.33	2	P 7
MO-79	2	3	3	3	3	4	5	6	4	5	4	3	100	3.75	2	P 1
MO-1	3	4	3	4	3	5	5	5	5	3	5	4	100	4.08	3	P 1, 3, 5, 10
MO-3	3	4	4	5	4	3	4	5	5	4	3	4	100	4.00	3	P 1, 6, 11
MO-5	5	3	3	5	4	6	5	7	4	5	6	4	100	4.75	3	P 2, 3
MO-6	3	7	6	6	5	5	x	5	5	5	5	3	92	5.00	3	P 1, 12
MO-8	5	x	4	6	3	3	6	6	5	6	5	7	92	5.09	3	P 5, 6
MO-9	5	5	6	3	3	3	4	4	4	5	5	5	100	4.33	3	P 3, 4, 5
MO-11	x	5	x	5	6	6	7	5	3	5	4	6	83	5.20	3	P 9
MO-13	5	7	6	6	x	5	5	6	3	6	5	7	92	5.55	3	P 9
MO-14	4	4	3	5	5	5	4	6	6	4	5	4	100	4.58	3	P 3
MO-15	3	3	3	4	3	3	5	4	4	4	4	4	100	3.67	3	P 1, 2, 3, 5, 6
MO-17	5	5	5	4	4	7	7	5	4	3	4	5	100	4.83	3	P 10
MO-19	3	3	3	4	4	4	4	5	5	4	4	4	100	3.92	3	P 1, 2, 3, 5, 6
MO-21	3	3	3	6	4	4	5	4	4	6	6	6	100	4.50	3	P 1, 2, 3
MO-22	4	3	3	3	3	3	5	5	4	x	7	x	83	4.00	3	P 2, 3, 4, 5, 6
MO-23	5	5	3	4	5	7	5	5	6	5	7	5	100	5.17	3	P 3
MO-26	4	4	4	3	x	3	6	5	5	4	5	5	92	4.36	3	P 4, 6
MO-27	3	5	3	3	4	3	6	6	5	3	4	6	100	4.25	3	P 1, 3, 4, 6, 10
MO-29	4	3	x	6	5	5	5	5	3	5	5	6	92	4.73	3	P 2, 9
MO-31	6	3	3	3	3	4	5	5	x	6	4	5	92	4.27	3	P 2, 3, 4, 5
MO-33	4	x	6	4	4	3	4	4	4	6	6	5	92	4.55	3	P 6
MO-34	4	3	3	3	3	4	x	x	4	4	x	3	75	3.44	3	P 2, 3, 4, 5, 12
MO-36	4	3	3	6	5	5	x	4	5	3	5	5	92	4.36	3	P 2, 3, 10
MO-37	3	3	3	4	3	4	x	5	5	4	4	4	92	3.82	3	P 1, 2, 3, 5
MO-38	4	4	3	5	4	4	3	5	5	3	3	4	100	3.92	3	P 7, 10, 11
MO-39	5	6	7	4	3	3	5	3	x	5	7	x	83	4.80	3	P 5, 6, 8
MO-40	3	8	8	4	5	3	x	5	4	8	8	7	100	5.25	3	P 1, 6, 11

Study 29I141G							Vigor Rating: 8/9/99									Table #4 - continued
Little Bluestem																
			1 = High				9 = Low									
Local	Rep 1			Rep 2			Rep 3			Rep 4			Percent	Living	Best	
Number	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Survival	Plants	Plant	Location/s
MO-43	6	3	4	4	4	4	5	6	5	4	5	3	100	4.42	3	P 2, 12
MO-45	4	4	3	3	4	3	4	5	3	3	4	4	100	3.67	3	P 3, 4, 6, 9, 10
MO-46	3	x	3	3	3	4	5	5	3	5	3	4	92	3.73	3	P 1, 3, 4, 5, 9, 11
MO-48	4	5	5	3	4	4	5	3	5	4	6	6	100	4.50	3	P 4, 8
MO-51	4	5	4	3	3	3	4	5	4	4	4	4	100	3.92	3	P 3, 4, 5
MO-52	5	4	5	5	3	4	5	6	5	5	4	5	100	4.67	3	P 5
MO-53	5	5	6	4	5	6	3	4	4	5	5	6	100	4.83	3	P 7
MO-54	x	x	x	5	7	3	6	7	7	6	3	4	75	5.33	3	P 11
MO-60	4	4	4	3	4	3	5	3	5	5	6	6	100	4.33	3	P 4, 6, 8
MO-62	4	4	4	3	4	5	4	4	4	5	6	7	100	4.50	3	P 4
MO-63	4	4	4	3	3	3	5	5	4	4	6	4	100	4.08	3	P 4, 5, 6
MO-65	3	4	4	6	x	x	5	6	5	5	7	6	83	5.10	3	P 1
MO-66	5	5	x	4	3	3	6	6	5	6	7	7	92	5.18	3	P 5, 6
MO-71	x	3	5	5	3	4	5	4	5	3	4	4	92	4.09	3	P 2, 5, 10
MO-72	3	3	3	3	5	4	3	4	5	5	4	3	100	3.75	3	P 1, 2, 3, 4, 7, 12
MO-73	6	5	3	3	3	3	5	7	4	6	7	6	100	4.83	3	P 3, 4, 5, 6
MO-77	6	x	6	5	3	5	3	4	5	6	6	6	92	5.00	3	P 5, 7
MO-78	6	4	4	4	6	4	4	5	3	4	4	3	100	4.25	3	P 9, 12
MO-80	4	3	x	3	3	3	6	6	5	3	6	6	92	4.36	3	P 2, 4, 5, 6, 10
MO-81	x	3	5	5	4	4	x	x	x	6	x	5	58	4.57	3	P 2
MO-2	4	5	5	4	5	6	4	4	5	4	4	4	100	4.50	4	
MO-18	4	6	4	4	5	7	x	x	x	6	4	6	75	5.11	4	P 1, 3, 4, 11
MO-20	4	6	6	6	5	5	6	5	5	4	6	4	100	5.17	4	
MO-28	6	4	5	4	6	5	5	6	5	4	x	x	83	5.00	4	
MO-30	4	5	5	4	4	x	5	5	6	5	4	4	92	4.64	4	
MO-41	4	7	4	5	5	4	6	x	5	4	x	4	83	4.80	4	
MO-44	6	4	4	5	5	5	7	x	6	5	4	6	92	5.18	4	
MO-49	8	8	8	8	8	x	7	7	6	6	4	4	92	6.73	4	
MO-50	5	5	5	4	4	4	6	6	4	5	5	5	100	4.83	4	
MO-55	x	5	x	4	6	5	5	4	x	6	x	4	67	4.88	4	
MO-57	4	5	x	5	4	x	6	5	x	5	6	5	75	3.75	4	
MO-58	6	5	4	6	5	6	7	7	7	4	4	5	100	5.50	4	
MO-59	7	6	5	5	4	4	7	6	7	6	6	5	100	5.67	4	
MO-68	5	5	5	4	5	5	5	4	4	6	4	5	100	4.75	4	
MO-74	5	6	6	4	4	5	5	5	5	5	5	4	100	4.92	4	
MO-10	6	7	7	5	5	5	5	6	6	7	6	4	100	5.75	5	
MO-64	x	7	7	5	7	7	6	6	6	x	7	5	83	6.30	5	
MO-70																
MO-75																
MO-76																

Study 29I141G							Vigor Rating: 8/9/99										Table #4 - continued
Little Bluestem																	
			1 = High				9 = Low										
Local	Rep 1			Rep 2			Rep 3			Rep 4				Percent	Living	Best	
Number	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12		Survival	Plants	Plant	Location/s
IA-3	x	x	5	x	3	2	6	6	7	7	5	5		75	5.11	2	P 6
IA-4	4	5	3	4	x	3	4	6	4	2	5	5		92	4.09	2	P 10
IA-5	6	6	6	4	5	6	6	5	6	2	5	x		92	5.18	2	P 10
IA-9	4	4	4	4	4	5	6	5	5	3	2	5		100	4.25	2	P 11
IA-10	3	4	5	3	4	4	5	5	5	6	2	x		92	4.18	2	P 11
IA-13	2	3	4	3	5	x	5	4	x	4	5	3		92	3.45	2	P 1
IA-15	5	4	4	x	x	x	2	x	6	4	4	5		67	4.25	2	P 7
IA-27	2	2	2	2	3	3	5	6	5	4	3	3		100	3.33	2	P 1, 2, 3, 4
IA-1	6	3	3	5	5	4	4	4	x	4	7	4		92	4.45	3	P 2, 3
IA-2	3	3	3	4	5	5	6	5	5	5	x	6		92	4.55	3	P 1, 2, 3
IA-6	6	4	4	4	3	3	5	4	4	7	3	5		100	4.33	3	P 5, 6, 11
IA-7	3	3	4	3	3	3	3	4	6	4	4	4		100	3.67	3	P 1, 2, 4, 5, 6, 7
IA-8	5	6	3	3	3	4	5	6	5	4	3	4		100	4.25	3	P 3, 4, 5, 11
IA-12	4	5	6	x	5	4	3	5	4	3	3	3		92	4.09	3	P 7, 10, 11, 12
IA-14	6	5	5	3	3	3	5	7	7	4	6	5		100	4.92	3	P 4, 5, 6
IA-16	x	x	4	3	5	4	3	x	5	x	5	6		67	4.38	3	P 4, 7
IA-17	4	6	5	4	x	4	5	x	4	3	5	3		83	4.30	3	P 10, 12
IA-18	5	6	5	5	4	5	4	4	5	3	3	4		100	4.42	3	P 10, 11
IA-23	4	4	4	5	6	6	5	5	x	3	3	4		100	4.08	3	P 10
IA-25	5	5	5	5	4	4	4	5	5	4	4	3		100	4.42	3	P 12
IA-26	x	6	4	3	4	5	x	x	4	4	6	x		67	4.50	3	P 4
IA-11	7	6	7	4	5	4	6	6	7	5	x	5		92	5.64	4	
IA-19	6	x	x	5	4	4	x	4	4	x	x	x		50	4.50	4	
IA-20	x	4	x	7	5	5	5	x	6	5	6	5		75	5.33	4	
IA-21	4	4	5	4	x	5	x	x	4	x	5	4		67	4.38	4	
IA-22	x	x	x	5	x	x	5	4	4	6	8	8		58	5.71	4	
IA-24	5	5	4	6	6	6	7	7	7	6	5	5		100	5.75	5	
IL-8	x	x	6	4	x	5	x	2	3	x	5	3		58	4.00	2	P 8
IL-12	6	6	2	3	5	3	4	4	3	3	2	x		92	3.73	2	P 3, 11
IL-1	7	x	3	5	7	6	5	6	8	6	5	5		92	5.73	3	P 3
IL-2	3	3	4	4	5	3	4	5	5	5	4	4		100	4.08	3	P 1, 2, 6
IL-3	3	7	3	5	x	x	6	7	6	5	x	x		67	5.25	3	P 1, 3
IL-5	5	5	6	5	3	4	5	6	5	5	4	5		100	4.83	3	P 5
IL-6	7	5	4	8	3	5	x	x	x	5	4	7		75	5.33	3	P 5
IL-9	5	x	3	x	4	5	5	3	3	5	4	6		92	3.91	3	P 3, 8, 9
IL-10	4	4	5	5	4	3	x	x	8	x	6	6		100	3.75	3	P 6
IL-11	x	x	3	x	4	x	3	x	5	x	x	x		33	3.75	3	P 3, 7
IL-13	x	5	x	4	5	5	6	6	7	x	6	3		75	5.22	3	P 12
IL-14	5	4	x	3	4	x	5	3	5	5	4	5		83	4.30	3	P 4, 8
IL-15	5	7	x	x	5	4	6	6	5	4	4	3		83	4.90	3	P 12

Study 29I141G						Vigor Rating: 8/9/99										Table #4 - continued
Little Bluestem																
			1 = High			9 = Low										
Local	Rep 1			Rep 2			Rep 3			Rep 4			Percent	Living	Best	
Number	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Survival	Plants	Plant	Location/s
IL-16	3	3	4	4	4	5	5	x	6	7	5	4	92	4.55	3	P 1, 2, 6
IL-17	4	4	3	3	3	3	3	3	3	3	3	3	100	3.17	3	P 3, 4, 5, 6, 7, 8, 9, 10,,11, 12
IL-18	4	3	5	4	4	3	5	6	4	4	5	4	100	4.25	3	P 2, 6
IL-19	4	4	6	3	3	3	5	3	4	4	3	4	100	3.83	3	P 4, 5, 6, 8, 11
IL-20	4	5	4	x	3	4	4	3	4	4	6	3	92	4.00	3	P 5, 8, 12
IL-21	7	7	7	3	5	4	6	5	5	5	5	5	100	5.33	3	P 4
IL-4	6	5	5	4	4	4	5	5	5	6	6	5	100	5.00	4	
IL-7	4	4	5	4	5	6	6	5	6	6	7	6	100	5.33	4	
IL-22																
Cimmeron	2	2	2	2	3	2	3	5	4	3	4	3	100	2.92	2	P 1, 2, 3, 4, 6
Aldous	4	3	4	3	3	3	5	5	4	3	3	3	100	3.58	3	P 2, 4, 5, 6, 10, 11, 12
Camper	3	3	3	4	5	5	5	5	6	x	5	5	92	4.45	3	P 1, 2, 3
Pastura	x	x	5	5	x	7	5	7	x	3	4	x	58	5.14	3	P 10

Study 29I141G - Assembly and Evaluation of Little Bluestem, *Schizachyrium scoparium* Michx.

Selected accessions for each region **Table #5**

Northern Region

IA - All

MO - North of Missouri River

IL - Northern 2/3rds of the state

ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
9078896	MO-4	Douglas Rainey	115	Clark	Missouri
9078913	MO-21	Frank Oberle	115	Adair	Missouri
9078914	MO-22	David S. Mackey	113	Knox	Missouri
9078924	MO-32	James A. Mayberry	109	Carroll	Missouri
9078934	MO-42	Curtis Walker	107	Buchanan	Missouri
9078849	IA-3	Janet M. Thomas/	107	Cherokee	Iowa
		John P. Vogel			
9078854	IA-8	Henry D. Tordoff	107	West	Iowa
				Pottawattamie	Iowa
9078861	IA-15	Rick Cordes	104	Howard	Iowa
9078862	IA-16	James Ranum	105	Allamakee	Iowa
9078884	IL-12	Bill Kleiman		Lee	Illinois
9078891	IL-19	Martha E. Sheppard	115	Calhoun	Illinois

Southern Region

MO - South of Missouri River

IL - Southern 1/3 of state

ACCESSION	REFERENCE NUMBER	COLLECTOR	MLRA	COUNTY	STATE
9078895	MO-3	Joe Tousignant	N116B	Cape Girardeau	Missouri
9078899	MO-7	Tommy Robins/	116	Ripley	Missouri
		Jim Hoefer			
9078915	MO-23	Claude F. Peifer	116B	Perry	Missouri
9078942	MO-51	Ian S. Kurtz	116A	Taney	Missouri
9078950	MO-59	Jerry Cloyed	M112	Barton	Missouri
9078952	MO-60	M. Denise Brown	N116A	Miller	Missouri
9078964	MO-73	Maurice Davis/		Pettis	Missouri
		Steve Clubine			
9078965	MO-74	Maurice Davis/		Pettis	Missouri
		Steve Clubine			
9078968	MO-79	Steve Clubine		Marries	Missouri
9078969	MO-80	Maurice Davis/			Missouri
9078893	IL-21	Remington T. Irwin	114	Wayne	Illinois

Production of Native Missouri Ecotypes of Grasses, Legumes and Forbs for Roadsides, Critical Areas, and All Other Vegetative Plantings Where Native Plants are Now Being Planted

Study No. 29I142G

National Project(s): Critical Area 1.1; Pasture/Hayland 1.1 and 2.1; Rangeland 1.1; Water Quality 2.1, 3.1, and 4.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Well-adapted native grass, legume and forb plantings offer many advantages as a low cost sustainable vegetative cover for management of soil and water resources. Native plant communities resist noxious weed invasion, provide excellent erosion control, and generally require relatively low maintenance.

These characteristics make native plants an excellent selection for use in roadside plantings, wildlife habitat enhancement, long-term land retirement programs, public land and all other vegetative plantings where mono-cultures of grasses are presently being planted. This is especially true along public transportation corridors that constitute a major land resource and management problem in the state of Missouri. Based on 1987 National Resource Inventory (NRI) data, over one million acres of Missouri land are devoted to rural transportation. Other federal and state agencies also own a significant land base in Missouri.

Proper vegetation management along these corridors is an important element in controlling soil loss and unwanted weedy plant species. Many of these acres are now seeded to introduce cool-season grass and legume species which are often invaded by noxious weeds requiring extensive mowing or herbicide treatment programs. These management techniques are expensive and can also result in additional water quality problems where herbicides are used extensively.

Managing or reseeding these acres to promote native grasses and forbs offers a low cost environmentally sound approach to roadside vegetation management. Herbicide use, soil erosion, and most mowing can be reduced significantly where a vigorous native grass and forb mixture dominates a roadside right-of-way. In addition, these goals are consistent with on-going NRCS programs designed to improve ground and surface water quality, reduce soil loss and increase wildlife habitat.

Many adapted forb, legume and grass species of native origin are either currently not commercially available or available only in very limited quantities, which make them very expensive. Species that are available are often varietal releases that have undergone an evaluation and selection process or a plant-breeding program. Most varieties are designed for high forage production and are highly vigorous plants. They are generally excellent for pasture and hay production but can be too domineering for diversified mixtures. Their origins are often not from within the state in which they are being planted. There is a need for additional native species for use on public lands and other types of conservation plantings with origins close to where they are being planted.

Objective: The objective of this study is to accelerate the availability of selected native grass, legume and forb species.

Procedure: The state of Missouri was divided into four zones: Northern Glaciated Plains, Zone #1; Western Prairie, Zone #2; Ozarks, Zone #3; and the Bootheel Region, Zone #4 (See Table #1). Plant materials were collected as seed by the study coordinator, selected personnel from USDA-NRCS, MDC, UMC, and other knowledgeable interested persons. Collections were made from prairie remnants throughout each zone striving for a relatively equal and representative sample. Large collections from one site were not allowed to dominate the mixture from

throughout the zone. Seed from each collection site was inventoried by location. Seed collected from within each zone was kept separate from the other zones. Increase plots were and will be established, as seed becomes available. Each species will be released as 'Source Identified' germplasm from the zone in which it was collected. Evaluation and selection or plant breeding procedures has not improved 'Source Identified' seed.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

1997
The Missouri Ecotype Enhancement Program was officially started as a plant materials study with the signing of the study plan in December of 1997. This plan is an agreement between cooperators and funded by a grant from the MDC. Several meetings preceded the document signing that included MDC, NRCS, UMC, Department of Transportation, Missouri Department of Natural Resources, and other interested individuals.

The initial grant from MDC to UMC was received July 1997 and a program coordinator was hired by UMC in September 1997 to work at the Elsberry Plant Materials Center.

1998
A grant was given to UMC once again by MDC that would fund the program through August of 1999. Goals were established for 1998 collections. Some species from 1997 were recollected and new species were added.

1999
The Missouri Ecotype program continued during 1999 and the species released listed in Table #2. Beginning in September, the Lincoln County Soil and Water Conservation District took over as the administrator for the Missouri Ecotype Program replacing UMC. MDC funded the program for the 1999-2000 fiscal year.

2000
The Missouri Ecotype program continued through August until funding was depleted. The program was continued under direction of Missouri Audubon Society and MDC in cooperation with the NRCS Plant Materials Center.

2001
The Missouri Ecotype program is growing increase plots at Elsberry and also at the Charles Green Conservation area near Ashland, Missouri.

2002
MDC took over as administrator of this study and is currently still funding the program with the aid of grants. The Missouri Ecotype program is continuing to increase plots at the Elsberry PMC and Green Conservation Area. New collections are being made of both old and new species.

2003
MDC is continuing to administrate the Missouri Ecotype program. All plots are still in production and seed is being allocated. The PMC is planning to increase plots for seed production in 2004.

2004
In the spring of 2004, the plots of zones 1 and 2 sideoats gramma, *Bouteloua curtipendula*, and zone 1 river oats, *Chasmanthium latifolium*, were increased for seed production. There were no new releases from the Missouri Ecotype Program in 2004 and there are no releases scheduled for 2005. Plans are to increase river oats-zone 1 again in 2005. Becky Erickson, Missouri Ecotype Program Coordinator, has several production plots located at the Green Conservation Area in Ashland, Missouri. The number of plots on the Green Area has increased over the past year and now sustains almost 35 different ecotypes. Plans for both the Plant Materials Center and the plots at the Green Conservation Area are to sustain the plots already established and increase the plots that display good seed production and survival. This will allow for potential releases as early as 2006.

2005
Chasmanthium latifolium, river oats from the northern zone were increased in the late summer of 2005. Plans are to increase several other better seed producing species in the spring of 2006, such as the big bluestem (northern zone), little bluestem (northern zone), sideoats gramma (northern and western zones), tall dropseed (northern and western zones), pale purple coneflower (northern and western zones), grayhead coneflower (northern zone), and Virginia wild rye (northern zone).

2006
Supplemental funding for the Missouri Ecotype Program was not extended past the agreement date of June 2007. Plans are to continue growing the species that have been previously released or have potential for high use in the commercial market. The PMC planted production plots of big bluestem (northern zone), little bluestem (northern zone), sideoats gramma (northern and western zones), tall dropseed (northern and western zones), pale purple coneflower (northern and western zones), and grayhead coneflower (northern zone) in the spring of 2006. A fall planting of Virginia wild rye (northern zone) was also planted. The plots were increased to provide more seed production and averaged ¼ to two acres in size.

2007
Production plots of sideoats grama were increased to help meet the demand for higher priority species requested by seed growers. In FY 2008, plans are to again increase these production plots. The PMC continued to put efforts into a select group of species (production species started in 2006) as they are the priority for most commercial growers interested in Missouri ecotypes. Those species are big bluestem (northern zone), little bluestem (northern zone), sideoats gramma (northern and western zones), tall dropseed (northern and western zones), pale purple coneflower (northern and western zones), and grayheaded coneflower (northern zone). Plans

are to release northern Missouri sideoats grama in 2008. With growing interest in southern zone little bluestem, the Elsberry PMC will expand the production plot in 2008.

2008
The flood of 2008 dramatically affected seed production of Northern Missouri germplasm sideoats grama, Northern Missouri germplasm big bluestem, and Northern Missouri germplasm tall dropseed. All three production fields were in the floodplain (field 7) and required transplanting to salvage the plantings. The entire 0.3 acre plot of sideoats grama was moved to field #1 and approximately a 0.1 of an acre of big bluestem was moved to field #1 also. Approximately 0.1 of an acre of tall dropseed was moved next to the northern zone of big bluestem production plot. Plans are to increase both northern and western zones of pale purple coneflower by dormant planting both plots in December or January. Northern and western zones of sideoats grama will potentially be planted with the pale purple coneflower as a companion crop to discourage heavy weed competition. Both species would be harvested for seed production. The Northern Missouri germplasm little bluestem is doing well, despite heavy inundation of water from spring rains in the south half of the production plot. Seed production remains consistent in the north half of the plot.

2009
All of the plots that were moved because of the 2008 flood survived and produced seed in 2009. The seed harvested will be used to start new production fields. The northern and western zones of pale purple coneflower were planted with a companion species, sideoats grama. Both plots were mowed during the growing season to discourage weed competition. In 2009, the northern and western zones of pale purple coneflower were released, they will be known as Northern Germplasm pale purple coneflower and Western Germplasm pale purple coneflower (*Echinacea pallida*).

2010
The Elsberry PMC is currently working approximately 15 different accessions from this study. Emphasis is focused around pollinator material and shorter growing warm season grasses for prairie restoration. Several growers are still interested in the material from this study and this continues to be the driving force behind the production of these species at the PMC.

2011-2012-2013
In 2011, 2012, and 2013, the PMC produced seed from 10 of the 15 releases that have come out of this study. The Native Seed Growers Association plays an active role in the demand for these releases. Below are the releases that have produced seed in the past 3 years. This study is discontinued and no other data or conclusions will be presented.

	Production Bulk Weight		
Release	**2011**	**2012**	**2013**
Andropogon geradii, Northern Germplasm Big Bluestem	18.3	16.3	
Bouteloua curtipendula, Northern Germplasm Sideoats	175.9	115.4	
Echinacea pallida, Northern Germplasm Pale Purple Coneflower	5.3	5.7	
Echinacea pallida, Western Germplasm Pale Purple Coneflower	14.5		3.6
Elymus virginicus, Northern Germplasm Virginia Wild Rye		96.1	128.6
Liatris pycnostachya, Northern Germplasm Prairie Blazing Star	0.01	8.9	25.4
Ratibida pinnata, Northern Germplasm Greyhead Coneflower	16.0	21.60	0.20
Schizachyrium scoparium, Northern Germplasm Little Bluestem	37.4	6.7	
Schizachyrium scoparium, Southern Germplasm Little Bluestem	101.1		
Sporobolus compositus, Northern Germplasm Tall Dropseed	*	*	*

* The plot is established but seed has not been harvested due to maintenance and grasshopper damage.

Study 29I142G - Missouri Ecotype Releases **Table #2**

Missouri Ecotype Releases from the Elsberry Plant Materials Center

Scientific Name	Release Name	Common Name	Accession Number	Cooperating Agency(ies)	Type of Release	Year of Release
Schizachyrium scoparium , Michx.	Southern MO	little bluestem	9079006	MOPMC, MDC	N	2004
Ratibida pinnata	Northern MO	grayheaded coneflow er	9079060	MOPMC, MDC	N	2004
Sporobolus compositus var.	Northern MO	tall dropseed	9079040	MOPMC, MDC, NAS	N	2001
Coreopsis palmata	Northern MO	prairie coreopsis	9079028	MOPMC, MDC, NAS	N	2001
Coreopsis palmata	Western MO	prairie coreopsis	9079029	MOPMC, MDC, NAS	N	2001
Echinacea pallida	Northern MO	pale purple coneflow er	9079032	MOPMC, MDC, NAS	N	2009
Echinacea pallida	Western MO	pale purple coneflow er	9079033	MOPMC, MDC, NAS	N	2009
Liatris pycnostachya	Northern MO	prairie blazing star	9079020	MOPMC, MDC, NAS	N	2001
Liatris pycnostachya	Western MO	prairie blazing star	9079021	MOPMC, MDC, NAS	N	2001
Elymus virginicus L.	Northern MO	Virginia w ildrye	9079044	MOPMC,UMC,MDC,MODOT	N	1999
Sorghastrum nutans (L) Nash.	Northern MO	Indiangrass	9079036	MOPMC,UMC,MDC,MODOT	N	1999
Sorghastrum nutans (L) Nash.	Western MO	Indiangrass	9079037	MOPMC,UMC,MDC,MODOT	N	1999
Andropogon gerardii Vitman	Northern MO	big bluestem	9079000	MOPMC,UMC,MDC,MODOT	N	1999
Schizachyrium scoparium , Michx.	Northern MO	little bluestem	9079004	MOPMC,UMC,MDC,MODOT	N	1999
Bouteloua curtipendula	Northern MO	Sideoats gramma	9079072	MOPMC	N	2008

Cooperating Agencies: MOPMC=Missouri Plant Materials Center; UMC=University of Missouri at Columbia; MDC=Missouri Department of Conservation; MODOT=Missouri Department of Transportation; NAS=National Audubon Society-Audubon Missouri;. Grow Native.

N=native releases; collected w ithin the USA, occurring naturally in the USA. Generally refers to a plant w hich occurs naturally in a particular region, state ecosystem or habitat w ithout direct or indirect human activity.

Nat.=naturalized releases; collected from a population w ithin the USA, but w ere originally introduced to the USA sometime in the past.

I=introduced; means that the original collection from w hich the release w as made w as not from w ithin the USA.

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa* Michx.

Study No. MOPMC-P-0001-WO,WL,WE

National Project(s): Forestland 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Bur oak is a large-size tree 60-80 feet tall and 2-3 feet in diameter (max. 170 by 7 feet); crown rounded with large, heavy branches. Leaves are deciduous, oblong to ovate; 6-12 inches long; characteristically 5-9 lobed, with rounded lobes. Fruit matures in one year; acorns are 3/5-2 inches long, ellipsoidal, brown, enclosed for 1/3 to all of its length in a characteristic fringe-margined cup. Twigs are stout; yellow-brown to gray, often with characteristic corky wings. Winter buds; 1/8-1/4 inch long, hairy. Bur oak is one of the largest American Oaks. Commonly distributed throughout Missouri, Iowa and Illinois, bur oak are is important bottomland tree, frequently found in moist flats, wetlands, and undulating flood plains. Important associates of bur oak include red maple, American elm, silver maple, swamp white oak, sycamore and eastern cottonwood.

Objective: The objective of this study is to select a local source, fast growing, and high nut producing bur oak.

Procedure: Field collections were assembled, accessioned, and held in storage until the collection period ended. The assemblage of collections began at the PMC in October 2000 and ended mid-December 2000. After the collection period was over the seed was stratified and planted in the greenhouse using the Root Pruning Method (RPM) containers. The plants will be transplanted in Field #7 on the PMC in mid to late April 2002. The design will be a randomized complete block with one plant per plot: one block for the Iowa collections, one for the Illinois collections and one block for the Missouri collections.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2000
A total of 24 collections were made from the PMC three state service area: seven from Iowa, two from Illinois and 15 from Missouri. As these collections arrived at the PMC they were given accession numbers and placed in stratification for 120 days (cool moist storage 38 degrees Fahrenheit). At the time this report was being developed, these collections were being germinated in the greenhouse.

2001
The 24 collections of bur oaks were taken out of the germination trays and placed in containers (3 5/8" x 6") and allowed to grow to approximately one foot tall. These plants were later transplanted into one-gallon size containers and placed in the portable greenhouse. In early December 2001 the plants were transported to the root cellar for over wintering. The scheduled planting date is April 2002. The plantings will be randomized complete block designs with one block for Iowa's collections, one block for Illinois' collections and one block for Missouri's collections. Refer to Table #1 for collection information.

2002
Three assemblies of bur oaks were planted in April 2002 representing each state's collections, Iowa, Illinois and Missouri. Iowa's collections were planted in Field #6 on April 18, 2002, Illinois' collections were planted in Field #12 on April 17, 2002, and Missouri's collections were planted in Field #7 on April 18 – 19, 2002. These collections were evaluated for height, spread, vigor, and

insect and disease resistance. The evaluation data was not documented in this year's report but will be in the 2003 Annual Technical Report. Table #1 reflects collection information.

2003
The three assemblies of bur oak representing the Missouri, Illinois, and Iowa collections were evaluated in October 2003. Performance characteristics evaluated were height, spread, vigor, and insect/disease resistance. The 2003 plant performance summaries can be found in Tables #2 and #8.

2004
All three plantings, Missouri, Iowa, and Illinois, were evaluated again for height, spread, vigor, and insect/disease resistance. Evaluation data for 2004 can be found in Tables #3 and #9. The Iowa and Missouri plantings originally were planted with two trees of each collection in each replication. Not all collections had enough material to allow for two trees in each replication, but most did. In 2004, the lesser dominant tree was removed to allow the dominant tree to grow without competition. There are some replications that had trees die and the extra (non-dominant) trees were, in some cases, used to replace trees that died. The 2005 evaluations will reflect the replacement trees. Fertilizer, 13-13-13, was added to the three plantings to encourage growth and healthier plants.

2005
Evaluations were taken in September for height, spread, vigor, and insect/disease resistance on the three plantings. Fertilizer, 13-13-13, again was added to each tree. Acorns were produced on a few trees in the Missouri accession in field #7. Evaluation data for 2005 can be found in Tables # 4 and #10.

2006
In early spring, all three plots of bur oaks were sprayed with an ounce per acre rate of Oust to control grass and weed competition. There was good control through mid-summer. Late summer broadleaf weeds and grasses encroached back around the tree. Fertilizer, 13-13-13, was also added at a rate of 8 oz. per tree. An evaluation for acorn production was done on all three plots (five year old trees); Missouri plot (Rep. 3, tree MO-11) produced several acorns and in the Iowa plot (Rep. 3, tree IA-5; Rep. 6, tree IA-6; and Rep. 7, tree IA-5) all produced significant amounts of acorns. There were no height, spread, and insect/disease resistant evaluations taken this year.

2007
In 2007, the seven surviving trees from Illinois in field #12 were moved to field #11 to make room for another planting. During the summer, these seven trees stressed heavily due to drought conditions. There were no evaluations for the Illinois trees and a determination will be made in FY 2008 if there is a need to continue with an Illinois source bur oak. There were no evaluations made on the Illinois planting in FY 2007. Missouri and Iowa bur oak plots look good and are performing well. Oust again was used in the spring to control white clover and grasses around the trees. Missouri source bur oaks have been susceptible to small galls that cover the leaf surface, possibly caused by small wasps. The damage is mostly cosmetic and seems to be mainly associated with the Missouri plot, but is also evident in the Iowa planting. The Iowa and Missouri plots were evaluated again for height, spread, vigor, insect/disease resistance, and acorn production. This year the trees were measured at 24 inches high to get a diameter measurement on the trunk. This will help determine how well each tree is performing against other trees in the planting. The Iowa planting had six trees that produced acorns, while the Missouri planting did not have any trees produce in 2007. The drought conditions could possibly have been the reason for little to no acorn production. The Iowa and Missouri evaluation data can be found in Tables #5 and #11.

2008

The remaining Illinois source trees died in FY08 and plans to start a new evaluation block of trees from Illinois were discontinued. The Missouri and Iowa source bur oak trees are doing very well. Again they were evaluated and plans are to evaluate the plots once more in FY09, before selections from each plot are made. Selections will consist of using a hydraulic tree spade and physically moving the trees to a new location, where they will be planted in a new crossing block. There will be a block for both Missouri and Iowa collections. The trees will be analyzed using statistical software based on the data that has been recorded over the past 7 years. Trees from accessions possessing superior characteristics will be selected for the crossing block. Data for 2008 can be found in Tables #6 and #12.

2009
Both plantings, IA and MO, were evaluated in October of 2009. The plantings were sprayed with a non-selective herbicide around the base of the trees in early spring to allow moisture and fertilizer to access the trees roots. 13-13-13 was also added to both plantings. All trees with limbs lower than 30 inches were cut. Once the evaluations have been analyzed, selections for superior trees will be made in FY10 and a new block will be established after the trees go dormant in the fall of 2010. Data for 2009 can be found in Tables #7 and #13.

2010
Selections were made in both the Iowa and Missouri plantings and unwanted trees were removed using a chainsaw. The trees, in both plots, will be allowed to cross and acorns will be collected in order to start seedlings for field testing. In 2011, smaller trees of the selected accessions may be removed depending on their size in proportion to the rest of the plot. Release information will be compiled, as well as data from field test information in order to make a potential release by 2013-2014.

2011-2012-2013
Acorns have been collected over the past 3 years and in 2011 and 2012 the germination was tested against previous releases Lippert (KS) and Boomer (TX). The germination from both the Iowa and Missouri collections were poor. Possible reason for such poor germination might be due to handling of the acorns after harvest. Cool, moist storage is required to maintain viability of the seed collected and it is speculated that the seed harvested at the Elsberry PMC may have dried out and/or wasn't stored in the cooler at the proper time after harvest. The acorns were "floated" in order to rid of any seed that may have been destroyed due to insect or disease. In the fall of 2012, seedlings were grown out in the greenhouse from both MOPMC collections, IA and MO, along with seedlings of Lippert from the KSPMC and Boomer from the TXPMC at Know City. The seedlings were planted in the small wetland cell at the MOPMC and are planned for flood tolerant testing. Testing was scheduled for spring of 2013, but due to water control structure damage, testing will occur in spring 2014.

Table # 1

Study Title: Assembly, Evaluation and Selection of Bur Oak *Quercus macrocarpa* Michx.

Temporary No.	State	County	MLRA	Collector
MO-1	Missouri	Calloway	115	Thomas L. Wekenborg
MO-2	Missouri	Chariton	NA	Charles Lewis
MO-3	Missouri	Shannon	053	Randy Misser
MO-4	Missouri	Lincoln	115	Jimmy Henry
MO-5	Missouri	Lincoln	115	Jimmy Henry
MO-6	Missouri	Lincoln		Wayne Lovelace
MO-7	Missouri			
MO-8	Missouri	Pike		Keith Jackson

Temporary No.	State	County	MLRA	Collector
MO-9	Missouri	Pike		Keith Jackson
MO-10	Missouri	Pike		Keith Jackson
MO-11	Missouri	Pike		Keith Jackson
MO-12	Missouri	Howard	N/A	Robert D. Dewitt
MO-13	Missouri	Boone	N/A	Robert D. Dewitt
MO-14	Missouri	St. Charles	115	Dan Crigler
MO-15	Missouri	Moniteau	115	Douglas Wallace
IL-1	Illinois	Clark	N/A	David E. Hiatt
IL-1	Illinois	Jasper	113	Dennis D. Clency
IA-1	Iowa	Dickinson	103	Tim K. Moran
IA-2	Iowa	Dickinson	103	Tim K. Moran
IA-3	Iowa	Dickinson	103	Tim K. Moran
IA-4	Iowa	Wayne	N/A	Duane Bedford
IA-5	Iowa	Decatur	109	Kevin Reynolds
IA-6	Iowa	Bremer	104	Richard J. Cornes
IA-7	Iowa	Black	104	Rick Cordes

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table #2**

2003 Evaluation

Summary of Iowa Collections, Located in Field #6

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	1.1	0.4	0.8	1.1	1.3	0.6	0.8	1.0	0.8	1.0	1.2	1.2	**0.93**
IA-2	0.7	0.8	0.8	0.8	1.2	1.0	1.3	0.8	0.8	0.8	1.1	1.3	**0.95**
IA-3	0.8	0.7	0.8	1.1	0.9	0.7	0.6	0.8	0.9	1.0	0.9	0.8	**0.81**
IA-4	1.3	1.3	1.2	0.8	0.8	1.0	0.0	0.9	1.3	1.1	0.9	0.0	**1.07**
IA-5	1.1	1.3	1.3	0.7	1.3	1.2	2.0	1.9	1.0	1.4	1.7	0.8	**1.30**
IA-6	0.8	0.7	1.0	1.1	1.0	1.0	0.4	0.3	0.5	1.1	0.6	0.7	**0.77**
IA-7	1.1	1.3	0.8	1.0	1.8	1.0	0.8	0.5	0.5	1.7	0.9	1.6	**1.08**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1		0.3	0.2	0.2	0.0			0.1	0.2	0.1	0.2	0.3	**0.17**
IA-2		0.3		0.1	0.2	0.2	0.1	0.2	0.1	0.0	0.0	0.2	**0.15**
IA-3			0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	**0.08**
IA-4		0.2	0.1	0.1	0.1		0.0	0.1	0.1	0.2	0.2		**0.14**
IA-5		0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.0	0.0	0.0	0.1	**0.13**
IA-6				0.2	0.2	0.1		0.0	0.1	0.2	0.0	0.2	**0.13**
IA-7	0.2	0.3	0.1		0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	**0.11**

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	4	5	4	3	4	6	4	4	6	4	4	4	**4.33**
IA-2	4	4	4	4	3	4	6	4	5	5	4	3	**4.17**
IA-3	dead	4	3	3	4	4	6	6	4	4	5	6	**4.45**
IA-4	3	3	3	4	4	4		4	3	4	4		**3.60**
IA-5	3	3	3	4	3	3	2	2	6	3	3	3	**3.17**
IA-6	4	4	3	3	4	4		9	7	4	6	6	**4.91**
IA-7	3	3	4	3	2	4	4	7	7	3	4	3	**3.92**

Summary of Insect and Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	3	3	2	2	2	2	5	4	3	2	3	2	**2.73**
IA-2	2	2	2	2	3	2	3	5	4	4	3	2	**2.91**
IA-3	2	3	3	3	2	3	3	3	2	4	3	3	**2.91**
IA-4	2	2	3	2	2		4	4	3	2	3		**2.78**
IA-5	3	2	3	3	3	2	2	2	4	2	2	2	**2.45**
IA-6	2	2	2	2	3	2	4	3	4	3	4	3	**2.91**
IA-7	3	3	2	2	2	3	2	3	3	3	4	3	**2.73**

Study MOPMC-P-0001-WE, WL **Table #3**

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx.

2004 Evaluation

Summary of Iowa Collections, Located in Field #6

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	2.2	4.0	2.8	2.9	2.6	2.4	2.2	2.3	3.7	3.6	3.6	3.5	**3.0**
IA-2	2.9	3.1	2.4	2.7	2.9	3.1	2.4	3.6	3.5	3.4	3.7	3.8	**3.1**
IA-3	3.7	2.3	2.5	3.0	2.7	3.2	2.4	dead	3.6	2.5	3.3	3.4	**3.0**
IA-4	3.0	4.0	3.4	4.1	3.2	3.1	3.8	3.1	4.4	3.8	4.1	4.3	**3.7**
IA-5	4.3	3.7	4.9	3.7	3.5	3.2	3.2	3.2	3.5	dead	3.2	2.6	**3.5**
IA-6	2.3	3.0	2.4	2.4	3.6	3.5	dead	dead	3.4	3.1	2.2	3.5	**2.9**
IA-7	3.5	3.2	3.2	3.2	3.7	3.6	3.2	4.1	2.4	3.4	3.8	4.1	**3.5**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	2	3.6	2.5	3.2	2.9	2.5	3	2	3.8	3.7	3	3.2	**3.0**
IA-2	2.7	2.7	2.4	2.1	2.2	2.8	3	3	2.6	3	2.9	2.6	**2.7**
IA-3	3.7	2.1	2.8	2.7	2.4	3.3	1.5	dead	3.3	3.1	2.2	3.6	**2.8**
IA-4	3	2.6	3.1	3.4	3	3.4	5	3.7	3	3.1	3.4	3.4	**3.3**
IA-5	4.4	3.2	3.3	4.1	3.8	2.5	2	3.4	2.9	dead	3.1	2.4	**3.2**
IA-6	2	3.6	2.2	2.4	3.4	3.4	dead	dead	3.8	3.2	2.6	2.5	**2.9**
IA-7	2.8	2.6	2.3	2.4	3.5	3.2	3.3	3.5	2.2	3.7	3	3.4	**3.0**

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	5	3	5	3	4	5	4	5	3	3	3	4	**3.9**
IA-2	4	3	5	5	4	4	5	3	4	4	3	4	**4.0**
IA-3	2	5	4	3	5	4	6	dead	3	4	5	3	**4.0**
IA-4	3	3	2	2	3	3	2	3	2	2	3	2	**2.5**
IA-5	1	3	1	2	2	4	5	3	4	dead	4	5	**3.1**
IA-6	5	3	5	4	3	3	dead	dead	3	3	5	4	**3.8**
IA-7	3	4	3	3	2	3	4	4	4	3	3	3	**3.3**

Summary of Insect and Disease Resitance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	2	3	3	3	1	4	2	3	2	2	2	2	**2.4**
IA-2	1	2	2	1	2	2	4	2	2	2	3	2	**2.1**
IA-3	2	2	3	3	2	3	2	dead	2	2	2	2	**2.3**
IA-4	2	3	2	2	3	2	3	2	3	2	2	1	**2.3**
IA-5	2	2	2	2	1	3	3	3	3	dead	5	2	**2.5**
IA-6	2	2	2	2	2	1	dead	dead	1	1	1	2	**1.6**
IA-7	2	3	2	1	2	2	2	2	2	2	4	2	**2.2**

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table #4**

2005 Evaluation

Summary of Iowa Collections, Located in Field #6

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	3.6	4.5	4.3	4.6	5.1	3.5	4.7	3.9	5.3	5	4.9	5.4	4.6
IA-2	4.3	4.6	3.8	3.8	4.5	4.9	3.6	4.4	4.6	4.9	5.2	5	4.5
IA-3	6.3	4	4	5.6	3.7	5.2	4	Dead	6	4.5	5.2	4.3	4.8
IA-4	5.2	5.4	4.8	6	4.6	5.1	5.8	5.2	6.2	5.4	6.3	6	5.5
IA-5	5.8	5.6	6.3	5.3	5.2	4.6	4.6	5	5.2	Dead	5	2.9	5
IA-6	3.5	5.2	4.2	4.5	5	4.5	Dead	Dead	4.3	5.1	3.2	4.4	4.4
IA-7	4.5	Dead	5.8	5.2	5.5	5	4.7	4.6	Dead	4.7	4.9	5.7	5.1

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	2.6	3	2.3	3.6	5.1	3.4	3.8	3.6	3.7	4	4.2	3.3	3.6
IA-2	2.6	3.2	2.6	3.6	3	3.5	3.6	3.6	3.6	3.2	3.6	3.1	3.3
IA-3	4.2	2.6	3	4	2	3	2.6	Dead	4.9	3	2.4	4.3	3.3
IA-4	4	3	3.5	5	3.6	4	4.7	4	3.4	4	3.4	4.4	3.9
IA-5	4.3	3.4	4.5	4	3.6	5	3.7	4	3.2	Dead	3	3.4	3.8
IA-6	2.2	4	2.5	3.5	2.5	4	Dead	Dead	3.6	4.2	2.4	2.6	3.2
IA-7	2.8	Dead	2.3	3.4	3.5	3.5	4.2	3.9	Dead	3	4	4	3.5

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	6	3	5	3	1	3	4	5	3	2	3	3	3.4
IA-2	5	4	5	5	5	2	6	3	3	3	3	3	3.9
IA-3	2	5	4	5	5	5	5	Dead	2	4	4	3	4.0
IA-4	3	3	3	1	3	3	1	2	2	3	2	6	2.7
IA-5	1	3	1	2	2	3	3	2	3	Dead	4	2	2.4
IA-6	6	3	5	3	3	4	Dead	Dead	3	3	6	4	4.0
IA-7	9	Dead	5	4		2	3	3	Dead	5	3	2	4.0

Summary of Insect/Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	3	2	2	2	2	2	2	2	3	3	2	2	2.3
IA-2	2	2	3	3	4	2	3	2	3	3	3	2	2.7
IA-3	3	4	2	7	3	4	1	Dead	1	3	2	2	2.9
IA-4	1	2	1	1	1	3	1	1	1	2	1	2	1.4
IA-5	2	3	2	2	3	1	1	3	1	Dead	2	1	1.9
IA-6	2	3	1	2	3	2	Dead	Dead	2	2	2	4	2.3
IA-7	9	Dead	5	3		1	1	3	Dead	2	2	2	3.1

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table #5**

2007 Evaluation

Summary of Iowa Collections, Located in Field #6

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	9.8	10.2	9.0	9.7	8.4	9.0	9.8	9.5	10.1	9.5	9.1	10.6	9.56
IA-2	8.0	9.4	7.5	7.2	6.8	7.5	9.8	9.4	9.7	8.2	8.6	6.7	8.23
IA-3	11.8	8.0	8.5	8.0	7.2	8.5	8.5	dead	11.4	9.0	8.9	8.5	8.94
IA-4	9.7	9.2	10.2	9.7	9.6	9.6	11.0	10.6	11.7	12.0	11.9	10.6	10.48
IA-5	11.6	10.8	11.0	9.8	9.6	7.6	8.3	11.2	10.6	dead	9.5	6.9	9.72
IA-6	5.6	9.0	7.7	9.3	9.3	7.0	dead	dead	10.8	8.9	8.0	7.3	8.29
IA-7	9.8	7.5	9.3	9.0	9.1	9.4	10.2	9.6	5.8	9.2	11.0	11.2	9.26

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	6.7	7.3	6.9	8.5	7.0	6.8	8.0	7.6	9.7	8.2	9.7	7.2	7.80
IA-2	5.7	8.0	7.4	6.8	6.0	7.5	9.3	8.1	9.8	6.9	7.9	6.0	7.45
IA-3	10.6	6.6	6.8	8.0	5.0	6.7	7.4	dead	10.0	7.2	5.6	8.6	7.50
IA-4	6.9	6.5	8.0	9.6	9.0	7.7	11.5	9.8	8.8	9.2	10.2	10.9	9.01
IA-5	11.0	8.9	9.2	8.2	8.0	8.7	9.3	11.5	8.3	dead	10.0	6.0	9.01
IA-6	5.0	8.5	6.8	7.5	10.2	8.2	dead	dead	9.5	8.4	5.7	7.0	7.68
IA-7	7.7	4.0	8.0	7.6	8.0	8.2	10.7	10.0	4.0	6.6	10.0	9.9	7.89

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	4	5	6	3	5	6	4	5	3	3	3	3	4.17
IA-2	5	5	6	7	8	6	3	4	3	5	5	7	5.33
IA-3	3	7	6	5	7	6	5	dead	2	5	5	4	5.00
IA-4	5	5	3	3	3	5	1	1	1	1	1	1	2.50
IA-5	2	4	2	3	4	4	4	1	2	dead	3	6	3.18
IA-6	7	5	5	4	4	6	dead	dead	2	5	5	6	4.90
IA-7	4	8	6	5	5	3	2	4	7	4	1	1	4.17

Summary of Insect/Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	5	3	4	3	3	5	4	3	3	3	1	3	3.33
IA-2	3	3	3	3	4	4	2	3	2	3	4	3	3.08
IA-3	4	2	3	3	3	3	1	dead	3	8	3	3	3.27
IA-4	4	3	2	2	1	2	3	1	3	3	2	2	2.33
IA-5	3	3	3	2	3	3	3	2	2	dead	3	2	2.64
IA-6	2	3	3	2	2	3	dead	dead	2	2	3	3	2.50
IA-7	3	3	5	3	3	3	3	3	2	4	2	3	3.08

Summary of Trunk Diameter Measured at 24 Inches High

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	5	6.5	5.5	8	6.25	6.75	5	5.5	7.75	6.5	7	6.25	6.33
IA-2	5.5	5.75	5.5	5	4	6.25	6.75	5.75	6.25	6.25	6	3.5	5.54
IA-3	8.25	4	5.75	5	6	5.5	4.5	dead	5.75	6.75	5.75	5.25	5.68
IA-4	9.25	8.2	7.75	8.5	7.25	8	9	8.25	7	7	9.5	9	8.23
IA-5	10	6.5	8.25	7.5	7.75	7.75	6.25	7.75	7.25	dead	6	4.5	7.23
IA-6	3.5	6.5	4.75	5.5	7.5	6	dead	dead	6.5	5.5	4.25	6	5.60
IA-7	6	3.5	5.25	5	7.5	6.75	6	5.75	2.25	6.25	6.75	5.75	5.56

2007 Evaluation

Summary of Iowa Collections, Located in Field #6 **Table #5 - Continued**

Sumary of Acorn Presence

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12
IA-1	no	no	no	no	no	no	no	no	YES	no	no	no
IA-2	no	no	no	no	no	no	no	no	no	no	no	no
IA-3	no	no	no	no	no	no	no	dead	no	no	no	no
IA-4	no	no	no	no	no	no	no	no	no	no	no	no
IA-5	YES	no	no	no	no	no	no	YES	no	dead	YES	YES
IA-6	no	no	no	YES	no	no	dead	dead	no	no	no	no
IA-7	no	no	no	no	no	no	no	no	no	no	no	no

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table #6**

2008 Evaluation

Summary of Iowa Collections, Located in Field #6

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	11.3	12.2	10.7	10.8	10.0	9.9	10.0	11.3	12.2	10.6	10.0	11.7	10.9
IA-2	8.2	10.7	9.4	9.4	8.3	8.8	11.1	10.4	12.2	9.0	8.9	8.2	9.6
IA-3	13.2	9.1	10.3	9.4	9.7	9.4	9.3	DEAD	13.2	10.2	10.0	8.8	9.4
IA-4	12.0	12.0	12.5	13.2	11.2	11.1	12.2	12.3	12.9	13.4	12.4	12.3	12.3
IA-5	13.0	11.4	13.3	12.0	11.1	9.3	10.6	13.0	12.6	DEAD	10.4	8.8	10.5
IA-6	6.8	10.6	8.9	10.9	10.8	9.2	DEAD	DEAD	11.5	9.9	8.6	9.4	8.1
IA-7	10.2	8.3	11.1	10.0	10.0	11.6	12.0	11.7	8.4	11.6	13.3	12.2	10.9

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	7.5	8.9	6.9	7.5	8.5	7.6	7.6	8.1	9.6	8.5	7.8	6.1	7.9
IA-2	5.6	7.7	8.3	7.4	6.1	8.1	9.4	8.4	10.4	6.7	8.8	6.7	7.8
IA-3	9.9	6.4	7.4	8.7	6.0	7.6	8.4	DEAD	11.2	7.4	8.0	8.9	7.5
IA-4	7.0	7.9	11.7	8.9	10.1	8.3	11.0	8.7	9.5	12.1	9.5	9.2	9.5
IA-5	11.4	8.8	11.4	9.2	8.4	10.0	10.8	11.5	8.4	DEAD	9.6	7.5	8.9
IA-6	5.9	10.0	8.7	8.6	11.4	8.9	DEAD	DEAD	8.2	8.6	4.8	8.2	6.9
IA-7	7.1	5.3	7.0	7.5	10.7	7.9	9.6	10.3	5.2	10.3	9.8	10.4	8.4

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	8	9	7	8	8	8	8	8	8	8	9	8	8.1
IA-2	7	7	7	6	6	6	7	8	9	7	7	6	6.9
IA-3	10	7	7	7	7	7	7	DEAD	10	7	8	7	7.0
IA-4	9	9	10	10	10	9	10	10	10	10	10	10	9.8
IA-5	10	9	10	9	9	9	9	10	9	DEAD	8	7	8.3
IA-6	6	8	7	8	9	6	DEAD	DEAD	8	6	7	7	6.0
IA-7	8	5	8	7	9	9	9	8	5	8	10	10	8.0

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. Table #6 continued

Summary of Insect/Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	8	8	8	9	8	8	8	8	7	9	10	9	8.3
IA-2	7	8	9	9	8	8	7	8	8	9	9	7	8.1
IA-3	9	8	7	9	9	9	8	DEAD	9	8	8	9	7.8
IA-4	7	9	9	10	10	9	10	10	10	10	10	10	9.5
IA-5	7	9	9	9	9	8	10	10	10	DEAD	9	8	8.2
IA-6	7	9	8	9	10	6	DEAD	DEAD	9	8	9	10	7.1
IA-7	8	8	8	8	8	9	9	8	8	9	10	10	8.6

Summary of Diameter @ 24"

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	2.00	2.50	2.25	3.00	2.50	2.50	2.00	2.25	2.50	2.75	2.50	2.50	2.44
IA-2	2.25	2.50	2.75	2.00	1.75	2.25	2.75	2.50	3.00	2.50	2.25	1.50	2.33
IA-3	3.25	1.75	2.25	1.75	2.25	2.25	2.00	DEAD	2.50	2.25	2.25	1.75	2.02
IA-4	3.25	3.50	3.25	3.75	3.00	3.25	3.75	3.25	3.00	3.50	3.50	3.25	3.35
IA-5	3.50	2.50	3.50	2.50	3.00	2.50	2.50	3.50	2.75	DEAD	2.50	2.00	2.56
IA-6	1.25	2.25	2.00	2.25	3.00	2.00	DEAD	DEAD	2.50	2.25	2.00	2.50	1.83
IA-7	2.50	1.50	2.25	2.00	2.75	2.75	2.75	2.50	1.00	2.25	3.00	2.25	2.29

Summary of Circumference

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Avg.
IA-1	6.28	7.85	7.07	9.42	7.85	7.85	6.28	7.07	7.85	8.64	7.85	7.85	7.65
IA-2	7.07	7.85	8.64	6.28	5.50	7.07	8.64	7.85	9.42	7.85	7.07	4.71	7.33
IA-3	10.21	5.50	7.07	5.50	7.07	7.07	6.28	DEAD	7.85	7.07	7.07	5.50	6.35
IA-4	10.21	10.99	10.21	11.78	9.42	10.21	11.78	10.21	9.42	10.99	10.99	10.21	10.53
IA-5	10.99	7.85	10.99	7.85	9.42	7.85	7.85	10.99	8.64	DEAD	7.85	6.28	8.05
IA-6	3.93	7.07	6.28	7.07	9.42	6.28	DEAD	DEAD	7.85	7.07	6.28	7.85	5.76
IA-7	7.85	4.71	7.07	6.28	8.64	8.64	8.64	7.85	3.14	7.07	9.42	7.07	7.20

Acorns Present

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Rep 11	Rep 12	Total
IA-1	N	N	N	N	N	N	N	N	N	N	N	N	0
IA-2	N	N	N	N	N	N	YES	N	N	N	YES	N	2
IA-3	N	N	N	YES	N	YES	N	DEAD	N	N	N	N	2
IA-4	N	N	N	N	N	N	N	N	N	N	N	N	0
IA-5	N	N	N	YES	YES	N	N	YES	YES	DEAD	YES	N	5
IA-6	N	N	N	YES	N	YES	DEAD	DEAD	N	N	N	N	2
IA-7	N	N	N	N	N	YES	YES	N	N	N	YES	N	3

Study MOPMC-P-0001-WE, WL **Table #7**

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx.

2003 Evaluation

Summary of Missouri Collections, Located in Field #7

Summary of Height (Feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Average
MO-1	2.1	1.2	2.1	1.5	1.3	1.6	1.7	1.8	1.7	1.6	**1.7**
MO-2	1.7	2.0	1.6	2.2	1.5	0.8	0.6	0.6	0.7	1.1	**1.3**
MO-3	1.4	1.1	0.6	0.4	0.8	1.3	1.9	2.0	1.4	2.0	**1.3**
MO-4	1.6	1.3	1.7	1.9	2.1	0.7	1.5	1.3	1.5	1.2	**1.4**
MO-5	1.5	1.1	1.3	1.1	1.2	1.4	0.6	1.6	1.1	1.4	**1.2**
MO-6	1.6	0.0	0.0	0.0	0.0	2.0	1.0	2.0	1.7	1.9	**1.7**
MO-7	1.8	1.8	1.6	1.8	1.5		1.0	1.0	1.3	1.4	**1.4**
MO-8	1.1	0.7	1.2	0.5	1.1	2.1	1.6	1.9	2.1	1.6	**1.4**
MO-9	1.8	1.4	1.6	2.3	1.0	1.5	1.5	2.1	1.4	1.7	**1.6**
MO-10	2.0	1.5	2.3	2.3	1.6	0.8	1.5	1.3	1.5	1.3	**1.6**
MO-11	1.2	2.0	2.0	2.0	0.9	0.6	1.5	1.8	2.2	1.5	**1.6**
MO-12	2.0	1.9	1.7	1.1	0.8	1.3	1.5	1.5	2.0	1.5	**1.5**
MO-13		2.1	1.7	2.1	1.5	2.1	2.1	1.6	2.0	1.4	**1.9**
MO-14	1.8	1.8	2.3	1.7	1.1	1.3	1.2	1.5	1.7	1.4	**1.6**
MO-15			1.2	1.4	1.6						**1.4**

Summary of Spread (Feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Average
MO-1	0.1	0.2	0.2	0.0	0.0	0.2	0.5	0.3	0.3	0.2	**0.2**
MO-2	0.4	0.2	0.2	0.3	0.4	0.1	0.1	0.2	0.0	0.4	**0.2**
MO-3	0.1	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.1	**0.1**
MO-4	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.1	**0.1**
MO-5	0.1	0.1	0.1	0.0	0.1	0.2	0.2	0.1	0.3	0.1	**0.1**
MO-6	0.2								0.1	0.3	**0.2**
MO-7	0.2	0.1	0.1	0.2	0.3		0.0	0.3	0.1	0.2	**0.2**
MO-8	0.3	0.2	0.3	0.1	0.3	0.3	0.1	0.2	0.1	0.1	**0.2**
MO-9	0.3	0.1	0.2	0.3	0.1	0.3	0.1	0.3	0.0	0.3	**0.2**
MO-10	0.3	0.2	0.2	0.1	0.1		0.4	0.2	0.1	0.0	**0.1**
MO-11	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.3	**0.1**
MO-12	0.3	0.3	0.3	0.2	0.1	0.0	0.2	0.2	0.3	0.1	**0.2**
MO-13		0.0	0.1	0.2	0.1	0.3	0.1	0.1	0.3	0.2	**0.2**
MO-14	0.2	0.2	0.2	0.3	0.4	0.2			0.3	0.2	**0.2**
MO-15			0.1	0.1	0.1						**0.1**

Study MOPMC-P-0001-WE, WL **Table #8**

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx.

2004 Evaluation

Summary of Missouri Collections, Located in Field #7

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	3.0	3.2	3.2	2.8	3.7	2.4	3.9	dead	dead	2.4	**3.1**
MO-2	2.8	3.4	dead	3.1	3.6	dead	dead	dead	dead	2.6	**3.1**
MO-3	3.8	3.4	3.3	3.1	2.8	2.1	2.8	2.7	1.7	2.4	**2.8**
MO-4	3.6	3.1	2.9	3.3	3.0	1.3	3.1	3.1	3.2	2.8	**2.9**
MO-5	1.9	2.8	3.1	3.8	3.3	2.8	dead	2.8	2.9	3.3	**3.0**
MO-6	3.4	R	R	R	R	2.2	3.0	3.0	1.5	3.0	**2.7**
MO-7	3.9	dead	2.5	2.8	2.1	dead	dead	2.6	dead	3.6	**2.9**
MO-8	3.2	2.1	3.0	2.2	2.6	2.4	3.0	3.6	2.7	3.2	**2.8**
MO-9	4.3	2.8	4.2	2.6	2.4	2.5	1.3	4.2	1.6	3.4	**2.9**
MO-10	3.2	3.4	3.3	2.7	2.2	2.6	2.3	2.5	2.2	dead	**2.7**
MO-11	2.6	3.1	2.5	2.1	1.7	2.8	2.4	2.4	2.7	3.0	**2.5**
MO-12	2.4	2.4	3.0	2.0	2.2	2.0	2.7	2.6	2.4	3.2	**2.5**
MO-13	3.8	3.8	2.8	3.6	2.9	3.1	2.9	2.4	3.2	1.7	**3.0**
MO-14	3.5	3.3	2.6	2.8	1.7	2.1	dead	2.1	2.9	2.6	**2.6**
MO-15		3.9	3.1	3.0	3.1						**3.3**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	2.4	3.5	3.2	2.5	3.7	2.7	3.8	dead	dead	2.2	**3.0**
MO-2	3.2	3	dead	3.1	2.3	dead	dead	dead	dead	3	**2.9**
MO-3	3	2.6	3.5	2.9	2.6	2.3	2.3	2.7	1.7	3	**2.7**
MO-4	2.6	2.8	2.5	2.6	2.3	1.1	2.9	2.4	3	3	**2.5**
MO-5	1.8	3	2.3	3.4	3.3	2.5	dead	2.5	2.6	2.6	**2.7**
MO-6	2.6	R	R	R	R	2	2.1	2.6	1.2	2.4	**2.2**
MO-7	3.3	dead	2.6	3.5	2.1	dead	dead	2.8	dead	4	**3.1**
MO-8	2.9	1.9	3.3	1.8	2.2	2.6	2.4	3.1	2.7	3.1	**2.6**
MO-9	4.2	2.7	3.2	2.3	2.4	2.1	1.3	4.3	1.5	2.9	**2.7**
MO-10	2.9	2.8	2.7	3	2.2	2.2	2.1	2	2.7	dead	**2.5**
MO-11	2.6	2.8	2.6	1.8	1.9	2.4	2	2.6	3.4	3.3	**2.5**
MO-12	1.5	2.8	2.7	2	2.3	2.4	2.7	3	3	4.2	**2.7**
MO-13	3.4	3.1	2.9	3.6	3	2.9	2.6	2.3	3.2	1.2	**2.8**
MO-14	2.1	4.4	2.3	3.4	2.1	2.1	dead	2.7	2.5	3.1	**2.7**
MO-15		3.3	3.3	2.7	3.1						**3.1**

2004 Evaluation **Table #8 - continued**

Summary of Missouri Collections, Located in Field #7

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	4	4	3	5	2	4	1	dead	dead	5	**3.5**
MO-2	5	4	dead	3	5	dead	dead	dead	dead	4	**4.2**
MO-3	3	4	3	4	4	5	4	4	7	4	**4.2**
MO-4	3	4	4	4	4	8	3	4	3	4	**4.1**
MO-5	6	5	4	1	3	4	dead	4	4	4	**3.9**
MO-6	4	R	R	R	R	5	4	4	8	4	**4.8**
MO-7	3	dead	5	3	6	dead	dead	5	dead	1	**3.8**
MO-8	3	6	3	6	5	4	4	2	4	3	**4.0**
MO-9	1	5	3	4	4	5	7	1	7	4	**4.1**
MO-10	4	4	3	3	4	5	4	6	5	dead	**4.2**
MO-11	4	4	5	6	6	4	5	4	3	3	**4.4**
MO-12	6	5	4	6	5	5	3	4	4	2	**4.4**
MO-13	3	3	4	2	3	3	4	6	4	7	**3.9**
MO-14	4	4	5	3	6	5	dead	4	4	4	**4.3**
MO-15		2	3	3	3						**2.8**

Summary of Insect and Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	3	5	3	2	4	1	2	dead	dead	3	**2.9**
MO-2	4	2	dead	2	4	dead	dead	dead	dead	2	**2.8**
MO-3	3	4	3	3	2	2	2	2	3	2	**2.6**
MO-4	2	2	3	3	2	1	2	2	2	1	**2.0**
MO-5	1	3	2	2	2	1	dead	2	2	2	**1.9**
MO-6	4	R	R	R	R	2	2	2	1	2	**2.2**
MO-7	3	dead	2	2	2	dead	dead	2	dead	1	**2.0**
MO-8	4	3	3	4	3	1	3	2	3	2	**2.8**
MO-9	2	2	3	2	1	3	1	3	2	2	**2.1**
MO-10	3	4	2	2	1	2	1	3	2	dead	**2.2**
MO-11	3	3	3	2	3	2	2	2	2	2	**2.4**
MO-12	2	2	4	4	2	3	1	1	3	1	**2.3**
MO-13	5	2	3	1	2	2	3	2	4	3	**2.7**
MO-14	6	3	2	3	2	2	dead	2	3	3	**2.9**
MO-15		2	3	3	1						**2.3**

R = Tree was originally MO-6 accession, but was replaced with MO-15 accession

Study MOPMC-P-0001-WE, WL **Table #9**

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx.

2005 Evaluation

Summary of Missouri Collections, Located in Field #7

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	4.5	4.0	6.5	3.3		3.6	4.6	Dead	Dead	4.0	**4.4**
MO-2	3.6	4.5	Dead	4.4		Dead	Dead	Dead	Dead	5.3	**4.5**
MO-3	5.0	5.0	4.3	4.3		1.9	3.6	3.8	Dead	2.9	**3.9**
MO-4	4.9	4.4	4.3	4.6		1.0	4.3	4.4	5.3	4.5	**4.2**
MO-5	3.7	5.0	4.3	4.3		3.8	Dead	3.8	5.8	3.2	**4.2**
MO-6	6.4	R	R	R		1.0	3.9	4.0	Dead	3.5	**3.8**
MO-7	6.1	Dead	3.9	3.3		Dead	Dead	3.5	Dead	6.0	**4.6**
MO-8	6.2	4.0	3.4	3.9		Dead	Dead	4.6	4.8	4.7	**4.5**
MO-9	6.1	3.7	5.0	3.0		3.2	Dead	5.0	Dead	3.9	**4.3**
MO-10	4.0	4.2	Dead	3.2		Dead	3.6	3.0	4.0	Dead	**3.7**
MO-11	3.7	4.0	3.8	Dead		3.2	3.3	3.7	4.7	4.4	**3.9**
MO-12	3.2	6.7	3.4	3.1		Dead	4.1	4.0	3.8	4.6	**4.1**
MO-13	4.3	4.2	4.0	4.7		3.6	3.7	3.4	5.0	Dead	**4.1**
MO-14	4.0	5.0	Dead	4.0		2.8	Dead	4.8	4.0	4.0	**4.1**
MO-15		5.2	4.3	4.7							**4.7**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	3.5	4.0	5.0	2.0		3.0	3.3	Dead	Dead	3.5	**3.5**
MO-2	3.2	3.6	Dead	3.6		Dead	Dead	Dead	Dead	4.0	**3.6**
MO-3	3.0	3.7	3.6	3.0		1.0	2.9	2.8	Dead	2.5	**2.8**
MO-4	3.3	3.1	2.7	3.0		1.0	2.8	2.3	4.0	2.9	**2.8**
MO-5	2.3	3.6	3.0	3.0		2.4	Dead	3.2	1.8	3.0	**2.8**
MO-6	3.7	R	R	R		1.0	3.0	3.0	Dead	2.9	**2.7**
MO-7	4.3	Dead	2.6	3.7		Dead	Dead	3.0	Dead	4.4	**3.6**
MO-8	4.0	3.0	2.8	2.0		Dead	Dead	2.5	3.2	2.7	**2.9**
MO-9	6.0	3.0	2.4	1.4		1.8	Dead	4.0	Dead	1.5	**2.9**
MO-10	3.0	3.7	Dead	3.0		Dead	2.7	2.5	2.0	Dead	**2.8**
MO-11	3.0	3.0	2.5	Dead		2.2	2.6	2.6	3.7	3.0	**2.8**
MO-12	1.2	3.3	2.5	2.5		Dead	3.0	3.2	3.0	4.0	**2.8**
MO-13	3.0	3.0	3.0	3.3		2.8	2.8	2.0	4.6	Dead	**3.1**
MO-14	3.0	2.2	Dead	3.6		2.3	Dead	3.2	2.5	4.0	**3.0**
MO-15		4.8	3.4	3.3							**3.8**

2005 Evaluation **Table #9 - continued**

Summary of Missouri Collections, Located in Field #7

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	3	3	1	6		6	3	Dead	Dead	4	**3.7**
MO-2	4	2	Dead	4		Dead	Dead	Dead	Dead	3	**3.3**
MO-3	3	2	3	4		8	4	4	Dead	6	**4.3**
MO-4	4	4	7	4		8	3	5	2	5	**4.7**
MO-5	7	3	5	3		5	Dead	4	3	6	**4.5**
MO-6	2	R	R	R		8	5	5	Dead	5.0	**5.0**
MO-7	2	Dead	7	5		Dead	Dead	5	Dead	1	**4.0**
MO-8	2	4	7	7		Dead	Dead	3	2	3	**4.0**
MO-9	1	2	5	8		6	Dead	1	Dead	8	**4.4**
MO-10	5	4	Dead	6		Dead	6	6	6	Dead	**5.5**
MO-11	6	4	6	Dead		6	6	4	2	4	**4.8**
MO-12	8	2	6	7		Dead	5	5	4	3	**5.0**
MO-13	5	2	5	4		5	3	6	2	Dead	**4.0**
MO-14	5	3	Dead	5		7	Dead	4	6	3	**4.7**
MO-15		1	4	5							**3.3**

Summary of Insect and Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	2	4	2	2		2	4	Dead	Dead	3	**2.7**
MO-2	3	2	Dead	2		Dead	Dead	Dead	Dead	2	**2.3**
MO-3	4	3	2	1		1	2	1	Dead	1	**1.9**
MO-4	3	5	4	2		8	2	3	2	2	**3.4**
MO-5	5	4	4	3		2	Dead	1	2	2	**2.9**
MO-6	3	R	R	R		8	2	2	Dead	1	**3.2**
MO-7	5	Dead	4	2		Dead	Dead	1	Dead	1	**2.6**
MO-8	3	3	3	4		Dead	Dead	3	3	2	**3.0**
MO-9	2	2	2	6		4	Dead	3	Dead	8	**3.9**
MO-10	5	5	Dead	4		Dead	3	1	2	Dead	**3.3**
MO-11	4	4	1	Dead		3	2	2	3	3	**2.8**
MO-12	5	2	3	1		Dead	3	3	1	4	**2.8**
MO-13	4	1	5	4		2	2	1	3	Dead	**2.8**
MO-14	4	3	Dead	3		1	Dead	4	2	1	**2.6**
MO-15		3	4	2							**3.0**

R = Tree was originally MO-6 accession, but was replaced with MO-15 accession

Replication #5 was removed and used in another study offsite of the PMC

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table # 10**

2007 Evaluation

Summary of Missouri Collections, Located in Field #7

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	8.3	7.3	10.7	7.9	Gone	7.8	9.9	Dead	Dead	7.5	**8.5**
MO-2	7.4	7.7	Dead	8.5	Gone	Dead	Dead	Dead	Dead	8.7	**8.1**
MO-3	10.3	8.8	8.3	8.6	Gone	3.9	8.1	6.6	Dead	7.5	**7.8**
MO-4	10.4	8.2	7.0	9.1	Gone	Dead	9.8	7.6	10.7	8.1	**8.9**
MO-5	7.9	9.8	8.9	9.6	Gone	6.7	Dead	7.9	11.1	8.2	**8.8**
MO-6	10.4	R	R	R	R	Dead	7.4	7.6	Dead	6.0	**7.9**
MO-7	11.6	Dead	8.2	8.1	Gone	Dead	Dead	6.3	Dead	10.0	**8.8**
MO-8	9.8	8.0	6.1	8.8	Gone	4.7	Dead	9.5	9.8	9.9	**8.3**
MO-9	11.0	5.9	7.3	3.0	Gone	5.1	Dead	8.8	Dead	7.5	**6.9**
MO-10	8.7	7.0	5.5	9.0	Gone	4.4	7.4	6.4	9.2	Dead	**7.2**
MO-11	6.9	9.1	8.0	4.0	Gone	7.3	8.1	7.4	10.2	9.6	**7.8**
MO-12	5.5	11.5	6.0	7.0	Gone	4.5	7.5	7.8	8.2	8.0	**7.3**
MO-13	7.8	9.1	6.6	8.5	Gone	7.6	7.6	8.9	7.7	Dead	**8.0**
MO-14	6.0	9.8	6.4	8.2	Gone	6.7	Dead	9.0	8.3	7.0	**7.7**
MO-15		9.6	9.0	8.8	Gone						**9.1**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	9.3	6.2	11.5	8.8	Gone	6.0	9.5	Dead	Dead	9.0	**8.6**
MO-2	7.6	9.0	Dead	10.0	Gone	Dead	Dead	Dead	Dead	7.1	**8.4**
MO-3	9.0	8.4	10.0	7.6	Gone	3.4	8.2	7.2	Dead	7.3	**7.6**
MO-4	10.2	8.0	5.7	7.3	Gone	Dead	9.4	6.0	12.0	6.6	**8.2**
MO-5	6.5	8.0	8.0	9.0	Gone	6.0	Dead	7.0	10.3	6.8	**7.7**
MO-6	8.0	R	R	R	R	Dead	7.2	8.0	Dead	7.1	**7.6**
MO-7	11.5	Dead	9.0	7.8	Gone	Dead	Dead	8.6	Dead	9.3	**9.2**
MO-8	6.9	9.0	6.5	6.0	Gone	4.0	Dead	9.2	11.0	8.0	**7.6**
MO-9	11.5	8.0	7.0	2.8	Gone	5.0	Dead	9.0	Dead	6.0	**7.0**
MO-10	6.5	11.5	4.3	6.4	Gone	3.7	7.7	7.0	7.8	Dead	**6.9**
MO-11	6.0	10.0	6.3	3.4	Gone	6.4	7.8	7.8	10.8	7.3	**7.3**
MO-12	5.0	8.0	8.0	6.0	Gone	3.7	7.0	7.9	8.2	11.0	**7.2**
MO-13	7.2	9.0	7.0	8.8	Gone	9.2	6.7	8.0	10.1	Dead	**8.3**
MO-14	4.8	11.0	6.5	7.5	Gone	5.2	Dead	9.2	6.9	8.2	**7.4**
MO-15		11.0	9.5	8.0	Gone						**9.5**

2007 Evaluation

Summary of Missouri Collections, Located in Field #7 **Table 10 - Continued**

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	4	5	1	5	Gone	4	4	Dead	Dead	5	**4.0**
MO-2	5	4	Dead	3	Gone	Dead	Dead	Dead	Dead	3	**3.8**
MO-3	2	3	3	3	Gone	8	4	5	Dead	5	**4.1**
MO-4	2	3	5	3	Gone	Dead	3	5	2	4	**3.4**
MO-5	6	2	4	3	Gone	4	Dead	5	1	4	**3.6**
MO-6	2	R	R	R	R	Dead	5	4	Dead	5	**4.0**
MO-7	1	Dead	4	4	Gone	Dead	Dead	6	Dead	2	**3.4**
MO-8	3	4	6	4	Gone	7	Dead	3	2	2	**3.9**
MO-9	1	6	4	9	Gone	6	Dead	2	Dead	5	**4.7**
MO-10	5	5	8	4	Gone	7	5	5	5	Dead	**5.5**
MO-11	7	3	4	8	Gone	4	3	5	2	3	**4.3**
MO-12	7	1	6	5	Gone	7	4	4	4	3	**4.6**
MO-13	6	3	7	3	Gone	4	4	4	4	Dead	**4.4**
MO-14	7	3	6	3	Gone	6	Dead	3	4	4	**4.5**
MO-15		2	3	4	Gone						**3.0**

Summary of Insect and Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	3	4	3	3	Gone	6	7	Dead	Dead	3	**4.1**
MO-2	3	2	Dead	2	Gone	Dead	Dead	Dead	Dead	4	**2.8**
MO-3	3	3	2	3	Gone	3	4	3	Dead	3	**3.0**
MO-4	3	3	3	3	Gone	Dead	3	3	2	2	**2.8**
MO-5	3	3	4	3	Gone	2	Dead	5	2	3	**3.1**
MO-6	2	R	R	R	R	Dead	2	3	Dead	3	**2.5**
MO-7	2	Dead	2	3	Gone	Dead	Dead	6	Dead	3	**3.2**
MO-8	4	3	4	3	Gone	8	Dead	3	2	3	**3.8**
MO-9	2	2	2	2	Gone	4	Dead	2	Dead	2	**2.3**
MO-10	2	4	2	3	Gone	2	3	2	3	Dead	**2.6**
MO-11	6	3	3	2	Gone	3	2	2	3	4	**3.1**
MO-12	2	3	3	5	Gone	4	2	2	7	3	**3.4**
MO-13	3	4	5	4	Gone	2	2	3	4	Dead	**3.4**
MO-14	4	1	2	3	Gone	3	Dead	3	3	4	**2.9**
MO-15		2	3	5	Gone						**3.3**

2007 Evaluation

Summary of Missouri Collections, Located in Field #7 **Table #10 - Continued**

Summary of Diameter of Trunk at 24 Inch Height

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	8.50	5.75	11.25	5.75	Gone	5.75	9.00	Dead	Dead	6.25	**7.5**
MO-2	5.25	5.25	Dead	6.75	Gone	Dead	Dead	Dead	Dead	5.75	**5.8**
MO-3	7.00	6.75	6.75	5.50	Gone	1.75	4.75	4.50	Dead	4.25	**5.2**
MO-4	8.50	5.75	5.75	6.75	Gone	Dead	8.75	6.25	6.75	5.25	**6.7**
MO-5	6.25	9.00	5.75	6.50	Gone	6.75	Dead	5.00	8.00	5.75	**6.6**
MO-6	9.25	R	R	R	R	Dead	7.75	6.50	Dead	5.00	**7.1**
MO-7	9.25	Dead	6.25	4.75	Gone	Dead	Dead	4.50	Dead	7.50	**6.5**
MO-8	7.25	7.75	4.25	7.00	Gone	2.25	Dead	6.75	9.25	8.50	**6.6**
MO-9	13.00	5.00	6.50	1.00	Gone	4.00	Dead	9.00	Dead	5.00	**6.2**
MO-10	5.50	8.00	2.50	5.00	Gone	2.75	4.25	4.50	5.00	Dead	**4.7**
MO-11	5.25	6.25	6.50	1.75	Gone	6.25	5.50	4.50	8.50	6.00	**5.6**
MO-12	3.50	8.00	5.00	3.50	Gone	2.25	6.50	5.50	5.75	8.00	**5.3**
MO-13	5.75	9.50	5.75	8.00	Gone	7.25	6.50	5.00	5.75	Dead	**6.7**
MO-14	5.50	6.00	2.50	7.50	Gone	5.25	Dead	9.75	6.50	5.25	**6.0**
MO-15		9.00	8.00	7.00	Gone						**8.0**

Summary of Visible Acorn Production

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
MO-1	no	no	no	no	Gone	no	no	Dead	Dead	no
MO-2	no	no	Dead	no	Gone	Dead	Dead	Dead	Dead	no
MO-3	no	no	no	no	Gone	no	no	no	Dead	no
MO-4	no	no	no	no	Gone	Dead	no	no	no	no
MO-5	no	no	no	no	Gone	no	Dead	no	no	no
MO-6	no	R	R	R	R	Dead	no	no	Dead	no
MO-7	no	Dead	no	no	Gone	Dead	Dead	no	Dead	no
MO-8	no	no	no	no	Gone	no	Dead	no	no	no
MO-9	no	no	no	no	Gone	no	Dead	no	Dead	no
MO-10	no	no	no	no	Gone	no	no	no	no	Dead
MO-11	no	no	no	no	Gone	no	no	no	no	no
MO-12	no	no	no	no	Gone	no	no	no	no	no
MO-13	no	no	no	no	Gone	no	no	no	no	Dead
MO-14	no	no	no	no	Gone	no	Dead	no	no	no
MO-15		no	no	no	Gone					

R = Tree was originally MO-6 accession, but was replaced with MO-15 accession

Replication #5 was removed and used in another study offsite of the PMC

Study MOPMC-P-0001-WE, WL

Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx. **Table # 11**

2008 Evaluation

Summary of Missouri Collections, Located in Field #7

Summary of Height (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	9.3	8.3	11.4	Dead	Gone	8.0	7.8	Dead	Dead	10.0	**9.1**
MO-2	8.5	8.8	Dead	10.0	Gone	Dead	9.6	Dead	Dead	Dead	**9.2**
MO-3	11.1	9.8	10.4	9.2	Gone	3.5	8.3	Dead	7.8	9.3	**8.7**
MO-4	11.0	10.0	Dead	10.7	Gone	Dead	9.4	11.8	10.0	10.8	**10.5**
MO-5	7.3	10.9	10.2	10.8	Gone	8.0	9.5	11.2	8.0	Dead	**9.5**
MO-6	12.1	R	R	R	Gone	Dead	7.3	Dead	8.6	8.5	**9.1**
MO-7	12.3	Dead	9.3	Dead	Gone	Dead	11.1	Dead	8.7	Dead	**10.4**
MO-8	11.3	9.0	Dead	9.8	Gone	Dead	11.2	10.1	10.6	Dead	**10.3**
MO-9	11.8	5.8	8.3	2.0	Gone	Dead	8.5	Dead	10.6	Dead	**7.8**
MO-10	10.0	8.0	Dead	10.2	Gone	Dead	Dead	10.2	Dead	8.7	**9.4**
MO-11	6.9	9.5	9.2	Dead	Gone	9.0	10.8	11.0	8.8	9.2	**9.3**
MO-12	5.5	12.1	Dead	Dead	Gone	3.7	8.9	9.2	9.8	9.0	**8.3**
MO-13	8.8	10.0	8.2	9.3	Gone	9.1	Dead	8.9	9.2	8.5	**9.0**
MO-14	7.6	11.0	Dead	9.3	Gone	8.1	8.1	9.6	9.1	Dead	**9.0**
MO-15		11.0	10.3	10.0	Gone						**10.4**

Summary of Spread (feet)

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	9.1	8.4	12.5	Dead	Gone	6.0	9.0	Dead	Dead	8.8	**9.0**
MO-2	8.2	8.5	Dead	8.2	Gone	Dead	6.8	Dead	Dead	Dead	**7.9**
MO-3	11.0	7.7	11.0	8.3	Gone	1.7	7.4	Dead	6.6	7.6	**7.7**
MO-4	11.2	9.0	Dead	7.0	Gone	Dead	7.0	10.3	7.3	10.2	**8.9**
MO-5	6.6	9.8	8.0	8.6	Gone	6.2	7.5	9.7	6.4	Dead	**7.9**
MO-6	11.0	R	R	R	Gone	Dead	7.0	Dead	7.0	7.0	**8.0**
MO-7	12.0	Dead	7.3	Dead	Gone	Dead	9.2	Dead	7.0	Dead	**8.9**
MO-8	7.5	7.8	Dead	5.9	Gone	Dead	8.6	10.9	8.0	Dead	**8.1**
MO-9	11.3	7.5	8.0	1.0	Gone	Dead	6.7	Dead	9.6	Dead	**7.4**
MO-10	7.1	10.5	Dead	6.4	Gone	Dead	Dead	7.7	Dead	6.9	**7.7**
MO-11	6.0	9.7	7.2	Dead	Gone	6.0	8.0	10.0	7.5	7.5	**7.7**
MO-12	6.0	10.7	Dead	Dead	Gone	1.0	10.4	9.2	8.8	7.0	**7.6**
MO-13	7.0	10.5	8.2	8.6	Gone	7.8	Dead	9.0	6.8	6.6	**8.1**
MO-14	5.4	11.0	Dead	8.4	Gone	5.4	8.4	7.8	8.7	Dead	**7.9**
MO-15		10.7	8.8	6.8	Gone						**8.8**

2008 Evaluation

Summary of Missouri Collections, Located in Field #7 **Table 11 - Continued**

Summary of Vigor (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	7	6	9	Dead	Gone	6	5	Dead	Dead	7	**6.7**
MO-2	6	6	Dead	8	Gone	Dead	7	Dead	Dead	Dead	**6.8**
MO-3	9	7	8	7	Gone	2	6	Dead	5	7	**6.4**
MO-4	9	6	Dead	7	Gone	Dead	6	7	6	9	**7.1**
MO-5	4	8	7	7	Gone	7	5	8	5	Dead	**6.4**
MO-6	9	R	R	R	Gone	Dead	4	Dead	6	6	**6.3**
MO-7	10	Dead	6	Dead	Gone	Dead	8	Dead	5	Dead	**7.3**
MO-8	8	5	Dead	5	Gone	Dead	7	8	7	Dead	**6.7**
MO-9	10	2	5	1	Gone	Dead	5	Dead	8	Dead	**5.2**
MO-10	7	4	Dead	5	Gone	Dead	Dead	6	Dead	6	**5.6**
MO-11	3	7	7	Dead	Gone	6	7	8	6	6	**6.3**
MO-12	3	9	Dead	Dead	Gone	2	6	6	7	6	**5.6**
MO-13	6	8	4	6	Gone	7	Dead	6	6	6	**6.1**
MO-14	4	8	Dead	6	Gone	6	6	6	7	Dead	**6.1**
MO-15		8	8	7	Gone						**7.7**

Summary of Insect and Disease Resistance (1-9 Rating) 1=Very Good 9=Poor

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	7	7	8	Dead	Gone	6	7	Dead	Dead	7	**7.0**
MO-2	8	6	Dead	7	Gone	Dead	8	Dead	Dead	Dead	**7.3**
MO-3	7	8	8	8	Gone	5	7	Dead	6	7	**7.0**
MO-4	7	6	Dead	7	Gone	Dead	7	7	7	8	**7.0**
MO-5	7	7	8	8	Gone	7	6	8	6	Dead	**7.1**
MO-6	8	R	R	R	Gone	Dead	5	Dead	8	6	**6.8**
MO-7	8	Dead	8	Dead	Gone	Dead	7	Dead	6	Dead	**7.3**
MO-8	7	6	Dead	6	Gone	Dead	7	7	6	Dead	**6.5**
MO-9	8	4	9	9	Gone	Dead	8	Dead	7	Dead	**7.5**
MO-10	8	5	Dead	7	Gone	Dead	Dead	7	Dead	6	**6.6**
MO-11	4	8	8	Dead	Gone	5	8	8	6	7	**6.8**
MO-12	8	9	Dead	Dead	Gone	6	7	8	8	5	**7.3**
MO-13	6	9	7	8	Gone	9	Dead	8	8	6	**7.6**
MO-14	7	8	Dead	8	Gone	7	7	7	7	Dead	**7.3**
MO-15		7	8	7	Gone						**7.3**

2008 Evaluation

Summary of Missouri Collections, Located in Field #7 **Table #11 - Continued**

Summary of Diameter of Trunk at 24 Inch Height

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	2.75	2.25	4.25	Dead	Gone	2.00	2.25	Dead	Dead	3.00	**2.8**
MO-2	2.25	2.00	Dead	2.75	Gone	Dead	2.25	Dead	Dead	Dead	**2.3**
MO-3	3.50	2.50	2.50	2.25	Gone	1.00	2.00	Dead	1.75	1.75	**2.2**
MO-4	2.75	2.00	Dead	2.50	Gone	Dead	2.00	2.75	2.25	3.50	**2.5**
MO-5	1.75	3.00	2.50	2.50	Gone	2.50	1.75	3.00	1.75	Dead	**2.3**
MO-6	3.25	R	R	R	Gone	Dead	1.75	Dead	2.50	2.50	**2.5**
MO-7	3.50	Dead	2.50	Dead	Gone	Dead	2.75	Dead	2.00	Dead	**2.7**
MO-8	2.75	2.50	Dead	2.50	Gone	Dead	3.00	3.50	2.50	Dead	**2.8**
MO-9	4.50	1.25	2.25	0.25	Gone	Dead	1.75	Dead	3.50	Dead	**2.3**
MO-10	2.25	1.50	Dead	1.75	Gone	Dead	Dead	2.25	Dead	1.50	**1.9**
MO-11	1.75	2.25	2.25	Dead	Gone	2.25	2.25	3.25	1.75	2.00	**2.2**
MO-12	1.25	3.25	Dead	Dead	Gone	0.75	3.00	2.25	2.25	2.50	**2.2**
MO-13	2.25	2.75	2.00	3.00	Gone	2.75	Dead	2.50	2.00	2.50	**2.5**
MO-14	2.00	2.50	Dead	2.50	Gone	2.25	2.00	2.25	3.25	Dead	**2.4**
MO-15		4.00	3.00	2.75	Gone						**3.3**

Summary of Circumference

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10	Avg.
MO-1	8.64	7.07	13.35	Dead	Gone	6.28	7.07	Dead	Dead	9.42	**8.6**
MO-2	7.07	6.28	Dead	8.64	Gone	Dead	7.07	Dead	Dead	Dead	**7.3**
MO-3	10.99	7.85	7.85	7.07	Gone	3.14	6.28	Dead	5.50	5.50	**6.8**
MO-4	8.64	6.28	Dead	7.85	Gone	Dead	6.28	8.64	7.07	10.99	**8.0**
MO-5	5.50	9.42	7.85	7.85	Gone	7.85	5.50	9.42	5.50	Dead	**7.4**
MO-6	10.21	R	R	R	Gone	Dead	5.50	Dead	7.85	7.85	**7.9**
MO-7	10.99	Dead	7.85	Dead	Gone	Dead	8.64	Dead	6.28	Dead	**8.4**
MO-8	8.64	7.85	Dead	7.85	Gone	Dead	9.42	10.99	7.85	Dead	**8.8**
MO-9	14.13	3.93	7.07	0.79	Gone	Dead	5.50	Dead	10.99	Dead	**7.1**
MO-10	7.07	4.71	Dead	5.50	Gone	Dead	Dead	7.07	Dead	4.71	**5.8**
MO-11	5.50	7.07	7.07	Dead	Gone	7.07	7.07	10.21	5.50	6.28	**7.0**
MO-12	3.93	10.21	Dead	Dead	Gone	2.36	9.42	7.07	7.07	7.85	**6.8**
MO-13	7.07	8.64	6.28	9.42	Gone	8.64	Dead	7.85	6.28	7.85	**7.8**
MO-14	6.28	7.85	Dead	7.85	Gone	7.07	6.28	7.07	10.21	Dead	**7.5**
MO-15		12.56	9.42	8.64	Gone						**10.2**

2008 Evaluation

Summary of Missouri Collections, Located in Field #7 **Table #11 - Continued**

Summary of Visible Acorn Production

Acc. No.	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
MO-1	N	N	YES	Dead	Gone	N	N	Dead	Dead	N
MO-2	N	YES	Dead	N	Gone	Dead	N	Dead	Dead	Dead
MO-3	N	N	N	N	Gone	N	N	Dead	N	N
MO-4	N	N	Dead	N	Gone	Dead	N	N	N	N
MO-5	N	N	N	N	Gone	N	N	N	N	Dead
MO-6	N	R	R	R	Gone	Dead	N	Dead	N	N
MO-7	N	Dead	N	Dead	Gone	Dead	N	Dead	N	Dead
MO-8	N	N	Dead	N	Gone	Dead	N	N	N	Dead
MO-9	N	N	N	N	Gone	Dead	N	Dead	N	Dead
MO-10	N	N	Dead	N	Gone	Dead	Dead	N	Dead	N
MO-11	N	YES	N	Dead	Gone	N	N	YES	N	N
MO-12	N	YES	Dead	Dead	Gone	N	N	N	N	N
MO-13	N	N	N	N	Gone	N	Dead	N	N	N
MO-14	N	N	Dead	N	Gone	N	N	N	N	Dead
MO-15		N	N	N	Gone					

R = Tree was originally MO-6 accession, but was replaced with MO-15 accession

Replication #5 was removed and used in another study offsite of the PMC

Study MOPMC-P-001 Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa* , Michx.

Plot Layout: 5-11-02

Field 7 - Missouri Collections **2 ROWS** **Table #12**

Reps				Reps
12	Border Plant		Border Plant **3**	
	14	accessions	1	**NORTH**
	13	"	2	
	12	"	3	
	11	"	4	
	10	"	5	
	9	"	6	
10	8	"	7	**1**
	7	"	8	
	6	"	9	
	5	"	10	
	4	"	11	
	3	"	12	
	2	"	13	
	1	"	14	
	14	accessions	1	
	13	"	2	
	12	"	3	
	11	"	4	
	10	"	5	
	9	"	15	
9	8	"	7	**2**
	7	"	8	
	6	"	9	
	5	"	10	
	4	"	11	
	3	"	12	
	2	"	13	
	1	"	14	
	Repeat	accessions	Repeat	
8	14		1 to 14	**3**
	to 1		replacing 6 w ith 15	
7	Repeat	accessions	Repeat	**4**
	14		1 to 14	
	to 1		replacing 6 w ith 15	
6	Repeat	accessions	Repeat	
	14		1 to 14	**5**
	to 1		replacing 6 w ith 15	
13	Border Plant		Border Plant **1**	

FOURTEEN ACCESSIONS PER REPLICATION. FIVE REPLICATIONS PER ROW.

TWO ROWS TOTALING 10 REPLICATIONS AND 70 PLANTS.

Study MOPMC-P-001 Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa* , Michx.

Plot Layout: 5-30-02 **Table # 13**

Two plants planted per location **BP=Border Plant (only one plant planted)**

FIELD 6 - Iowa Collections

2 ROWS

	3 (BP)	3 (BP)		NORTH
REPS	2	6	REPS	
	5	2		
	6	7		
12	4	1	1	
	7	3		
	1	5		
	3	4		
	4	5		
	7	3		
	5	7		
11	1	2	2	
	3	6		
	2	1		
	6	4		
	4	1		
	7	3		
	2	2		
10	1	7	3	
	3	5		
	5	4		
	6	6		
	5	7		
	4	3		
9	3	1		
	7	4	4	
	1	6		
	2	2		
	6	5		
	1	4		
	6	2		
	5	5		
8	3	3	5	
	7	1		
	4	6		
	2	7		
	1	2		
	6*	5		
	4	7		
7	2	1	6	
	7	3		
	3	6*		
	5	4		
	2 (BP)	1 (BP)		

*ONLY ONE OF PLANT 6 PLANTED IN THESE LOCATIONS. RAN OUT OF PLANT 6. **(BP=Border Plant)**

Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips

Study No. MOPMC-T-0106,BU

National Project(s): Cropland 4.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: A need has developed out of a three-state technical review committee and approved by the State Conservationists Advisory Committee to evaluate different native cool season grasses and sedges for filter strips.

Grasses and sedges to be considered are Virginia wildrye, *Elymus canadensis*; Canada wildrye, *Elymus canadensis*; Junegrass, *Koeleria crista*; bluejoint, *Calamagrostic canadensis*; sweet woodreed, *Cinna arundinacea*; river oats, *Uniola latifolia*; longhair sedge, *Carex cosmosa*; Frank sedge, *Carex frankii*; shoreline sedge, *Carex hyalinolepis*; wheat sedge, *Carex atherodes*; raven's foot sedge, *Carex crus-corvi* Shuttlew; short sedge, *Carex shortina*; hop sedge, *Carex lupulina* Muhl.; crested sedge, *Carex cristatella* Britton; bristle bract sedge, *Carex tribuloides*; and greater straw sedge, *Carex normalis*.

Objective: There is little to no documented information regarding native cool season grasses and sedges being used in filter strip situations. In an attempt to respond to this lack of information, the PMC has been directed to initiate this study. Depending upon the performance of selected native cool season grasses and sedges in filter strip situations, previous recommendations may change to include those native cool season grasses and sedges performing excellently in this situation.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2001
The study plan for this study was initiated and approved by the State Conservationists' Advisory Committee in August of 2001. Selected field offices in the PMC service area will be contacted in the spring of 2002 requesting their participation in this collection, however everyone is welcomed to participate. One to three collections per state per species are being requested, both seeds and plants. The plants will be grown in the PMC greenhouse and later transplanted in randomized complete blocks. Each block will be one foot wide and five feet long with approximately 30 plants per plot. The spacing of the plants in the blocks will be six inches x six inches.

2002-2003
Collections of native sedges and cool season grasses began on July 2, 2002. The following chart reflects a listing of the collections made as of the time this report was developed. The collection period was extended one more year to make collections of
those species that have not been made or those species needing more collections. Fourteen additional collections were made in the state of Missouri and eleven were made in Iowa during 2003. Samples of seed from each different species were planted in the greenhouse to determine the germination percentage. The results will be documented in the 2004 Annual Technical Report. Field #10 on the PMC has been selected as the site for this study because of the access to water. Two collections of river oats were planted (vegetatively) on September 9, 2002. Both collections were performing with fair to good vigor.

2004
The planting site for this project was changed from Field #10 to Field #7. There is still available water and space. There were two separate wetland cells constructed by using a landscraper in

order to simulate a wetland environment. The wetland cells measure 20 feet x 200 feet and are made up of several different individual blocks. The blocks themselves measure 5 feet x 20 feet (refer to Table #2 for map). Collections that did well in the greenhouse were stepped up in plug containers. They were planted in Field #7 on May 3 and were evaluated for percent stand, percent cover, lodging, and survival in late June (refer to Table #3). The west cell contains 17 blocks that include 100 plants per block of a particular species. The east cell contains 27 different collections consolidated into 11 different blocks. These collections were added together because they did not contain 100 plants. All blocks were planted on one foot by one foot spacing. Each collection will be evaluated three times in 2005, (late winter, summer, and fall) for percent stand and cover, lodging, and survival. The cells will be kept fairly damp throughout the growing season and will be treated with a pre-emergent grass herbicide in the sedge plots to help control annual grasses.

2005
Two evaluations were completed (refer to Table # 5) in 2005. Six species were selected based on evaluations for increase plantings. The species selected for increase are larger straw sedge (*Carex normalis*), Crested Sedge (*Carex cristella*), Fox Sedge (*Carex vulpinoidea*), Crowfoot Sedge (*Carex crus-corvi*), Franks Sedge (*Carex frankii*), and Green Bulrush (*Scirpus atrovirens*). The increase plantings are scheduled for January 2006.

2006
On February 15, 2006 the six selected species were planted into production blocks. The blocks were 0.25 acre in size. The plots were planted to cereal rye the season prior to planting and mowed in the fall, plowed in January 2005, disked and rolled prior to planting. Plots were planted in 8" rows with the plot planter on the surface to 1/4" deep. All six species (larger straw sedge (*Carex normalis*), Crested Sedge (*Carex cristella*), Fox Sedge (*Carex vulpinoidea*), Crowfoot Sedge (*Carex crus-corvi*), Franks Sedge (*Carex frankii*), and Green Bulrush (*Scirpus atrovirens*)) were planted at an estimated rate of 40 pure live seed per square foot. See figure 1 for production plantings in field 7A. Plots were sprayed with both Poast (grass herbicide) and 2,4-D (broadleaf herbicide). When the plots were sprayed no sedges were present, weed competition was extreme with white clover dominating the plots. The plots were evaluated several times throughout the growing season, but the selected sedges were not observed. Plans are to replant the same plots with the same species at a later date (April) in 2007. The selected species will be put in the germinator to check germination percent.

2007
On April 25, 2007, the six selected species were planted again in the same areas of field 7 in an attempt to establish production plots of each. Again all six species (larger straw sedge (*Carex normalis*), crested sedge (*Carex cristella*), fox sedge (*Carex vulpinoidea*), crowfoot sedge (*Carex crus-corvi*), franks sedge (*Carex frankii*), and green bulrush (*Scirpus atrovirens*)) were planted at an estimated rate of 40 pure live seed per square foot. Neither Poast, nor 2,4-D were used; instead a new chemical called Stinger was used to control weed competition. Several seedlings were identified, but the plots still struggled to establish. Weed competition again became a problem by late summer and drought conditions did not help in the survival of these wetland species. After speaking with Chris Hoag, Aberdeen PMC in Idaho, it was determined that water would play a huge factor in establishing the different species of sedges.

Seed from the PMC evaluation plots was depleted after planting plots in April 2007. The decision was made to make more collections of the same species from the US Fish and Wildlife Refuge in Annada, Missouri. Candy Chambers, assistant manager of the Clarence Cannon Refuge, assisted in collecting the seed. Collections were made from June to August 2007; some by hand and two were harvested by using the plot combine. Plans for FY 2008 are to plant production plots at the Clarence Cannon Refuge in Annada where the amount and level of water is easily controlled.

Species of Sedges Collected from Clarence Cannon Refuge in 2007		
Scientific Name	**Common Name**	**Amount Collected in Lbs.**
Carex vulpinoidea	Fox Sedge	82.9
Carex hyalinolepis	Thinscale Sedge	6.1
Carex frankii	Franks Sedge	0.3
Carex crus-corvi	Crowfoot sedge	1.2
Carex lupulina	Hops Sedge	0.3
Carex cristella	Crested Sedge	0.2
Scirpus atrovirens	Green Bulrush	0.1

2008
In 2008, plans were to establish 5 plots at the Clarence Cannon Refuge in Annada, MO in late June. The flood, that occurred most of the summer, engulfed most of the bottom ground. The 20 x 40 ft. plots would have to wait until November in order to be planted. The five species that will be planted are crested sedge, ravenfoot sedge, Franks sedge, hops sedge, and green bulrush. They will be evaluated for how well they establish and ability to survive in the controlled water levels.

The six plots in field 7 at the PMC were planted in April of 2007 and were inundated with water for 4 weeks during the flood. When the flood waters had receded, it was obvious that Franks, crowfoot, fox, and crested sedge had survived and showed signs of flourishing without the extra competition.

2009
The plots of Franks, crowfoot, fox, and crested sedge were maintained in field 7. There is an emphasis on seed production from these four species so that field testing may begin. Thinscale sedge is showing promise of competing well vegetatively and might be a possible plant material to use in place of Reeds canarygrass. There was very little seed harvested in 2009 and only crested sedge and green bulrush were harvested from field 7. The production plots in field 7 are filling in well and seed production in the future years should be good.

2010
The plots in field 7 of Franks, crowfoot, fox, and crested were maintained. Seed from the production plot of Franks sedge (*Carex frankii*) were harvested and a total of 29 bulk pounds were cleaned. The production field of (Carex crus-corvi) crowfoot sedge produced 0.6 pounds of bulk seed.

2011-2012-2013
Seed has been produced from each of the five sedges that have shown potential in an agronomic seeding practice. This study is discontinued and no other data or conclusions will be presented.

	Seed Production Bulk Wt.		
Sedge	***2011***	***2012***	***2013***
Carex frankii Franks Sedge 9083346	19.3	6.9	16.0
Carex crus-corvi Crowfoot Sedge 9083306	17.1	33.5	37.5
Carex vulpinoidea Fox Sedge 9083278	2.1	0	0
Carex hyalinolepis Thinscale Sedge	0	0	0
Carex cristatella Crested Sedge 9083279	6.5	0	0

Table #1
Study MOPMC-T-0106, BU - Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips

Initial Collections

Scientific Name	Common Name	Collector	City, State	Temp. Acc. No
Carex crus-corvi	Ravens foot sedge	Dennis Shirk	Vienna, MO	MO-1
Carex grayii	Gray sedge	Dennis Shirk	Vienna, MO	MO-2
Carex atherodes	Slough Sedge	Dennis Shirk	Vienna, MO	MO-3
Carex vulpinoidea Michx.	Fox sedge	Dennis Shirk	Vienna, MO	MO-4
Carex vulpinoidea Michx.	Fox sedge	Kaiser & Henry	Elsberry, MO	MO-5
Carex hyalinolepis Steud.	Thinscale scale	Kaiser & Henry	Elsberry, MO	MO-6
Carex crus-corvi Shuttlew	Crowfoot sedge	Kaiser & Henry	Elsberry, MO	MO-7
Carex hyalinolepis Steud.	Thinscale sedge	Paul Freese	Albany, MO	MO-8
Carex vulpinoidea Michx	Fox sedge	Kaiser & Henry	Elsberry, MO	MO-9
Scirpus atrovirens	Green bulrush	Kaiser & Henry	Elsberry, MO	MO-10
Scirpus atrovirens	Green bulrush	Kaiser & Henry	Elsberry, MO	MO-11
Carex frankii Kunth.	Franks sedge	Paul Frese	Albany, MO	MO-12
Carex lupulina Muhl.	Hop sedge	Raleigh Redman	Warrensburg, MO	MO-13
Carex grayii	Gray's sedge	Raleigh Redman	Warrensburg, MO	MO-14
Carex hyalinolepis Steud.	Thinscale sedge	Raleigh Redman	Warrensburg, MO	MO-15
Carex frankii Kunth	Frank's sedge	Lingwall & Ellis	Ralls Co., MO	MO-17
Carex crus-corvi	Crowfoot sedge	Lingwall & Ellis	Ralls Co., MO	MO-18
Carex hyalinolepis Stued.	Thinscale sedge	Lingwall & Ellis	Ralls Co., MO	MO-19
Carex frankii Kunth	Frank's sedge	Raleigh Redman	Warrensburg, MO	MO-20
Chasmanthium latifolium	River oats	J. Kaiser	Troy, MO	MO-21

Table # 1-Study MOPMC-T-0106, BU - cont.

Scientific Name	Common Name	Collector	City, State	Temp. Acc. No
Chasmanthium latifolium	River oats	Travis Dinsdale	Springfield, MO	MO-22
Chasmanthium latifolium	River oats	Rodney Doolen	Puxico, MO	MO-23
Chasmanthium latifolium	River oats	J. Kaiser	Troy, MO	MO-24
Chasmanthium Latifolium	River oats	William Brouk	Benton, MO	MO-25
Carex crus-corvi Shuttlew	Ravensfoot sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-26
Carex shartina	Short sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-27
Carex	Shoreline sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-28
Carex hyalinoepis	Thinscale sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-29
Carex vulpinoidea Michx.	Fox sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-30
Carex crus-corvi Shuttlew	Ravensfoot sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-31
Carex vulpinoides Michx	Fox sedge	J. Kaiser J. Henry	BK Leach Wildlife Area	MO-32
Scipus atrovirens	Green bulrush	Aaron Jeffries	Howard Co, MO	MO-33
Carex frankii	Frank's sedge	Aaron Jeffries	Howard Co, MO	MO-34
Carex lupulina	Hop sedge	Aaron Jeffries	Howard Co, MO	MO-35
Carex shortina	Short sedge	Aaron Jeffries	Howard Co, MO	MO-36
Scirpus acutus	Hard-stemmed bulrush	Aaron Jeffries	Howard Co, MO	MO-37
Scirpus atrovirens	Green bulrush	Paul Frese	Gentry Co, MO	MO-38
Chasmanthium latifolium	River oats	Travis Dinsdale	Webster Co, MO	MO-39
Carex hyalinoepis Steud.	Thinscale sedge	Dave Hiatt	Martinsville, IL	IL-1

Table 1-Study MOPMC-T-0106, BU - cont.

Scientific Name	Common Name	Collector	City, State	Temp. Acc. No
Carex lupulina Muhl.	Hop sedge	Christine Talige	Fairfield, IA	IA-1
Carex cristatella Britton	Crested sedge	Tim Meyer	Williamsburg, IA	IA-2
Carex cristatella Britton	Crested sedge	Tim Meyer	Williamsburg, IA	IA-3
Carex vulpineidea	Fox sedge	Tim Meyer	Williamsburg, IA	IA-4
Scirpus atrovirens	Green bulrush	Tim Meyer	Williamsburg, IA	IA-5
Juncus interior Weigand	Inland rush	Tim Meyer	Williamsburg, IA	IA-6
Calamagrostis Canadensis	Bluejoint	Tim Meyer	Williamsburg, IA	IA-7
Scirpus atrovirens	Green bulrush	Tim Meyer	Williamsburg, IA	IA-8
Carex normalis	Larger straw sedge	Tom Hurford	Atlantic, IA	IA-9
Carex tribuloides	Bristle bract sedge	Tom Hurford	Atlantic, IA	IA-10
Carex normalis	Larger straw sedge	Tom Hurford	Atlantic, IA	IA-11
Scirpus atrovirens	Green bulrush	Tom Hurford	Atlantic, IA	IA-12

Sedge, Rush, and Cool Season Grass Plot - Field #7

North

Table #2

MO-1	
MO-4	
MO-5	MO-16 | MO-13
MO-10	MO-20 | MO-9
MO-11	MO-7 | MO-18 | MO-19 | MO-15 | MO-6 | MO-29
MO-12	MO-17
MO-22	MO-3 | MO-36 | MO-28 | MO-31 | MO-26 | MO-35 | MO-37
MO-23	IA-8 | IA-12
MO-24	IA-9
MO-25	IA-11
MO-27	IA-2 | IA-1
MO-30	IA-6 | | IA-7
MO-32	MO-21
MO-39	Planted between 5/3/04 & 5/10/04
	Each individual plot is 5 foot by 20 foot.
IA-3	Each plant is planted 1 foot apart in a
	5 x 20 foot block.
IA-4	Plots on the west side, were planted with a
	complete 100 plant block. Plots on the
IA-5	east side are made up of partial collections.

Study ID Code: MOPMC-T-0106, BU **Table #3**

Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips

MISSOURI COLLECTIONS

Collection	Common Name	Scientific Name	# of Plants
MO-1	Crowfoot Sedge	Carex crus-corvi	100 Plants
MO-3	Slough Sedge	Carex obnupta	7 plants
MO-4	Fox Sedge	Carex vulpinoidea	100 Plants
MO-5	Fox Sedge	Carex vulpinoidea	100 Plants
MO-6	Thinscale Sedge	Carex hyalinolepis	8 Plants
MO-7	Crowfoot Sedge	Carex crus-corvi	47 Plants
MO-9	Franks Sedge	Carex frankii	45 Plants
MO-10	Green Bulrush	Scirpus atrovirens	100 Plants
MO-11	Green Bulrush	Scirpus atrovirens	100 Plants
MO-12	Franks Sedge	Carex frankii	100 Plants
MO-13	Hop Sedge	Carex lupulina	25 Plants
MO-15	Thinscale Sedge	Carex hyalinolepis	3 Plants
MO-16	Franks Sedge	Carex frankii	75 Plants
MO-17	Franks Sedge	Carex frankii	76 Plants
MO-18	Crowfoot Sedge	Carex crus-corvi	11 Plants
MO-19	Thinscale Sedge	Carex hyalinolepis	3 Plants
MO-20	Franks Sedge	Carex frankii	54 Plants
MO-21	River Oats	Chasmathium latifolium	76 Plants
MO-22	River Oats	Chasmathium latifolium	100 Plants
MO-23	River Oats	Chasmathium latifolium	100 Plants
MO-24	River Oats	Chasmathium latifolium	100 Plants
MO-25	River Oats	Chasmathium latifolium	100 Plants
MO-26	Crowfoot Sedge	Carex crus-corvi	6 Plants
MO-27	Bottlebrush Sedge	Carex comosa	100 Plants
MO-28	Thinscale Sedge	Carex hyalinolepis	9 Plants
MO-29	Thinscale Sedge	Carex hyalinolepis	13 Plants
MO-30	Fox Sedge	Carex vulpinoidea	100 Plants
MO-31	Crowfoot Sedge	Carex crus-corvi	11 Plants
MO-32	Fox Sedge	Carex vulpinoidea	100 Plants
MO-35	Hop Sedge	Carex lupulina	19 Plants
MO-36	Squarrose Sedge	Carex squarrosa	6 Plants
MO-37	Hard-stemmed Sedge	(hard-stemmed bulrush) Schoenoplectus acutus	18 Plants
MO-39	River Oats	Chasmathium latifolium	100 Plants

Table 3 - continued

IOWA COLLECTIONS

Collection	Common Name	Scientific name	# of Plants
IA-1	Hop Sedge	Carex lupulina	23 Plants
IA-2	Crested Sedge	Carex cristatella	52 Plants
IA-3	Crested Sedge	Carex cristatella	100 Plants
IA-4	Fox Sedge	Carex vulpinoidea	100 Plants
IA-5	Green Bulrush	Scirpus atrovirens	100 Plants
IA-6	Inland Rush	Juncus interior	17 Plants
IA-7	Bluejoint	Calamagrostis canadensis	23 Plants
IA-9	Larger Straw Sedge	Carex normalis	76 Plants
IA-8	Green Bulrush	Scirpus atrovirens	38 Plants
IA-11	Larger Straw Sedge	Carex normalis	76 Plants
IA-12	Green Bulrush	Scirpus atrovirens	60 Plants

Shoreline sedge is the same as thinscale sedge

Crowfoot sedge is the same as ravenfoot sedge

Study ID Code: MOPMC-T-0106, BU **Table #4**

Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips

Sedge, Cool Season Grass, and Bulrush Evaluation

DATE: 6/22/04

Collection #	Name	Number of Plants	Percent Stand	Percent Cover	Lodging (1-9 Rating)	Notes
MO-1	Crowfoot Sedge	100	100	20	1	
MO-4	Fox Sedge	100	100	20	1	
MO-5	Fox Sedge	100	100	20	1	
MO-10	Green Bulrush	100	100	15	1	
MO-11	Green Bulrush	100	100	15	1	
MO-12	Franks Sedge	100	100	25	1	
MO-22	River Oats	100	80	5	1	
MO-23	River Oats	100	100	5	1	
MO-24	River Oats	100	95	5	1	
MO-25	River Oats	100	95	5	1	
MO-27	Bottlebrush Sedge	100	100	20	1	
MO-30	Fox Sedge	100	100	15	1	
MO-32	Fox Sedge	100	100	15	1	
MO-39	River Oats	100	80	5	1	
IA-3	Crested Sedge	100	100	30	1	
IA-4	Fox Sedge	100	100	15	1	
IA-5	Green Bulrush	100	100	20	1	
MO-13	Hop Sedge	25	100	25	1	
MO-16	Franks Sedge	75	100	25	1	
MO-9	Franks Sedge	45	100	25	1	
MO-20	Franks Sedge	54	100	20	1	
MO-29	Thinscale Sedge	13	100	15	1	
MO-6	Thinscale Sedge	8	100	20	1	
MO-15	Thinscale Sedge	3	66	15	1	
MO-19	Thinscale Sedge	3	33	15	1	
MO-18	Crowfoot Sedge	11	100	15	2	
MO-7	Crowfoot Sedge	47	100	20	2	
MO-17	Franks Sedge	76	100	10	1	
MO-37	Hard-stemmed Sedge	18	100	10	1	
MO-35	Hop Sedge	20	100	20	1	
MO-26	Crowfoot Sedge	6	100	10	2	
MO-31	Crowfoot Sedge	11	100	25	1	
MO-28	Thinscale Sedge	9	100	10	1	
MO-36	Squarrose Sedge	6	85	15	1	
MO-3	Slough Sedge	7	100	15	1	
IA-12	Green Bulrush	60	100	10	1	

Table #4 - continued

Collection #	Name	Number of Plants	Percent Stand	Percent Cover	Lodging (1-9 Rating)	Notes
IA-8	Green Bulrush	38	100	10	1	
IA-9	Larger Straw Sedge	76	100	20	1	
IA-11	Larger Straw Sedge	76	100	10	1	
IA-1	Hop Sedge	23	100	15	1	
IA-2	Crested Sedge	52	100	25	1	
IA-7	Bluejoint	21	92	15	1	
IA-6	Inland Rush	16	96	15	1	
MO-21	River Oats	76	95	5	1	
1-9 Rating	**1 = No Lodging**	**9 = Severe Lodging**				

Study MOPMC-T-0106, BU - Collection and Evaluation of Native Cool Season Grasses and Sedges

Table #5

2005 Evaluation Averages For Each Species

Name	Collection #	% Stand	% Cover	Lodging	Vigor
Bluejoint	IA-7	62.5	47.5	4	6
Bottlebrush Sedge	MO-27	100	82.5	4	6
Crested Sedge	IA-2	100	54.5	5	1
Crested Sedge	IA-3	100	85	5.5	1
Crowfoot Sedge	MO-1	100	90	3	1
Crowfoot Sedge	MO-7	100	95	4.5	2
Crowfoot Sedge	MO-18	100	90	4	2
Crowfoot Sedge	MO-26	100	90	5	3
Crowfoot Sedge	MO-31	100	95	7	2
Fox Sedge	IA-4	100	72.5	4.5	3
Fox Sedge	MO-4	99	95	5	2
Fox Sedge	MO-5	100	87.5	5	2
Fox Sedge	MO-30	100	87.5	5.5	3
Fox Sedge	MO-32	100	80	4.5	4
Franks Sedge	MO-9	100	90	3	3
Franks Sedge	MO-12	100	85	2.5	1
Franks Sedge	MO-16	100	92.5	3	3
Franks Sedge	MO-17	98.5	75	3	5
Franks Sedge	MO-20	100	85	3	3
Green Bulrush	IA-5	100	57.5	4.5	4
Green Bulrush	IA-8	100	87.5	5	4
Green Bulrush	IA-12	100	72.5	4.5	4
Green Bulrush	MO-10	99.5	52.5	3	5
Green Bulrush	MO-11	100	50	3	6
Hop Sedge	IA-1	100	92.5	7	2
Hop Sedge	MO-13	100	85	2	3
Hop Sedge	MO-35	100	90	3	2
Inland Rush	IA-6	95		3.5	4
Larger Straw Sedge	IA-9	100	95	5.5	2
Larger Straw Sedge	IA-11	100	92.5	5	1
River Oats	MO-21				9
River Oats	MO-22	70	15	1	9
River Oats	MO-23	97	25	1	9
River Oats	MO-24	95	20	1	9
River Oats	MO-25	90	20	1	9
River Oats	MO-39	85	15	1	9
Slough Sedge	MO-3	100	62.5	3.5	5

Study MOPMC-T-0106, BU - Collection and Evaluation of Native Cool Season Grasses and Sedges

Table #5 - continued

2005 Evaluation Averages For Each Species

Name	Collection #	% Stand	% Cover	Lodging	Vigor
Squarrose Sedge	MO-36	100	50	5	5
Thinscale Sedge	MO-6	100	80	4.5	1
Thinscale Sedge	MO-15	100	75	2	2
Thinscale Sedge	MO-19	100	65	2	5
Thinscale Sedge	MO-28	100	70	2	4
Thinscale Sedge	MO-29	100	77.5	1.5	2

Lodging
1 = No Lodging **9= Severe Lodging**

Vigor
1= Highly Vigorous **9= Low Vigor**

Evaluation and Release of a Shade Tolerant Big Bluestem, *Andropogon gerardii*, L., for Silvopasture

Study No. MOPMC-P-0613-PA, WL

National Project(s): Forestland 1.1

Study Leader: Jerry Van Sambeek, Doug Wallace, G. Garret, Ron L. Cordsiemon

Introduction: Big bluestem is one of the most widespread important forage grasses of the North American tallgrass prairie region. It is usually associated with one or more of the other three dominant species; Indiangrass, switchgrass, and little bluestem. Big bluestem occurs on sub-irrigated lowlands, nearly level to gently undulating glacial till plains, overflow sites, level swales and depressions, residual and glacial uplands, and stream terraces and bottomlands along rivers and tributaries. The abundant, leafy forage is palatable to all classes of livestock.

The Elsberry PMC initiated a big bluestem collection from the Ozark region (Missouri, Arkansas, and Oklahoma) in 1988 to develop an improved big bluestem that would be better adapted to this region. The collection effort resulted in an assembly of 370 big bluestem accessions and three releases, OZ70 germplasm, a selected release for forage; Refuge germplasm, a medium height selection for buffers, filters and wildlife; and OH370 germplasm, a source identified release for diversity.

There is limited information available on species selected for forage to be primarily used for savannas and silvopasture systems throughout Missouri.

Objective: An existing PMC big bluestem collection displays an amazing range of morphological and phonological characteristics – color, plant height, blade width, stem erectness, rust resistance, spring emergence, anthesis, etc. This collection has never been evaluated for shade attributes that might be valuable in silvopasture systems or with savanna restoration efforts. This study will select and evaluate for forage production in relation to shade tolerance.

Procedure: Randomized complete block design with three replications, five shade levels: full sun, 30% shade, 55% shade, 78% shade with sunflecks, and 80% shade.

Twenty-two accessions of big bluestem were selected based on original collection site descriptions and phenotypic characteristics such as leaf width, and chlorophyll content. These collections came from previous work (Study 29I097G) at the Elsberry and Arkansas PMC's and were assembled in 2005 at the University of Missouri Agroforestry Center (HARC). Additional species being evaluated are eastern gamagrass, Canada wildrye, riveroats, cluster fescue, and tall fescue. Plants were started in the greenhouse and planted in replicated plots the spring 2006.

Forty-five pots for each accession were randomized within each treatment. Above ground dry weight, leaf weight, and forage quality (acid detergent fiber, neutral detergent fiber, crude protein) will be collected for each accession.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2005/2006

Key Findings:

All big bluestem accessions exhibited growth reductions in harvested seasonal biomass (summer plus fall harvest in 2005) under reduced light, although four accessions had produced greater biomass at 70% of full sunlight than under full sunlight (Table 1). Response of most accessions

closely approximated a linear relationship between harvested biomass and percentage reduction in light from full sunlight. When fitted to the equation Y = MX + B where Y is g/pot harvested biomass and X is percent reduction from full sunlight, M approximates decrease in biomass per percent reduction in full sunlight and B approximates yield under full sun. We hypothesize the best accessions for most agroforestry practices will exhibit a compromise between relatively low values for M and relatively high values for B such as exhibited by PMC-6925, a high producing shade tolerant accession, compared to PMC-6974, an accession that did poorly under increasing shade (fig. 1). Yield data was also fitted to a second order polynomial and first derivative solved to estimate the percent of full sunlight produced maximum yields (estimated peak biomass production was at 76 % and >100% of full sunlight for PMC-6925 and PMC-6974, respectively).

Analysis of summer 2005 big bluestem biomass for forage quality showed highly significant interactions for Crude Protein (CP), Acid Detergent Fiber (ADF), and Relative Feed Value (RFV) under differing shade levels with and overall increase in CP and ADF and an overall decrease in RFV as shade levels increased (Table 2). Neutral Detergent Fiber (NDF) and Total Digestible Nutrients (TDN) also showed significant and very significant responses, respectively, to increasing shade levels.

Table 1.—Seasonal biomass production in 2005 for 21 accessions of big bluestem under five light regimes, coefficients for linear regression for each accession, and calculated percentage of full sunlight for maximum biomass yield.

State of origin	PMC number	2005 combined summer and fall biomass (g/pot) under five light regimes					Reg. coeff. for mx + b		Max. yield
		Full sun	70%	45%	20%	Sunfleck	b	x	% fs
AR	6967(02)	71	70	51	31	38	77	-0.51	>100
MO	6832(04)	85	81	67	39	32	92	-0.66	89
MO	6812(05)	75	85	61	37	44	86	-0.52	80
MO	6885(06)	96	86	79	32	42	104	-0.76	88
AR	6896(07)	94	82	73	43	50	98	-0.61	95
AR	6972(08)	88	81	78	42	52	94	-0.53	85
MO	6807(10)	91	76	64	47	46	92	-0.57	>100
AR	6974(12)	94	73	53	23	27	97	-0.89	>100
AR	6902(13)	90	80	58	32	46	94	-0.68	>100
MO	6802(14)	110	89	89	52	60	112	-0.66	>100
AR	6905(15)	88	75	67	40	45	91	-0.58	>100
OK	7049(16)	103	92	74	54	53	107	-0.65	>100
MO	6741(17)	87	93	77	52	56	96	-0.47	79
AR	6925(19)	91	96	89	65	58	100	-0.41	76
MO	6838(21)	96	96	78	45	57	105	-0.64	86
MO	6704(22)	73	67	57	37	35	77	-0.48	98
AR	6935(24)	85	64	60	26	37	86	-0.65	>100
OK	7039(25)	78	72	57	52	53	79	-0.34	>100
MO	OZ-70(26)	88	62	54	18	26	89	-0.83	>100
MO	Rountree	85	88	79	55	56	92	-0.41	78
OK	7007(29)	67	54	32	17	20	68	-0.62	>100

Figure 1.—Individual pot biomass in 2005 for shade tolerant PMC-6925 (squares) and intolerant PMC-6974 (diamonds) and fitted linear and quadratic responses as a function of full sunlight.

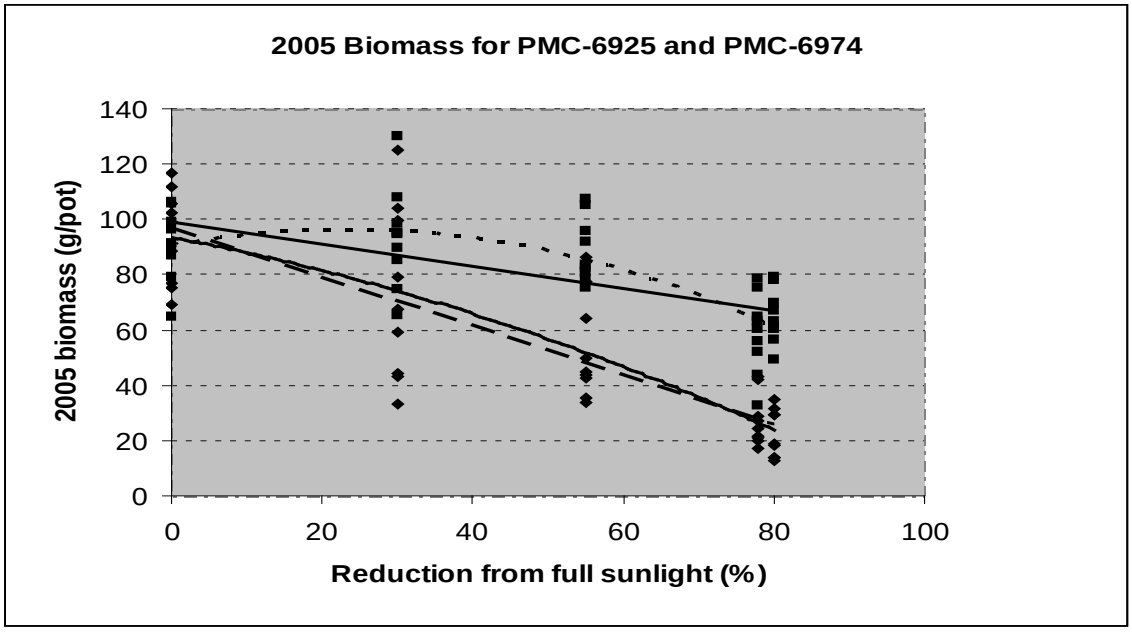


Table 2.– Summer 2005 forage quality mean and standard deviation (SD) averaged across 21 big bluestem (BBS) under five light regimes for percent crude protein (CP=true protein plus non-protein nitrogen), acid detergent fiber (ADF=highly indigestible fiber), neutral detergent fiber (NDF=cell wall or structural components), total digestible nutrients (TDN=111.8 + 0.95 CP - 0.36 ADF- 0.7 NDF), and relative feed value (RFV=(%DDM x %DMI)/1.29 or relative to full bloom alfalfa set at 100).

Light regime	CP (%)		ADF (%)		NDF (%)		TND (%)		RFV	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Full sun	6.2	1.0	36.0	3.2	63.5	2.6	60.2	3.3	89.4	6.8
70 % of full sun	6.2	1.5	39.2	3.6	65.7	3.3	57.6	4.0	83.0	8.0
45 % of full sun	6.9	1.9	40.0	3.9	65.9	3.4	57.7	4.4	81.8	8.1
20% of full sun	8.7	1.9	40.8	3.0	66.4	2.4	58.9	3.9	80.2	5.9
22% sunfleck	8.3	1.9	40.2	2.8	65.6	2.5	59.3	3.8	81.9	5.7
Sign: Shade	***		***		*		**		***	
5% LSD	0.5		1.2		1.5		1.3		2.5	
Interaction sign.: Shade x Acces.	***		ns		ns		**		ns	

2007

Key Findings:

Analysis of 2006 forage quality data compared to 2005 results (Table 3) showed that general trends for 2006 were similar to 2005. TDN and RVF values decreased as shade levels increased; while crude protein, ADF and NDF, values increased for all combined accessions.

Table 3. Seasonal forage quality in 2005 and 2006 for combined accessions of big bluestem under four light regimes.

	CP (%)		**ADF (%)**		**NDF (%)**		**TDN (%)**		**RFV**	
Light regime	*2005 Mean*	*2006 Mean*	*2005 Mean*	*2006 Mean*	*2005 Mean*	*2006 Mean*	*2005 Mean*	*2006 Mean*	*2005 Mean*	*2006 Mean*
Full sun	6.2	5.0	36.0	35.6	63.5	62.9	60.2	59.7	89.4	90.4
70 % of full sun	6.2	4.4	39.2	36.2	65.7	64.0	57.6	58.2	83.0	88.4
45 % of full sun	6.9	4.3	40.0	37.7	65.9	65.3	57.7	56.6	81.8	85.0
20% of full sun	8.7	4.6	40.8	39.1	66.4	66.5	58.9	55.6	80.2	82.0
5% LSD	0.5	0.4	1.2	1.1	1.5	1.4	1.3	1.3	2.5	2.5

Substantial variation exists among the 21 big bluestem accessions for total forage production (sum of boot-stage plus fall harvest) in both 2005 and 2006 (Table 4). Both boot-stage and fall biomass yields for big bluestem plants were substantially lower in 2006 than in 2005 when the plants were first established. Examination of the root systems after the 2006 growing season indicated plants were heavily root-bound with many roots circling the inside of the 2-gallon pots. The number of days to mid-boot or late-boot (just before inflorescence emerges from the sheath of a flag leaf) showed greater variability among the big bluestem accessions during the 2006 growing season than the 2005 growing season. In addition, four accessions (PMC-6832, 6896, 6295, and 7007) in 2006 had plants that failed to flower especially at the lowest light levels.

Table 4. Seasonal biomass production in 2005 and 2006 for 21 accessions of big bluestem under five light regimes with sunfleck treatment yielding 22% of full sunlight.

State of origin	**PMC number**	**2005 combined summer and fall biomass (g/pot) under five light regimes**					**2006 combined summer and fall biomass (g/pot) under five light regimes**				
		Full sun	70%	45%	20%	Sun fleck	Full sun	70%	45%	20%	Sun fleck
AR	6967(02)	71	70	51	31	38	28	23	24	29	28
MO	6832(04)	85	81	67	39	32	38	32	26	27	31
MO	6812(05)	75	85	61	37	44	31	33	28	32	34
MO	6885(06)	96	86	79	32	42	41	45	41	27	34
AR	6896(07)	94	82	73	43	50	21	19	21	17	22
AR	6972(08)	88	81	78	42	52	19	22	31	29	24
MO	6807(10)	91	76	64	47	46	31	25	35	36	38
AR	6974(12)	94	73	53	23	27	67	56	51	42	43

State of origin	PMC number	2005 combined summer and fall biomass (g/pot) under five light regimes					2006 combined summer and fall biomass (g/pot) under five light regimes				
AR	6902(13)	90	80	58	32	46	24	24	34	31	27
MO	6802(14)	110	89	89	52	60	58	43	49	52	50
AR	6905(15)	88	75	67	40	45	20	29	26	29	28
OK	7049(16)	103	92	74	54	53	23	33	39	46	48
MO	6741(17)	87	93	77	52	56	24	30	30	37	30
AR	6925(19)	91	96	89	65	58	31	37	45	32	43
MO	6838(21)	96	96	78	45	57	30	30	39	38	43
MO	6704(22)	73	67	57	37	35	31	35	40	39	34
AR	6935(24)	85	64	60	26	37	26	28	40	26	30
OK	7039(25)	78	72	57	52	53	29	19	24	27	22
MO	OZ70(26)	88	62	54	18	26	27	37	41	28	25
MO	Rountree	85	88	79	55	56	37	47	46	42	41
OK	7007(29)	67	54	32	17	20	30	31	33	31	32
Means	-----	87	79	67	40	44	29	32	33	31	31

2010

Doug Wallace, study leader, took a different position within NRCS, therefore no data has been reported for this study in the last two years. Data has been collected and the Elsberry PMC personnel are working with Jerry Van Sambeek, Forest Service, to compile the data and it will be reported in the 2011 ATR.

2011

Jerry Van Sambeek, Forest Service, provided the following final report regarding the information that was collected at the University of Missouri HARC farm. This study is finished.

Elsberry NRCS Plant Materials Center Report November 2011

Screening for Shade Tolerance within Big Bluestem

J. W. Van Sambeek, Research Plant Physiologist, US Forest Service Northern Research Station;
Doug Wallace, Retired National Agroforester, USDA Natural Resource Conservation Service;
John Thompson, Research Assistant, University of Missouri Center for Agroforestry
H. E. 'Gene' Garrett, Emeritus Professor of Silviculture, University of Missouri Department of Forestry and Former Director for University of Missouri Center for Agroforestry.

Agroforestry practices, such as silvopasture and alley-cropping, frequently involve managing a ground cover under decreasing solar or photosynthetically-active radiation (PAR) as the tree crowns develop. PAR is likely to be only 30 to 50 percent of full sunlight in a managed agroforestry practice compared to 10 to 20 percent of full sunlight in a managed hardwood forest. This project was designed to screen accessions of big bluestem (*Andropogon gerardii*) for tolerance to reductions in PAR where light is theoretically the only environmental factor limiting growth.

During the summers of 2005 and 2006, thirty accessions of big bluestem that included 'Rountree', 'OZ-70', and twenty-eight accessions originating from a three-state collection at the Elsberry Plant Materials Center were selected for evaluation in the Shade Tolerance Screening Laboratory (STSL) at the Horticulture and Agroforestry Research Center (HARC). These accessions were selected, in part, because the original ortets originated from savanna or woodland environments. One big bluestem accession was mixed with little bluestem and seven of the big bluestem accessions failed to produce a sufficient number of potted plants and were replaced with native cool-season grasses.

The Shade Tolerance Screening Laboratory (STSL) consists of three rows of five structures 16 feet wide by 32 feet long by 8 feet high (4.9 x 9.8 x 2.4 m) set on a well-drained crushed limestone bed with at least 16 feet (4.8 m) to the next nearest structure. Within each row of structures, one is left open and three are covered with 30%, 55%, or 80% black shade cloth yielding 100, 70, 45, and 20 percent of full sunlight. The structures for the full sun treatment were randomly placed in the interior of the laboratory to allow surrounding structures to reduce air movement and more closely mimic the reduced air movement inside the structures covered with shade cloth. The fifth structure in each row was covered with 'ginseng' shade cloth designed to create a range of small sunflecks. Light levels under ginseng cloth are approximately 22 percent of full sunlight based on daily cumulative PAR measured by using sensors mounted at plant height and summing the hourly averages from measurements made at one minute intervals. In addition, light monitoring also revealed approximately 25% of the incoming light that reaching the crushed limestone was reflected back as PAR into the plant canopies.

Within each structure, the potted plants were arranged into 13 rows of 7 pots on nominal 2.3- to 2.5-foot (70 to 75 cm) square spacing. An adjustable 16-position timer controlled length of time irrigation water from a stock pond was pumped to the trickle irrigation distribution system within each structure. A single emitter was placed within each pot and checked daily for blockage or rabbit damage to tubing. In August, timer settings were typically 1, 1, 2, 3, and 4 minutes daily for the sunfleck, 20%, 45%, 70% and full sun structures, respectively. Average maximum air temperatures during early August 2005 within the structures receiving 20, 45, 70, and 100

percent of full sunlight were 47.6, 46.9, 45.1, and 43.4 C, respectively, compared to 37 C at the official open field reporting station for the HARC agriculture experiment station. To decrease these temperature differences in 2006, the shade cloth was raised about 20 cm above the gravel on all sides to increase air flow.

In 2005, fifty plants of each accession were established in a greenhouse in 2-gallon white plastic pots (Nursery Supplies C-1200, Hummert International, Earth City, MO). Pots were filled with a potting medium composed of pine bark, peat moss, vermiculite, perlite, and sand (0.5, 0.2, 0.2, 0.05, and 0.05 by volume, respectively) supplemented with micronutrients, urea, and slow-release 13N-13P-13K fertilizer. Plants were started in the greenhouse from dormant rhizomes with 1 to 3 live buds. Rhizomes were washed and harvested from 20 x 20 cm clumps dug on 18 May 2005 from stock plants of each accession being grown and evaluated under full sun at the Elsberry Plant Materials Center. Established plants were hardened off in an outdoor shade house under 50% shade cloth for one week before being moving to the shade structures. At the end of the 2005 growing season, pots were moved into the alleys and grouped by accession and light treatment within accession before covering with an 8-foot wide strip of 1 cm thick white closed-cell polyethylene foam (Nursery Blanket, Hummert International, Earth City, MO) held in place by two rows of straw bales.

On 27 March 2006, potted plants were uncovered and given 3 g (0.5 teaspoon) of a slow-release ammonium nitrate (equivalent to 150 pounds actual N/acre across top of pot). Following re-randomizing of treatments among structures and plants within structures, three plants of each accession were again moved to a structure with the same light treatment as in the previous year. The full sun structures were again randomly located toward the center of the laboratory (structures 2, 3, or 4 within each block row. The poor growth observed in 2006 indicates many of the overwintered plants were already or quickly became pot-bound and forage production is a result of shading and other stressors. In November 2006, potted plants were again overwintered under Nursery Blanket and live plants were used the following spring to establish the big bluestem screening trials within an alley-cropping practice in the HARC cherrybark oak (*Quercus pagoda*) planting.

Before placing plants in each structure, structures were divided into south, center, and north sections and one potted plant of each accession was randomly placed within each pseudo-replicate. Target dates to install and remove shade cloth over plants are the week when most oaks are bursting bud or defoliating in central Missouri, respectively. Actual dates were 13 June 2005 when all plants were also clipped to an 8-inch (20 cm) stubble and 17 April in 2006. Shade cloth was removed on 21 November 2005 and 14 November 2006.

Boot-stage forage biomass was determined by harvesting to 15 cm stubble as the inflorescence filled the sheath of the flag leaf or the tips of the awns were just beginning to emerge. For plants that did not develop flowering culms, a boot-stage harvest was completed on 28 July 2005 and 29 August 2006. Information recorded on each harvest bag was number of the structure, light treatment, accession, pseudo-replicate, and flowering culms and/or tillers along with harvest date and any notes documenting disease symptoms, such as ergot, or atypical physical features. Bags were placed on greenhouse benches and opened to allow forage to air dry. The greenhouse had operating air vents on the roof for temperature control and maximum recorded air temperatures were as high as 50 to 55 C during the summer. In August 2005 and September 2006, bags were closed and placing in a forced air drier at 60 C for 48 hours before determining the boot-stage forage dry weight of each plant.

Forage biomass for the three plants of the same accession within a structure were combined and ground in a Wiley Mill to pass a 1 mm sieve, thoroughly mixed, and a 200 cm^3 composite sample taken. A 20 cm^3 subsample of each composite sample was placed in coin envelopes and submitted to the Arkansas Diagnostic Laboratory (Fayette, Arkansas) for analyses of crude protein, ADF, and NDF. For big bluestem, total digestible nutrients (TDN) were calculated as 111.8 + 0.95 CP – 0.36 ADF – 0.7 NDF. This formula was developed in 1998 for warm-season grasses in Arkansas by George Davis in the University of Arkansas Animal Sciences Department (Nancy Wolf, personal communication). The relative feed value (RFV) with full-bloom alfalfa being 100 percent was calculated as the product of digestible dry matter (88.9 - (0.799 ADF)) and digestible matter intake (120/NDF) divided by 1.29 (or multiplied by 0.775). Subsamples of the accessions grown in sunfleck treatment were not submitted for chemical analyses in 2006. Composite samples by accession from each shade structure for 2005 and 2006 are being stored at room temperature in a cool dry basement in the Natural Resource Building in Columbia, MO.

The post-killing frost forage biomass for each plant was determined by harvesting to 10 cm stubble after one or more nights with killing frosts (-2 C or more). Harvest dates were 16 to 21 November 2005 and 13 to 16 November 2006. Harvest bags for all live plants documented the number of the structure, light treatment, accession, and pseudo-replicate and any notes documenting disease symptoms. Samples were air-dried in the same vented greenhouse as for boot-stage forage biomass, until the post-killing frost forage biomass could be dried in the forced air oven at 60 C for 48 hours. After determination of dry weight, post-killing frost forage was discarded. Boot-stage and post-killing frost dry weights were added together to determine annual forage biomass for each plant.

Individual plant data were entered into a spreadsheet to include year, block, pseudo-replicate, light treatment (100, 70, 45, and 20 percent full sunlight or sunfleck), boot-stage harvest date (DOY after January 1), number of culms plus tillers, boot-stage forage dry weight, post-killing frost forage dry weight, and annual forage dry weight, crude protein, NDF, ADF, TDN, and RFV for forage, and values of either 0 (absent) or 1 (present) for variables such as presence of ergot or still vegetative at first harvest. The same percent crude protein, NDF and ADF values were entered for each of the three pseudo-replicates within an accession within a structure. Post-killing frost forage dry weight was entered as 0.0 grams for plants that were alive at boot-stage harvest and did not have a post-killing frost forage harvest because plants either died or failed to initiate new tillers. If a plant was already dead at the boot-stage forage harvest, the post-killing frost forage dry weight was entered as a missing value so that plant would be ignored during statistical analyses.

Values for all variables were checked for outliers from a normal distribution by light treatment using the PROC UNIVARIATE procedure in SAS Version 8.2 (SAS Institute, Cary, NC). Values more than three quartiles from the mean were checked for key-boarding errors and corrected or considered outliers and changed to a missing value. Accession means by structure were determined using PROC MEANS and subjected to analysis of variance using PROC GLM for a randomized complete block design for a split-plot arrangement of treatments with light as the main plots and accession as the subplots. Significant differences among light treatments were tested using the block x light interaction mean sums of squares and its respective degrees of freedom in error. When the accession x light interaction was statistically significant (alpha = 0.05), the LSMEANS were determined to estimate the average LS means standard errors needed

to test for differences between accessions within each light treatment assuming the 5% least significant difference (LSD) is two times the LS means standard error.

Tables 1 to 10 list the means for boot-stage harvest date, number of culms and tillers, boot-stage forage dry weight, post-killing frost forage dry weight, annual forage dry weight, crude protein, ADF, NDF, TDN, and RFV, respectively, for 100, 70, 45, 20 percent of full sunlight plus sunflecks for 2005 and 2006 for big bluestem. In addition, tables also list overall means, minimum, and maximum values. The mean sum of squares and probability of significant differences is given for the variance components for 2005 and 2006 along with average least squares mean standard errors for the variance components.

To aid in screening for the most promising accessions for use in shaded environments, two additional variables that simultaneously consider both forage quantity and quality were computed in addition to the earlier ranking using normal equivalence (see earlier UMCA report for Agricultural Research Service review). The first was yield of digestible nutrients in grams per plant determined as the product of boot-stage forage dry weight in grams and percent total digestible nutrients in decimal percent. The second was the product of percentile ranks for boot-stage forage dry weight and percent total digestible nutrients of live plants in each structure. Percentile ranks were determined as the relative placement between 0 (lowest forage quantity or quality) and 1 (sample value – minimum value/maximum value-minimum value) for each plant within each structure. Graphing of the percentile rank of these two variables as a scatter plot, places the most productive plants for both forage quantity and quality in the upper right hand corner. Plants in the upper third for both variables will have a product greater than 0.5 and in the upper quarter of the scatter plot. The most shade-tolerant accessions will in theory have with the highest average product and should be accessions recommended for inclusion in a future breeding block similar to what was done for development and release of accession 26 (OZ-70).

Table 1.—Mean days after January 1 (DOY) for boot-stage harvest for 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again 2006 under the same light treatment. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	201	202	201	205	203	202	212	222	215	225	228	220
MO-6832	4	201	202	201	203	203	202	215	230	238	247	223	230
MO-6812	5	202	202	202	205	203	203	203	204	211	220	208	209
MO-6885	6	201	202	201	203	201	202	216	213	215	230	225	220
AR-6896	7	205	206	205	208	208	207	234	245	241	247	249	243
AR-6972	8	205	205	206	205	207	206	233	233	228	231	238	232
MO-6807	10	202	202	201	203	203	202	216	220	214	216	204	214
AR-6974	12	202	202	202	202	203	202	200	198	202	204	198	200
AR-6902	13	201	202	201	204	201	202	226	223	218	216	218	220
MO-6802	14	203	202	202	204	206	203	213	222	223	230	227	223
AR-6905	15	203	203	202	205	206	204	240	225	238	234	238	235
OK-7049	16	202	203	204	207	207	205	246	222	217	238	207	226
MO-6741	17	201	201	201	201	202	201	217	217	218	232	230	223
AR-6925	19	201	203	202	204	206	204	221	234	228	250	209	229
MO-6838	21	200	201	201	202	202	201	205	213	201	208	194	204
MO-6704	22	200	201	201	201	201	201	208	196	201	206	209	204
AR-6935	24	206	204	204	206	207	205	233	223	218	232	236	228
OK-7039	25	205	206	207	206	206	206	219	235	229	236	238	231
OZ-70	26	205	208	205	208	208	207	222	218	224	231	233	226
Rountree	28	201	203	201	202	201	202	198	210	203	222	214	210
OK-7007	29	205	205	206	206	208	206	227	219	215	218	220	220
Average	----	203	203	203	204	204	203	219	220	219	227	221	221
Minimum	----	200	201	201	201	201	201	198	196	201	204	194	200
Maximum	----	206	208	207	208	208	207	246	245	238	247	249	243

ANOVA mean sum of squares and probability for significant differences for mean DOY (days after January 1) for boot-stage harvest in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	8.80	----	267.3	----
Light (L)	4	46.64	0.0278	774.0	0.0266
Error A = B x L	8	9.61	----	157.2	----
Accession (A)	20	60.53	<0.0001	1869.3	<0.0001
A x L	80	2.60	0.0420	167.4	0.1551
Error B	200	1.91	----	139.6	----

2005 and 2006 Light LS means standard error = 0.174 and 1.578, respectively.
2005 and 2006 Accession LS means standard error = 0.356 and 3.044, respectively.
2005 and 2006 Interaction LS means standard error = 0.797 and 6.807, respectively.

Table 2.—Average number of tillers and flowering culms per pot at boot-stage harvest for 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 in same light treatment. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	5.89	4.89	4.78	4.67	4.11	4.87	18.9	25.8	23.0	21.4	21.1	22.0
MO-6832	4	4.44	5.11	5.44	5.67	5.11	5.15	24.3	29.4	22.2	24.6	25.0	25.1
MO-6812	5	6.78	7.00	6.67	6.89	6.00	6.67	22.6	27.1	25.4	21.3	26.6	24.6
MO-6885	6	3.67	4.56	5.00	4.22	3.56	4.20	23.7	24.2	24.6	20.2	15.3	21.6
AR-6896	7	5.22	7.00	8.44	7.22	8.89	7.35	22.7	28.0	29.4	18.7	21.4	24.0
AR-6972	8	4.89	4.44	6.44	5.00	5.67	5.29	21.4	24.3	32.0	26.1	34.0	27.6
MO-6807	10	5.22	6.44	6.78	8.11	7.00	6.71	22.6	29.1	24.1	30.2	28.3	26.8
AR-6974	12	5.00	3.67	4.00	2.11	3.56	3.67	33.6	24.8	24.3	15.8	19.4	23.6
AR-6902	13	5.22	7.56	5.22	4.44	6.44	5.78	16.9	27.9	24.0	18.1	21.0	21.6
MO-6802	14	5.33	4.89	6.44	6.44	7.44	6.11	33.9	29.1	29.9	26.6	26.7	29.2
AR-6905	15	5.22	5.33	4.44	3.44	4.89	4.66	22.2	25.8	21.3	17.4	20.8	21.5
OK-7049	16	4.00	5.78	5.89	8.11	7.56	6.27	44.0	36.4	36.1	28.6	24.3	33.9
MO-6741	17	6.89	8.56	8.11	7.33	7.89	7.76	17.7	49.0	44.9	34.5	48.8	39.0
AR-6925	19	6.11	6.44	8.89	8.89	8.33	7.73	26.9	38.8	33.9	40.7	37.8	35.6
MO-6838	21	5.00	6.00	5.89	6.56	6.33	5.96	15.2	23.2	20.8	22.2	20.0	20.3
MO-6704	22	3.67	4.22	3.89	4.78	4.11	4.13	18.0	22.9	22.2	20.7	19.4	20.6
AR-6935	24	2.67	3.67	3.11	4.00	4.00	3.49	20.3	23.1	20.2	16.9	30.4	22.2
OK-7039	25	5.89	7.22	7.11	7.56	7.22	7.00	23.4	25.3	21.9	24.3	17.7	22.5
OZ-70	26	5.00	5.00	5.00	4.67	4.39	4.81	21.6	28.1	23.7	19.9	21.0	22.9
Rountree	28	6.00	9.11	7.33	8.78	7.44	7.73	22.8	26.7	27.9	27.2	25.9	26.1
OK-7007	29	4.00	3.67	2.44	2.89	2.00	3.00	27.7	24.6	22.4	19.0	22.7	23.3
Average	----	5.05	5.74	5.78	5.80	5.81	5.64	23.8	28.3	26.1	23.7	25.2	25.4
Minimum	----	2.67	3.67	2.44	2.11	2.00	3.00	15.2	22.9	20.2	15.8	15.3	20.3
Maximum	----	6.89	9.11	8.89	8.89	8.89	7.76	44.0	49.0	44.9	40.7	48.8	39.0

ANOVA mean sum of squares and probability for significant differences for average number of culms and tillers at boot-stage harvest in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	3.47	----	44.8	----
Light (L)	4	6.72	0.0712	273.3	0.0243
Error A = B x L	8	2.04	----	45.7	----
Accession (A)	20	32.54	<0.0001	383.2	<0.0001
A x L	80	2.31	0.0045	64.6	0.0078
Error B	200	1.44	----	41.7	----

2005 and 2006 Light LS means standard error = 0.151 and 0.893, respectively.
2005 and 2006 Accession LS means standard error = 0.310 and 1.667, respectively.
2005 and 2006 Interaction LS means stanard error = 0.693 and 3.728, respectively.

Table 3.—Average boot-stage forage dry weight (g/pot) to 15 cm stubble for 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 in the same light treatment. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	Fleck	Ave
AR-6967	2	24.8	29.1	23.0	15.4	17.7	22.0	12.2	12.6	13.1	24.2	21.3	16.7
MO-6832	4	28.2	35.5	29.8	22.9	17.8	26.8	19.0	21.6	21.9	23.6	23.3	21.9
MO-6812	5	30.8	40.2	34.8	23.6	24.1	30.5	10.7	14.8	16.3	25.6	22.7	18.0
MO-6885	6	28.7	27.2	27.6	13.1	14.0	22.1	22.0	24.3	25.9	24.9	21.5	23.7
AR-6896	7	28.7	33.7	40.2	28.0	32.5	32.6	13.5	14.8	18.5	15.9	20.5	16.6
AR-6972	8	26.9	27.7	32.8	22.2	24.1	26.7	10.5	11.6	22.6	22.4	18.4	17.1
MO-6807	10	27.6	27.5	27.5	23.1	20.7	25.3	10.7	14.0	20.9	28.5	22.3	19.3
AR-6974	12	25.5	19.9	16.5	8.1	9.9	16.0	29.7	27.1	24.3	27.3	26.6	27.0
AR-6902	13	39.1	41.1	30.2	18.4	26.2	31.0	15.1	16.0	24.9	22.9	18.8	19.5
MO-6802	14	35.0	36.5	40.8	29.1	34.0	35.1	35.2	29.3	37.3	41.2	41.6	36.9
AR-6905	15	28.8	30.3	32.6	20.6	23.3	27.1	13.9	18.9	20.8	24.4	21.9	20.0
OK-7049	16	24.6	29.3	33.5	29.0	30.0	29.2	17.5	22.2	24.9	40.4	32.5	27.5
MO-6741	17	28.5	37.5	32.2	24.1	24.3	29.3	11.0	16.1	19.7	26.7	19.7	18.6
AR-6925	19	31.2	39.9	45.2	37.8	33.1	37.4	17.4	26.9	29.5	28.5	34.3	27.3
MO-6838	21	32.5	40.3	35.5	25.8	28.9	32.6	9.2	15.4	18.8	25.2	24.1	18.5
MO-6704	22	30.1	29.6	27.9	19.7	19.2	25.3	11.3	14.2	21.6	24.9	21.1	18.6
AR-6935	24	19.3	20.7	22.7	13.6	15.8	18.4	16.0	18.2	27.2	19.6	26.3	21.5
OK-7039	25	22.3	28.9	25.7	27.0	23.9	25.6	10.3	13.7	14.8	20.5	16.6	15.2
OZ-70	26	24.4	13.4	17.3	7.0	10.9	14.6	15.5	24.4	31.5	24.7	17.8	22.8
Rountree	28	34.3	44.8	44.0	35.4	34.8	38.7	15.0	27.6	29.2	34.0	30.2	27.2
OK-7007	29	17.2	17.5	10.5	7.6	7.6	12.2	17.7	18.6	18.3	22.9	20.1	19.5
Average	----	28.0	30.9	30.0	21.5	22.5	26.6	15.9	19.1	22.9	26.1	23.9	21.6
Minimum	----	17.2	13.4	10.5	7.0	7.6	12.1	9.2	11.6	13.1	15.9	16.6	15.2
Maximum	----	39.1	44.8	45.2	37.8	34.8	38.7	35.2	29.3	37.3	41.2	41.6	36.9

ANOVA mean sum of squares and probability for significant differences for boot-stage forage dry weight for 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	3.6	----	24.3	----
Light (L)	4	1179.6	0.0003	1042.0	<0.0001
Error A = B x L	8	59.9	----	18.2	----
Accessions (A)	20	772.4	<0.0001	402.3	<0.0001
A x L	80	40.0	<0.0001	37.4	0.0337
Error B	200	13.6	----	26.0	----

2005 and 2006 Light LS means standard error = 0.465 and 0.533, respectively.
2005 and 2006 Accession LS means standard error = 0.952 and 1.327, respectively.
2005 and 2006 Interaction LS means standard error = 2.130 and 2.968, respectively.

Table 4.—Average post-killing frost forage dry weight (g/pot) or post boot-stage recovery forage dry weight to 15 cm stubble for 21 accessions of big bluestem grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	46.5	41.0	28.2	16.0	20.0	30.3	15.8	10.1	10.9	6.5	6.2	9.9
MO-6832	4	56.3	45.1	37.0	15.6	14.3	33.7	18.9	10.7	8.0	3.2	7.5	9.6
MO-6812	5	44.6	45.1	26.4	13.8	19.6	29.9	20.4	17.8	12.0	6.0	11.2	13.5
MO-6885	6	66.9	59.0	51.1	18.9	27.8	44.7	19.1	20.3	14.7	6.0	12.0	14.4
AR-6896	7	65.0	48.1	32.5	15.1	17.5	35.6	7.1	4.2	2.8	1.2	1.3	3.3
AR-6972	8	61.1	53.2	45.7	20.2	27.9	41.6	8.9	11.5	8.2	6.5	5.9	8.0
MO-6807	10	63.5	48.4	36.6	23.4	25.6	39.5	19.9	11.7	16.3	11.9	15.0	14.8
AR-6974	12	68.4	53.4	36.6	14.6	17.4	38.1	31.1	27.7	26.5	14.4	16.3	23.2
AR-6902	13	50.9	38.5	27.5	13.1	19.8	30.0	11.9	11.1	9.4	8.1	8.5	19.8
MO-6802	14	75.0	52.4	48.3	23.1	26.1	44.6	22.5	13.2	11.9	8.4	8.0	12.8
AR-6905	15	59.6	44.8	34.7	18.9	22.1	36.0	6.5	10.6	5.6	4.4	6.0	6.6
OK-7049	16	78.2	62.3	40.9	25.2	22.7	45.9	5.5	10.7	13.8	5.8	15.2	10.2
MO-6741	17	58.4	55.4	45.4	27.4	32.0	43.7	13.3	13.7	10.4	8.1	11.1	11.1
AR-6925	19	59.9	56.0	43.8	27.1	25.4	42.2	13.5	10.0	15.2	3.6	12.2	11.9
MO-6838	21	63.8	56.0	42.8	19.3	25.4	42.1	20.4	15.1	20.6	13.1	18.9	17.6
MO-6704	22	42.6	37.2	28.8	17.6	16.0	28.4	19.9	20.6	18.3	14.3	13.3	17.3
AR-6935	24	64.8	43.5	37.5	11.9	21.3	35.8	9.5	9.9	12.8	6.7	3.9	8.6
OK-7039	25	55.3	43.1	31.6	25.1	29.0	36.8	19.2	5.6	8.9	6.1	5.0	8.9
OZ-70	26	63.6	48.4	36.6	11.4	15.4	35.1	11.4	12.8	9.5	3.6	6.8	8.8
Rountree	28	50.3	43.5	35.4	19.8	21.4	34.1	22.1	19.3	17.0	8.1	10.6	15.4
OK-7007	29	49.8	33.9	21.7	10.0	12.7	26.3	12.8	12.2	15.0	8.9	10.9	11.9
Average	----	59.2	48.1	36.7	18.4	22.0	36.8	15.7	13.2	12.8	7.3	9.8	11.8
Minimum	----	42.6	33.9	21.7	10.0	12.7	26.3	7.1	4.2	2.8	1.2	1.3	3.3
Maximum	----	78.2	62.3	51.1	27.4	32.0	45.9	31.1	27.7	26.5	14.4	18.9	23.2

ANOVA mean sum of squares and probability for significant differences for post-killing frost forage dry weight for 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	325	----	8.4	----
Light (L)	4	18662	<0.0001	667.1	0.0007
Error A = B x L	8	117	----	41.9	----
Accessions (A)	20	512	<0.0001	287.3	<0.0001
A x L	80	63	0.0027	27.1	0.1711
Error B	200	38	----	22.8	----

2005 and 2006 Light LS means standard error = 0.779 and 0.815, respectively.
2005 and 2006 Accession LS means standard error = 1.596 and 1.234, respectively.
2005 and 2006 Interaction LS means standard error = 3.570 and 2.759, respectively.

Table 5.—Mean annual forage dry weight production (g/pot) for 20 accessions of big bluestem plus ‘Rountree’ grown under four light regimes and sunflecks (22% of full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when pot-bound. Values are means of means from three plants in each of three blocks.

PMC	STL	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	71	70	51	31	38	52.3	28	23	24	31	28	26.4
MO-6832	4	85	81	67	39	32	60.5	38	32	30	27	31	31.5
MO-6812	5	75	85	61	37	44	60.4	31	33	28	32	34	31.5
MO-6885	6	96	86	79	32	42	66.9	41	45	41	30	36	38.5
AR-6896	7	94	82	73	43	50	68.2	21	19	21	17	22	20.0
AR-6972	8	88	81	78	42	52	68.4	19	22	31	29	24	25.1
MO-6807	10	91	76	64	47	46	64.8	31	26	37	39	38	34.0

AR-6974	12	94	73	53	23	27	54.0	61	55	51	42	43	50.2
AR-6902	13	90	80	58	32	46	60.7	27	27	34	31	27	29.3
MO-6802	14	110	89	89	52	60	80.0	58	43	49	50	50	49.7
AR-6905	15	88	75	67	40	45	63.1	20	29	26	29	28	26.6
OK-7049	16	103	92	74	54	53	75.1	23	33	39	46	48	37.7
MO-6741	17	87	93	77	52	56	73.0	24	30	30	35	30	29.8
AR-6925	19	91	96	89	65	58	80.0	31	37	45	32	46	38.2
MO-6838	21	96	96	78	45	57	79.1	30	30	39	38	43	36.1
MO-6704	22	73	67	57	37	35	53.7	31	35	40	39	34	35.9
AR-6935	24	85	64	60	26	37	54.2	26	28	40	26	30	30.0
OK-7039	25	78	72	57	52	53	62.4	29	19	24	27	22	24.1
OZ-70	26	88	62	54	18	26	49.7	27	37	41	28	25	31.6
Rountree	28	85	88	79	55	56	72.7	37	47	46	42	41	42.6
OK-7007	29	67	54	32	17	20	38.5	30	31	33	32	31	31.4
Average	----	87.2	79.0	66.7	39.9	44.4	63.4	31.6	32.3	35.7	33.4	33.8	33.4
Minimum	----	67	54	32	17	20	38.5	19	19	21	17	22	20.0
Maximum	----	110	96	89	65	60	80.0	58	47	49	50	50	50.2

ANOVA mean sum of square and probability for significant difference in annual forage production for 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	315	----	121.5	-----
Light (L)	4	27305	<0.0001	154.6	0.2015
Error A = B x L	8	215	----	80.8	-----
Accessions (A)	20	1680	<0.0001	902.8	<0.0001
A x L	80	119	0.0007	77.8	0.1362
Error B	200	67	----	63.8	-----

2005 and 2006 Light LS means standard error = 1.032 and 1.132, respectively.
2005 and 2006 Accession LS means standard error = 2.114 and 2.062, respectively.
2005 and 2006 Interaction LS means standard error = 4.728 and 4.612, respectively.

Table 6.—Average crude protein (6.25 N) content (%) for boot-stage harvest from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment and pot-bound. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	6.02	7.05	7.56	9.18	10.20	8.01	6.03	5.04	5.36	5.00	ND	5.36
MO-6832	4	6.15	6.88	6.74	8.03	8.47	7.25	5.62	4.06	3.93	4.30	ND	4.48
MO-6812	5	5.88	5.61	5.10	6.26	6.16	5.80	5.12	4.32	4.29	4.61	ND	4.58
MO-6885	6	6.25	6.90	7.14	11.70	11.50	8.70	4.24	4.03	4.51	4.82	ND	4.40
AR-6896	7	6.19	6.91	7.33	7.68	8.55	7.33	4.80	4.44	4.23	4.37	ND	4.47
AR-6972	8	6.24	6.60	6.85	9.36	8.69	7.55	5.35	4.90	4.45	5.08	ND	4.95
MO-6807	10	6.22	6.45	8.26	10.53	10.20	8.33	5.32	5.01	4.68	4.60	ND	4.90
AR-6974	12	8.63	10.30	10.10	10.59	10.20	9.90	4.59	4.44	4.33	5.04	ND	4.60
AR-6902	13	4.90	5.24	7.32	8.37	6.97	6.56	4.96	4.49	3.94	4.53	ND	4.48
MO-6802	14	6.73	5.60	6.17	7.64	6.98	6.62	3.74	3.81	3.51	4.03	ND	3.77
AR-6905	15	6.22	5.48	5.75	9.06	7.26	6.76	4.86	4.31	3.94	4.35	ND	4.37
OK-7049	16	6.56	5.34	5.69	8.06	7.31	6.59	4.15	4.34	3.86	4.04	ND	4.10
MO-6741	17	6.24	5.40	5.82	8.26	8.15	6.77	4.96	4.58	4.95	4.99	ND	4.87
AR-6925	19	5.44	4.86	4.87	7.42	7.16	5.95	4.26	3.51	3.66	3.68	ND	3.78
MO-6838	21	5.90	4.90	5.47	8.59	7.29	6.43	4.97	4.25	4.37	5.17	ND	4.71
MO-6704	22	4.93	6.09	5.87	7.24	5.95	6.02	5.40	4.96	4.71	5.69	ND	5.19
AR-6935	24	5.85	6.17	6.99	8.57	9.01	7.32	4.63	4.06	3.75	4.57	ND	4.24
OK-7039	25	5.59	5.25	5.67	6.17	6.61	5.86	5.93	4.71	4.93	5.21	ND	5.20
OZ-70	26	7.49	7.92	11.00	10.90	9.69	9.26	5.32	4.74	3.87	4.51	ND	4.61
Rountree	28	6.43	6.26	5.28	6.96	7.37	6.46	4.97	4.21	4.06	3.88	ND	4.28

OK-7007	29	6.66	5.68	9.90	11.7	11.16	9.02	5.01	4.26	4.56	4.95	ND	4.69
Average	----	6.21	6.22	6.86	8.68	8.33	7.26	4.96	4.40	4.29	4.62	ND	4.57
Minimum	----	4.90	4.86	4.87	6.17	5.95	5.80	3.74	3.51	3.51	3.68	ND	3.77
Maximum	----	8.63	10.30	11.00	11.70	11.50	9.90	6.03	5.04	5.36	5.69	ND	5.36

ANOVA mean sums of squares and probability of significant differences of mean crude protein concentration for boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	2.40	----	0.033	-----
Light (L)	4	86.51	<0.0001	5.426	0.0081
Error A = B x L	8	1.53	----	0.519	-----
Accessions (A)	20	21.36	<0.0001	2.138	<0.0001
A x L	80	2.17	0.0006	0.261	0.1850
Error B	200	1.21	----	0.218	------

2005 and 2006 Light LS means standard error = 0.139 and 0.090, respectively.
2005 and 2006 Accession LS means standard error = 0.284 and 1.135, respectively.
2005 and 2006 Interaction LS means standard error = 0.635 and 0.262, 0.269, respectively.

Table 7.—Average neutral detergent fiber (NDF) content (%) for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when pot-bound). Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	65.0	63.6	67.3	65.1	65.8	65.4	64.4	64.9	65.3	67.7	ND	65.6
MO-6832	4	64.8	63.3	66.9	66.7	66.0	66.3	62.5	65.3	65.3	66.5	ND	64.9
MO-6812	5	64.3	66.5	68.2	68.8	67.8	67.1	61.9	62.7	62.6	66.6	ND	63.4
MO-6885	6	64.1	65.4	65.1	62.6	65.1	64.5	61.8	62.6	63.1	65.2	ND	63.2
AR-6896	7	64.8	64.0	63.7	66.0	64.1	64.5	63.7	63.6	63.6	65.8	ND	64.2
AR-6972	8	63.6	65.5	64.8	65.5	66.2	65.1	61.8	63.3	63.6	64.0	ND	63.2
MO-6807	10	65.6	68.9	68.6	67.1	67.5	67.5	62.4	63.1	64.7	65.5	ND	63.9
AR-6974	12	62.6	66.5	66.8	66.3	66.0	65.6	62.8	63.7	65.9	67.9	ND	65.1
AR-6902	13	64.7	65.8	66.9	66.5	67.1	66.2	62.7	62.8	66.0	67.3	ND	64.7
MO-6802	14	62.8	66.5	64.8	67.3	66.9	65.6	65.6	67.0	64.9	66.7	ND	66.0
AR-6905	15	64.6	65.8	67.3	66.7	64.1	65.7	61.0	60.8	63.2	64.7	ND	62.4
OK-7049	16	63.3	67.2	65.3	67.3	65.1	65.6	63.8	66.0	68.8	67.9	ND	66.6
MO-6741	17	62.9	66.2	64.7	67.7	64.3	65.2	61.9	61.3	61.6	63.2	ND	61.9
AR-6925	19	59.2	61.4	62.5	63.1	63.5	61.9	62.0	64.0	64.0	64.2	ND	63.6
MO-6838	21	64.5	66.7	69.0	66.7	65.6	66.5	63.1	65.5	66.4	67.7	ND	65.6
MO-6704	22	67.1	69.4	70.2	69.7	70.4	69.4	64.8	65.0	67.2	68.9	ND	66.5
AR-6935	24	61.3	67.5	69.3	68.0	64.3	66.1	63.0	64.4	67.8	67.7	ND	65.7
OK-7039	25	63.7	65.4	65.7	67.6	65.6	65.6	62.4	62.1	63.8	65.6	ND	63.5
OZ-70	26	61.3	61.6	60.4	64.7	64.4	62.5	63.7	65.9	68.2	67.9	ND	66.4
Rountree	28	62.3	62.1	62.8	67.0	64.8	63.8	64.2	66.1	67.4	67.5	ND	66.3
OK-7007	29	61.5	70.3	64.5	63.1	62.4	64.4	63.9	64.8	65.4	66.5	ND	65.1
Average	----	63.5	65.9	65.9	66.4	65.6	65.5	63.0	64.0	65.2	66.4	ND	64.7
Minimum	----	59.2	61.4	60.4	62.6	62.4	61.9	61.8	60.8	62.6	63.2	ND	61.9
Maximum	----	67.1	70.3	70.2	69.7	70.4	69.4	65.6	67.0	68.8	68.9	ND	66.6

ANOVA mean sums of squares and probability of significant differences for NDF concentration of boot-stage forage for 2005 and 2006

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	70.70	----	1.23	----
Light (L)	4	78.06	0.0158	132.60	<0.0001
Error A = B x L	8	12.87	----	1.27	----
Accessions (A)	20	39.52	<0.0001	22.70	<0.0001
A x L	80	6.05	0.1005	2.31	0.0172
Error B	200	4.49	----	1.49	-----

2005 and 2006 Light LS means standard error = 0.267 and 0.144, respectively.
2005 and 2006 Accession LS means standard error = 0.547 and 0.353, respectively.
2005 and 2006 Interaction LS means standard error = 1.224 and 0.706, respectively.

Table 8.—Average acid detergent fiber (ADF) content (%) for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when also pot-bound). Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	37.5	37.6	40.3	39.4	41.0	39.2	36.0	35.8	36.3	39.2	ND	36.8
MO-6832	4	36.5	40.0	41.1	40.4	39.5	39.5	34.8	37.1	37.8	38.1	ND	36.9
MO-6812	5	37.0	40.0	39.2	44.3	43.3	40.8	33.3	34.7	35.4	38.3	ND	35.4
MO-6885	6	37.1	38.5	39.7	36.4	38.4	38.0	35.1	35.2	35.8	38.1	ND	36.1
AR-6896	7	33.7	36.2	37.7	39.6	37.0	36.8	35.5	35.5	38.5	38.5	ND	36.3
AR-6972	8	35.5	38.0	38.3	40.4	40.6	38.5	35.9	37.3	37.4	38.5	ND	37.3
MO-6807	10	40.3	43.5	43.8	42.1	41.4	42.2	36.4	37.4	37.7	38.8	ND	37.6
AR-6974	12	35.7	41.2	43.1	41.8	40.1	40.4	33.9	34.0	37.1	40.0	ND	36.2
AR-6902	13	37.7	41.0	42.1	42.7	42.1	41.1	35.1	35.5	38.7	39.6	ND	37.2
MO-6802	14	33.3	40.2	38.6	41.8	41.6	39.1	36.9	34.0	38.2	40.3	ND	37.4
AR-6905	15	37.1	38.4	42.5	42.3	39.6	40.0	36.5	37.0	39.0	40.4	ND	38.2
OK-7049	16	33.4	38.4	37.9	39.2	38.7	37.5	36.4	37.3	39.2	40.5	ND	38.3
MO-6741	17	34.9	40.0	38.3	41.3	38.2	38.6	33.3	33.3	34.4	35.9	ND	34.2
AR-6925	19	33.2	34.4	37.7	37.3	38.7	36.2	36.3	36.9	36.1	36.8	ND	36.5
MO-6838	21	37.3	41.1	45.9	41.8	40.8	41.4	36.7	38.0	38.8	39.8	ND	38.3
MO-6704	22	40.8	42.7	44.6	45.3	45.6	43.8	36.1	36.3	38.5	40.5	ND	37.8
AR-6935	24	33.5	39.5	43.0	43.2	38.5	39.5	35.9	37.8	40.6	40.4	ND	38.7
OK-7039	25	36.3	37.9	38.0	42.2	39.9	38.7	37.4	36.6	36.7	38.9	ND	37.4
OZ-70	26	33.1	34.4	34.2	36.4	40.2	35.7	36.1	36.6	40.2	40.4	ND	38.3
Rountree	28	37.0	35.6	37.4	42.5	42.1	38.9	35.9	36.7	38.3	39.8	ND	37.7
OK-7007	29	34.3	44.1	36.6	37.2	37.5	37.9	35.0	36.7	36.9	39.5	ND	37.0
Average	----	36.0	39.2	40.0	40.8	40.2	39.2	35.7	36.2	37.6	39.2	ND	37.2
Minimum	----	33.1	34.4	34.2	36.4	37.0	35.7	33.3	33.3	35.7	35.9	ND	34.2
Maximum	----	40.8	44.1	45.9	45.3	45.6	43.8	37.4	38.0	40.6	40.5	ND	38.7

ANOVA mean sums of squares and probability of significant differences for ADF concentration of boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	0.6	----	6.43	----
Light (L)	4	233.0	<0.0001	153.57	<0.0001
Error A = B x L	8	7.8	----	2.12	----
Accessions (A)	20	57.9	<0.0001	13.13	<0.0001
A x L	80	9.3	0.1230	2.34	0.0006
Error B	200	7.5	----	1.20	----

2005 and 2006 Light LS means standard error = 0.345 and 0.191, respectively.
2005 and 2006 Accession LS means standard error = 0.707 and 0.316, respectively.
2005 and 2006 Interaction LS means standard error = 1.581 and 0.633, respectively.

Table 9.—Average total digestible nutrient (TDN) concentration (%) for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when pot-bound). Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	58.5	60.4	57.4	60.8	60.7	59.5	59.5	58.3	58.1	55.1	ND	57.7
MO-6832	4	59.2	59.7	56.5	58.2	59.4	58.0	60.9	56.6	56.2	55.6	ND	57.3
MO-6812	5	59.0	56.2	54.8	53.6	54.6	55.7	61.4	59.5	59.3	55.8	ND	59.0
MO-6885	6	59.5	58.7	58.7	66.0	63.3	61.2	60.0	59.1	59.0	57.0	ND	58.8
AR-6896	7	60.2	60.6	60.6	58.7	61.8	60.4	59.0	58.7	58.6	55.9	ND	58.0
AR-6972	8	60.5	58.6	59.2	60.3	59.1	59.5	60.7	58.8	58.0	58.0	ND	58.9
MO-6807	10	57.3	54.0	55.9	59.7	59.3	57.2	60.1	58.9	57.4	56.4	ND	58.2
AR-6974	12	63.3	60.2	59.1	60.4	60.9	60.7	60.0	59.2	56.4	54.7	ND	57.6
AR-6902	13	57.6	55.9	56.8	57.8	56.3	56.9	60.0	59.4	55.4	54.7	ND	57.4
MO-6802	14	62.3	56.1	58.4	56.9	56.6	58.1	56.1	55.6	55.9	54.4	ND	55.5
AR-6905	15	59.1	57.1	54.8	58.5	59.6	57.8	60.6	60.0	57.3	56.1	ND	58.5
OK-7049	16	61.7	56.0	57.8	58.3	59.3	58.6	58.0	56.3	53.2	53.6	ND	55.3
MO-6741	17	61.1	56.2	58.2	57.4	60.8	58.7	61.2	61.2	58.4	59.4	ND	60.5
AR-6925	19	63.6	61.1	59.1	61.3	60.2	61.1	59.4	57.1	57.5	57.1	ND	57.8
MO-6838	21	58.8	55.0	52.2	58.2	58.1	56.4	59.2	56.3	55.6	55.0	ND	56.5
MO-6704	22	54.8	53.6	52.2	53.6	51.8	53.2	58.8	57.9	55.4	54.5	ND	56.6
AR-6935	24	62.4	56.2	54.5	56.8	61.5	58.3	59.2	57.0	53.3	54.1	ND	55.9
OK-7039	25	59.5	57.4	57.5	55.2	57.8	57.5	60.3	59.6	58.6	56.8	ND	58.8
OZ-70	26	64.1	63.8	67.6	63.8	61.5	64.0	59.2	57.0	53.2	54.0	ND	55.9
Rountree	28	61.0	61.4	59.4	56.2	58.3	59.3	58.7	56.3	54.7	53.9	ND	55.9
OK-7007	29	62.7	52.1	62.9	65.3	65.2	61.7	59.3	57.3	57.1	55.8	ND	57.4
Average	----	60.3	57.5	57.8	58.9	59.3	58.8	59.6	58.2	56.6	55.7	ND	57.5
Minimum	----	54.8	52.1	52.2	53.6	51.8	53.2	56.1	55.6	53.2	53.6	ND	55.3
Maximum	----	64.1	63.8	67.6	66	65.2	64.0	61.4	61.2	59.3	59.4	ND	60.7

ANOVA mean sums of squares and probability of significant differences for total digestible nutrient concentration for boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	41.01	----	2.72	----
Light (L)	4	83.61	0.0050	181.33	<0.0001
Error A = B x L	8	9.47	----	0.97	----
Accessions (A)	20	83.35	<0.0001	20.97	<0.0001
A x L	80	12.86	0.0091	2.52	0.0046
Error B	200	8.40	----	1.67	----

2005 and 2006 Light LS means standard error = 0.365 and 0.126, respectively.
2005 and 2006 Accession LS means standard error = 0.748 and 0.373, respectively.
2005 and 2006 Interaction LS means standard error = 1.673 and 0.746, respectively.

Table 10.—Average relative feed value (RFV) for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when also pot-bound. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	85.4	87.3	79.6	83.3	80.6	83.2	87.9	87.5	86.4	80.2	ND	85.5
MO-6832	4	87.4	86.2	79.1	80.2	82.0	81.7	92.1	85.5	84.7	82.9	ND	86.3
MO-6812	5	87.2	80.8	79.6	73.7	75.8	79.4	94.7	91.8	91.2	82.6	ND	90.1
MO-6885	6	87.3	83.9	82.9	90.1	84.3	85.7	92.7	91.2	89.9	84.5	ND	89.6
AR-6896	7	90.0	88.4	87.3	81.9	87.4	87.0	89.6	89.6	89.2	83.3	ND	87.9
AR-6972	8	89.7	84.3	84.9	81.8	80.5	84.2	91.8	88.0	87.4	85.6	ND	88.2
MO-6807	10	81.7	74.3	74.4	78.0	78.0	77.3	90.2	88.1	85.6	83.4	ND	86.8
AR-6974	12	90.7	79.4	77.2	79.1	81.7	81.6	92.7	91.3	84.7	79.2	ND	86.9
AR-6902	13	85.7	80.5	78.1	77.9	77.8	80.0	91.3	90.9	82.9	80.2	ND	86.3
MO-6802	14	93.3	80.7	84.6	77.9	78.6	83.0	85.3	85.3	84.9	80.1	ND	83.9
AR-6905	15	86.6	83.4	77.4	78.1	84.3	82.0	92.2	92.0	86.2	82.6	ND	88.3
OK-7049	16	92.5	81.6	84.8	80.7	84.0	84.7	88.3	84.4	79.0	78.7	ND	82.6
MO-6741	17	91.2	81.3	85.0	78.0	85.6	84.2	95.7	95.5	93.9	89.7	ND	93.4
AR-6925	19	99.1	94.2	88.9	88.3	86.2	91.3	91.0	87.5	88.4	87.4	ND	88.6
MO-6838	21	86.4	79.3	71.7	78.6	81.1	79.4	89.1	84.2	82.3	79.5	ND	83.8
MO-6704	22	79.2	74.6	72.1	71.6	70.6	73.6	87.3	86.8	81.6	77.6	ND	83.3
AR-6935	24	95.3	80.3	74.4	75.6	85.4	82.2	90.1	85.9	78.6	78.8	ND	83.4
OK-7039	25	89.1	85.4	84.5	77.2	82.3	83.7	89.1	90.5	88.0	83.1	ND	87.7
OZ-70	26	96.0	93.8	96.5	87.2	83.4	91.4	88.7	85.3	78.5	78.7	ND	82.8
Rountree	28	89.8	92.0	88.9	77.6	80.7	85.8	88.3	84.8	81.6	79.8	ND	83.6
OK-7007	29	94.1	72.2	87.0	88.3	89.0	86.1	89.9	86.7	85.7	81.4	ND	85.9
Average	----	89.4	82.7	81.9	80.2	81.9	83.2	90.3	88.2	85.2	81.8	ND	86.4
Minimum	----	79.2	72.2	71.7	71.6	70.6	73.6	85.3	84.2	78.5	77.6	ND	82.6
Maximum	----	99.1	94.2	96.5	90.1	89.0	91.4	95.7	95.5	91.2	89.7	ND	93.8

ANOVA mean sums of squares and probability of significant differences for relative feed value of boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	117.2	----	14.15	----
Light (L)	4	804.6	0.0002	827.41	<0.0001
Error A = B x L	8	34.4	----	7.25	----
Accessions (A)	20	259.7	<0.0001	86.59	<0.0001
A x L	80	39.3	0.0544	11.34	0.0046
Error B	200	29.4	----	6.05	----

2005 and 2006 Light LS means standard error = 0.683 and 0.345, respectively.
2005 and 2006 Accession LS means standard error = 1.400 and 0.720, respectively.
2005 and 2006 Interaction LS means standard error = 3.130 and 1.421, respectively.

Table 11.—Average digestible nutrient production (g/pot) for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment when also pot-bound. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	14.5	17.7	13.2	9.4	10.7	13.1	7.3	7.3	7.6	13.3	ND	8.9
MO-6832	4	16.6	20.1	16.9	13.3	10.6	15.5	11.5	12.2	12.3	13.1	ND	12.3
MO-6812	5	18.0	21.9	19.1	12.6	13.2	17.0	6.6	9.5	9.7	14.3	ND	10.0
MO-6885	6	16.9	15.9	16.2	8.7	8.9	13.3	13.2	14.4	15.2	14.2	ND	14.3
AR-6896	7	17.3	20.4	24.2	16.4	20.1	19.7	7.9	8.7	12.4	8.9	ND	9.5
AR-6972	8	16.2	16.2	19.4	13.4	14.2	15.9	6.4	6.8	13.1	12.9	ND	9.8
MO-6807	10	15.8	14.9	15.4	13.8	12.3	14.4	6.4	8.2	12.0	16.1	ND	10.7
AR-6974	12	16.2	11.9	9.8	4.8	6.0	9.7	17.8	16.0	13.7	14.9	ND	15.6
AR-6902	13	22.5	22.3	17.1	10.7	14.7	17.4	9.1	9.5	13.7	12.5	ND	11.2
MO-6802	14	21.7	20.5	23.8	16.5	19.2	20.3	19.8	16.5	20.9	22.3	ND	19.9
AR-6905	15	17.0	17.3	17.7	12.0	13.8	15.6	8.4	11.3	11.9	13.7	ND	11.3
OK-7049	16	15.1	16.5	19.4	16.9	17.7	17.1	10.1	12.5	13.2	21.5	ND	14.3
MO-6741	17	17.4	20.9	18.8	13.8	14.7	17.1	7.8	9.9	11.9	16.6	ND	11.6
AR-6925	19	19.9	24.4	26.6	23.2	20.0	22.8	10.3	15.3	16.9	16.2	ND	14.7
MO-6838	21	19.1	22.1	18.5	15.1	16.8	18.3	5.4	8.7	10.5	13.8	ND	9.6
MO-6704	22	16.5	15.9	14.6	10.6	9.9	13.5	6.6	8.2	11.9	13.5	ND	10.1
AR-6935	24	12.1	11.6	12.4	7.7	9.7	10.7	9.5	10.4	14.4	10.6	ND	11.2
OK-7039	25	13.4	16.7	14.7	14.8	13.8	14.7	6.2	8.1	8.7	11.6	ND	8.7
OZ-70	26	15.7	8.5	11.7	4.5	6.7	9.4	9.2	13.8	16.7	13.3	ND	13.3
Rountree	28	21.0	27.4	26.1	19.9	20.2	22.9	8.8	15.5	15.9	18.4	ND	14.6
OK-7007	29	10.8	9.1	7.0	5.0	4.9	7.4	10.5	10.6	10.4	12.7	ND	11.1
Average	----	16.8	17.7	17.3	12.5	13.2	15.5	9.5	11.0	13.0	14.5	ND	12.0
Minimum	----	10.8	8.5	7.0	5.0	4.9	7.4	6.2	6.8	8.7	8.9	ND	8.7
Maximum	----	22.5	27.4	26.6	23.2	20.2	22.9	19.8	16.5	20.9	22.3	ND	20.2

ANOVA mean sums of squares and probability of significant differences for digestible nutrient content of boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	2.3	----	5.96	----
Light (L)	4	375.4	0.0003	296.86	<0.0001
Error A = B x L	8	18.9	----	7.81	----
Accessions (A)	20	258.2	<0.0001	88.85	<0.0001
A x L	80	13.4	<0.0001	11.92	0.0009
Error B	200	4.7	----	6.28	----

2005 and 2006 Light LS means standard error = 0.274 and 0.601, respectively.
2005 and 2006 Accession LS means standard error = 0.562 and 0.723, respectively.
2005 and 2006 Interaction LS means standard error = 1.256 and 1.446, respectively.

Table 12.—Average forage quantity and quality shade tolerance index values for boot-stage forage from 20 accessions of big bluestem plus 'Rountree' grown under four light regimes and sunflecks (22% full sunlight) in an outdoor shade tolerance facility in 2005 and again in 2006 under the same light treatment. Values are means of means from three plants in each of three blocks.

PMC	Accs	2005 percent of full sunlight						2006 percent of full sunlight					
#	#	100	70	45	20	fleck	Ave	100	70	45	20	fleck	Ave
AR-6967	2	0.159	0.279	0.127	0.146	0.213	0.185	0.094	0.087	0.124	0.148	ND	0.113
MO-6832	4	0.197	0.223	0.169	0.169	0.193	0.190	0.221	0.115	0.150	0.152	ND	0.160
MO-6812	5	0.204	0.232	0.153	0.066	0.132	0.158	0.124	0.175	0.192	0.192	ND	0.171
MO-6885	6	0.207	0.211	0.186	0.192	0.203	0.200	0.226	0.290	0.304	0.251	ND	0.268
AR-6896	7	0.252	0.321	0.333	0.217	0.458	0.316	0.078	0.134	0.228	0.106	ND	0.137
AR-6972	8	0.238	0.211	0.242	0.207	0.250	0.230	0.101	0.101	0.231	0.253	ND	0.172
MO-6807	10	0.142	0.111	0.137	0.209	0.221	0.164	0.091	0.140	0.188	0.258	ND	0.169
AR-6974	12	0.308	0.168	0.097	0.059	0.113	0.149	0.325	0.337	0.182	0.152	ND	0.249

AR-6902	13	0.232	0.224	0.167	0.128	0.182	0.187	0.152	0.187	0.141	0.124	ND	0.151
MO-6802	14	0.399	0.211	0.290	0.179	0.266	0.269	0.001	0.103	0.266	0.205	ND	0.144
AR-6905	15	0.217	0.198	0.130	0.151	0.250	0.189	0.139	0.252	0.179	0.209	ND	0.195
OK-7049	16	0.239	0.171	0.220	0.222	0.321	0.235	0.078	0.096	0.044	0.117	ND	0.084
MO-6741	17	0.274	0.211	0.220	0.163	0.301	0.234	0.164	0.260	0.274	0.429	ND	0.281
AR-6925	19	0.408	0.406	0.344	0.419	0.409	0.397	0.141	0.161	0.271	0.281	ND	0.214
MO-6838	21	0.241	0.193	0.092	0.197	0.274	0.200	0.056	0.059	0.110	0.154	ND	0.095
MO-6704	22	0.082	0.111	0.078	0.056	0.033	0.072	0.061	0.102	0.119	0.107	ND	0.098
AR-6935	24	0.188	0.110	0.087	0.076	0.202	0.132	0.121	0.104	0.052	0.084	ND	0.091
OK-7039	25	0.180	0.200	0.140	0.118	0.220	0.172	0.090	0.145	0.157	0.191	ND	0.146
OZ-70	26	0.309	0.138	0.190	0.069	0.132	0.168	0.119	0.135	0.055	0.103	ND	0.103
Rountree	28	0.351	0.452	0.350	0.196	0.339	0.338	0.088	0.123	0.140	0.144	ND	0.124
OK-7007	29	0.162	0.030	0.064	0.087	0.108	0.090	0.145	0.121	0.154	0.168	ND	0.147
Average	----	0.238	0.210	0.182	0.158	0.230	0.203	0.124	0.154	0.169	0.178	ND	0.156
Minimum	----	0.082	0.030	0.064	0.056	0.033	0.072	0.001	0.059	0.052	0.084	ND	0.084
Maximum	----	0.408	0.452	0.350	0.419	0.458	0.397	0.325	0.337	0.304	0.429	ND	0.279

ANOVA mean sums of squares and probability of significant differences for forage quantity and quality shade tolerance index values for boot-stage forage in 2005 and 2006.

Component	df	2005 MS	Probability	2006 MS	Probability
Block (B)	2	0.01761	----	0.00054	----
Light (L)	4	0.06955	0.0015	0.03800	0.0120
Error A = B x L	8	0.00544	----	0.00419	----
Accessions (A)	20	0.09018	<0.0001	0.03736	<0.0001
A x L	80	0.00813	0.0799	0.00840	<0.0001
Error B	200	0.00631	----	0.00382	----

2005 and 2006 Light LS means standard error = 0.0100 and 0.0083, respectively.
2005 and 2006 Accession LS means standard error = 0.0205 and 0.0178, respectively.
2005 and 2006 Interaction LS means standard error = 0.0459 and 0.0357, respectively.

Summary of significant observations:

-- Plants grown in the white plastic pots in the full sun treatment did not show evidence of a 'zone of death' along one side of root plug when plants were removed in spring 2007 which had been problematic with black plastic pots in previous screening trials.

-- Accession 26 (OZ-70) was the most difficult accession to establish in pots. It required two harvests from the PMC stock plants to obtain the necessary 50 potted plants for this study. As a result, it started with the smallest plants and that is potentially the reason for its poor performance. OZ-70, initiated from seeds collected in a crossing plot with 70 of the best performing accessions from a three-state area, is probably not a single clone as are 'Rountree' and the other accessions.

-- Interpretation of plant responses to increasing shading needs to recognize that although shade cloth reduces incoming solar radiation, it does not alter the ratio of red/far-red light as does 'green' shade from tree canopies. Black shade cloth is used because it produces a uniform reduction in incoming solar radiation unlike tree canopies. Lack of statistical differences for most variables between the plants in the sunfleck treatment (22 percent of full sun) and under 80% shade cloth indicate big bluestem did not respond to sunflecks in the same way as many tropical plants.

-- Ergot was observed on 17 plants in 2006 on eleven different accessions with nearly half the occurrences in the sunfleck treatment.

-- The forage quality values for the accessions that have the earliest boot-stage harvest dates in 2005 may actually reflect forage quality values of plants harvested in late boot-stage and flower emergence because at time of the first harvest, 43%, 36%, 63%, 54%, and 58% of the plants in the sunfleck and 20%, 45%, 70%, and full sun treatments, respectively, had already reached boot-stage. DOY for boot-stage harvest was the only variable in 2005 that did not appear normally distributed.

-- Day of year (DOY) for boot-stage harvest in 2006 is also not normally distributed because of the date assigned to all plants that were still vegetative (development score = 1.9) going into the fall. The percentage of plants still vegetative on Day 255 were 21%, 21%, 12%, 13%, and 16% in the sunfleck and 20%, 45%, 70%, and full sun treatments, respectively. Because most of these plants did not produce new harvestable tillers, the post-killing harvest in 2006 has a bimodal distribution.

-- Accession 7 (AR-6896) had statistically more plants in 2005 that failed to develop flowering culms than any other accession, especially at the lower light levels. In 2006, half the plants of Accession 7 remained vegetative followed by Accession 19 with 33% and Accession 4 (MO-6832), 25 (OK-7039), and 29 (OK-7007) with 25 to 30% and remaining accessions less than 10 percent. Because Accession 7 repeatedly had a high percentage of plants that remain vegetative under low light and ranked either third or fourth for optimization of 2005 forage quantity and quality, it has excellent potential for use in silvopasture practices.

-- Accession 16 (OK-7049), a potential release as 'Skyblue', had values in the top half in 2005 for both measures optimizing forage quantity and quality.

-- Both variables calculated to identify accessions with optimal forage quantity and quality (digestible nutrient production (g/pot) and the shade tolerance index (product of percentile ranks for boot-stage forage (g/pot) and percent total digestible nutrients (TDN)) generally identified the same accessions in the top third. In 2005, accessions 7, 14, 19, and 28 were in the top four accessions followed by accessions 16, 17, and 21. Of these accessions, accessions 14, 16, 19, and 28 were in the top third for yield per plant of digestible nutrients in 2006 and accessions 14, 17, and 19 were in the top third for the shade tolerance index. Results suggest accessions 14, 16, 19, and possibly 28 ('Rountree') do well in both high and low stress environments that include shade and are suitable candidates for inclusion in a crossing block for breeding shade-tolerance into big bluestem.

Acknowledgments

The authors are deeply indebted to the Horticulture and Agroforestry Research Center staff for assisting in the annual putting up and taking down of the shade structures. Special thanks to Ray Glendening for designing and overseeing construction and operation of the irrigation system. Likewise we were thankful for the help from Dennis Priest, a forestry technician with the USDA Forest Service, for the many hours he spent harvesting plants and keyboarding data into spreadsheets on which we depended for statistical analyses. This study would not have been done without the assistance of Jerry Kaiser, Plant Materials Specialist, and Ron Cordsiemon, Plant Materials Center Manager, at the USDA Natural Resource Conservation Service Plant Materials Center in Elsberry with providing requested plant materials and initial propagation of some accessions. We also need to acknowledge the financial support from the University of Missouri Center for Agroforestry through a grant from the USDA Agriculture Research Service and from the USDA Natural Resource Conservation Service for the chemical analyses of the forage samples.

This study is discontinued and no other data or conclusions will be presented.

In-field Weathering Effects on Biomass Yield and Biofuel Quality of Warm Season Grasses

Study No. MOPMC-T-0716-BF

National Project(s): Biomass/Biofuel 1.1

Study Leaders: Ron L. Cordsiemon, Joel Douglas

Introduction: Dedicated energy crops grown for direct combustion or gasification to generate electricity; ethanol production for transportation fuel; or thermochemical conversion into other by products, require different biofuel quality (McLaughlin et al., 1996). For direct combustion or gasification, biofuel quality needs to have low concentration of alkali metals, especially potassium, low levels of total ash-forming materials, and higher calcium content to mitigate slagging and fouling of conventional boilers (Baxter et al., 1998, Miles et al., 1996). Conversely, for ethanol fermentation and thermochemical conversion by gasification, the biofuel quality must have low moisture, nitrogen, and ash content and a high concentration of lignocellulose in the biomass (McKendry, 2002).

Time and frequency of harvest play a major role in biofuel quality. Nitrogen and ash content of 'Alamo' switchgrass (Panicum virgatum L.), 'Highlander' eastern gamagrass (Tripsacum dactyloides [L.] L.) and caucasian bluestem (Bothriochloa baldhii [Retz.] S.T. Blake) were reduced in a single fall harvest regime compared to a two harvest regime, which consisted of an early summer and early fall harvest in Mississippi (Grabowski et al., 2004). Deferring native grass species for two years in Canada produced the greatest biomass yield with highest cellulosic content for ethanol production as compared to three and four year deferral period, which seem to favor livestock forage for beef cattle (Jefferson et al., 1999). Exposing standing biomass to natural field weathering has shown to be advantageous for achieving biofuel quality. Delaying switchgrass harvest from the fall to spring in Pennsylvania reduced moisture and mineral content to a level suitable for all biofuel conversion systems (Alder et al., 2006). However, these authors reported lower yields due to loss of leaves and panicles during the winter months, and difficulty during the harvesting operations because of the brittleness of the biomass and lodging from snowfall. In contrast, Boe and Lee (2005) found little to no difference in biomass yield in the northern Great Plains from fall to spring, but clipping height was adjusted from 10 cm in the fall to near ground level in the spring, resulting in higher yields due to heavier stems near the base of the plant.

There is limited information available on biofuel quality and biomass yield of warm season grasses in relation to effects of weathering in the field throughout the winter.

Objective: Cultivars/selections of warm season grasses will be compared in replicated plots to evaluate the effects of fall, winter and early spring harvest on dry matter production and biofuel quality.

Procedure: Randomized split plot design with four replications.

Species/cultivars or selections (see list below) from appropriate sources will be planted by seed or propagules (*miscanthus*) into plots containing seven rows with 36" spacing and 20 feet long. Interior five rows will be clipped for biomass and grab samples will be taken for fuel quality estimates. Outside rows will be border rows. Plots will be planted April/May 2007. Irrigation will be applied as needed during the establishment year only. Timing and rate of fertilizer amendments will be determined at a later date.

Species/cultivars to be tested	Seeding rate(seeds/row ft--#/ac
'Cave-in-rock' switchgrass	50 PLS/row ft - 2.80#PLS/ac
'Kanlow' switchgrass	50 PLS/row ft - 2.80#PLS/ac
'Rumsey' Indiangrass	50 PLS/row ft - 4.16#PLS/ac
9083274 big bluestem (MOPMC)	50 PLS/row ft - 5.03#PLS/ac
'Alamo' switchgrass	50 PLS/row ft - 2.8#PLS/ac
Miscanthus (sterile)	3 ft spacing within and between rows

Supporting evaluations

Stems or plants per row foot at end of first growing season

Harvest Treatments

A 14' 6" swath will be clipped from the center of each plot beginning at seed maturity (2008-2010) and every six weeks until spring (2009-2011).

Harvest Dates (approximate)
September 15
November 1
December 15
February 1
March 15

Biomass production and biofuel quality of N, lignin, ADF, NDF, ash (total) caloric value, Ca, Mg, S, P, K and gross energy will be determined at each harvest date.

This study is being replicated at four locations, Elsberry, Missouri; Knox City, Texas; Temple, Texas and Starkville, Mississippi.

Potential Products: Information Technology

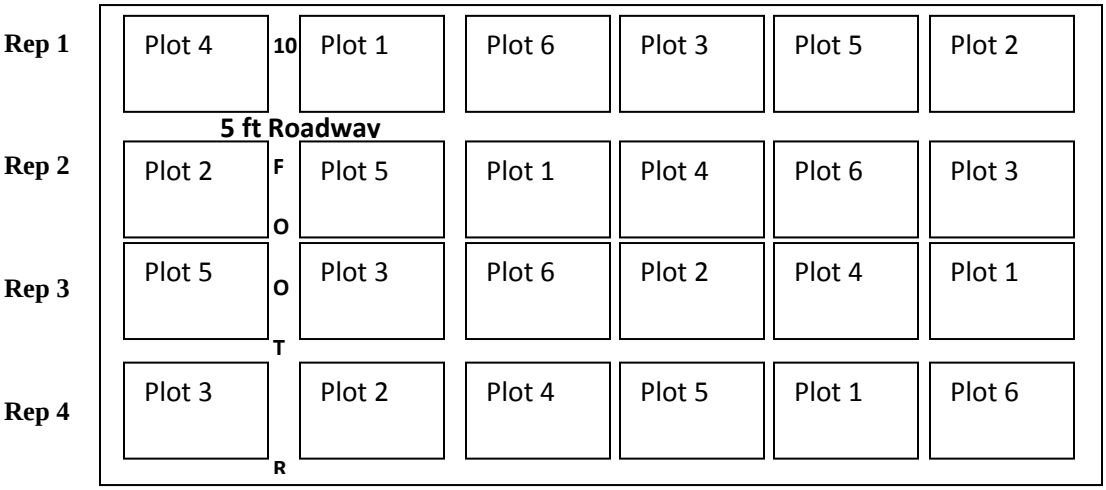
Progress or Status:

2007

The study site was fallowed in 2006 using roundup and tillage. The site was then tilled and rolled in 2007 prior to establishment of the plots April 19, 2007. Preemergant chemical weed control was used after planting using atrazine on the switchgrass, plateau on the big bluestem and Indiangrass, and prowl on the miscanthus. The study was planted using a randomized split plot design with four replications. (See table #1.) The switchgrass plots encountered herbicide damage and were replanted June 4, 2007. During establishment, the plots were irrigated, weeded, and roto-tilled as needed. The plots were evaluated for first year establishment, stem counts, and a visual rating of percent stand. (See table #2.) Any segments of a row missing plants will be filled in with live plants the spring of 2008 to ensure all rows being complete.

Plot Layout MOPMC-T-0716-BF **Table #1**

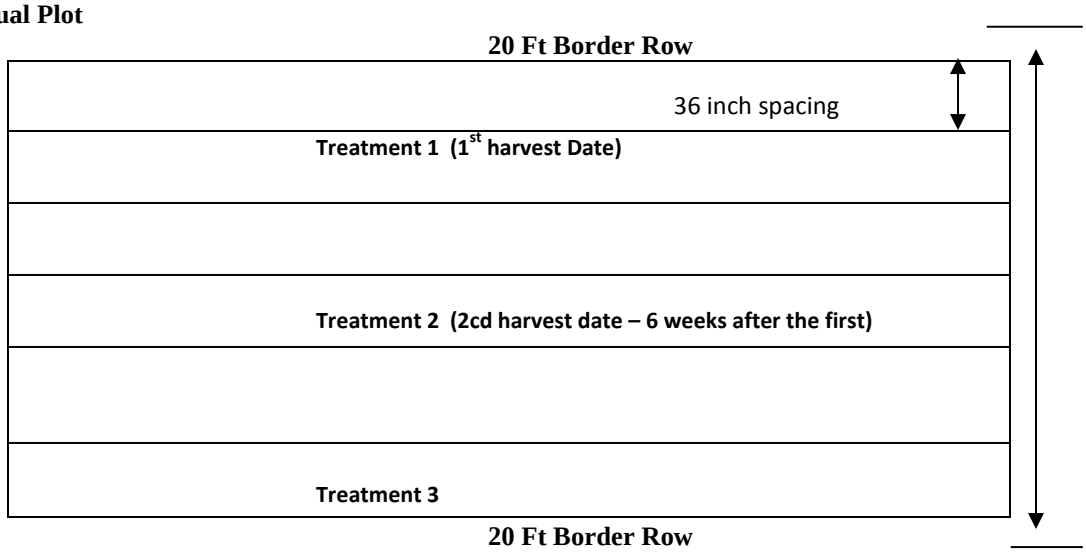
North



Plot #

1	'Cave-In-Rock'	Switchgrass	4		Miscanthus
2	9083274	Big bluestem	5	'Kanlow'	Switchgrass
3	'Alamo'	Switchgrass	6	'Rumsey'	Indiangrass

Individual Plot



Discussion

2008

The plots established very well in 2007. During 2008 the plots were first burned, rototilled between the rows, and 100# actual N (nitrogen) applied as urea and incorporated. Greenhouse grown plugs were planted into any open space of about 4 inches or more within the row, very few plants were necessary. The plots also received chemical weed control.

The plots were harvested one row at a time (1/1000 acre) and evaluated for lodging, and biomass production. (See Table #3) Rows were harvested randomly with row one being harvested at anthesis (at least 50% of seed mature). Row 2 was harvested six weeks after row 1 and that sequence maintained through row 5.

2009
The plots were harvested and evaluated again in 2009 as they were in 2008. All plots received 50# actual N (nitrogen) in May. Biomass production is located in table #4 and element contents are in tables #5-10.

2010
The plots were harvested and evaluated in 2010 as they were in 2008 and 2009. All plots received 50#/acre actual nitrogen (N) in April. Data for all years will be compiled for a final report.

2011-2012-2013
No new data was collected for this study. Data may be compiled in a separate report at a later date. This study is discontinued and no other data or conclusions will be presented.

MOPMC-T-0716 **Table #2**
Biofuel Study **Establishment Evaluation** **11/19/2007**

Cave-in-Rock switchgrass Stm ct		**Rep #1**	**Rep#2**	**Rep#3**	**Rep #4**	**Ave**
(Stems per row foot)	**row #2**	67	34	63	72	59
	row #3	48	55	61	65	57.25
	row #4	47	72	59	63	60.25
	row #5	66	93	71	51	70.25
	row #6	49	46	76	53	56

Cave-in-Rock switchgrass % Std		**Rep #1**	**Rep#2**	**Rep#3**	**Rep #4**	**Ave**
	row #2	100	85	92	95	93
	row #3	96	100	99	85	95
	row #4	95	100	100	95	97.5
	row #5	98	100	97	95	97.5
	row #6	99	100	95	80	93.5

Alamo switchgrass Stm ct		**Rep #1**	**Rep#2**	**Rep#3**	**Rep #4**	**Ave**
(Stems per row foot)	**row #2**	88	99	106	120	103.25
	row #3	65	58	105	104	83
	row #4	167	118	121	88	123.5
	row #5	103	64	106	61	83.5
	row #6	118	85	98	114	103.75

Alamo switchgrass % Std		**Rep #1**	**Rep#2**	**Rep#3**	**Rep #4**	**Ave**
	row #2	100	100	100	100	100
	row #3	100	100	100	100	100
	row #4	100	100	100	100	100
	row #5	100	100	100	95	98.75
	row #6	100	100	100	100	100

Kanlow switchgrass Stm ct		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
(Stems per row foot)	**row #2**	91	80	77	88	84
	row #3	81	39	42	42	51
	row #4	95	19	48	78	60
	row #5	63	48	111	85	76.75
	row #6	67	77	64	61	67.25

Kanlow switchgrass % Std		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
	row #2	100	95	99	100	98.5
	row #3	100	100	97	95	98
	row #4	100	100	99	100	99.75
	row #5	100	100	100	95	98.75
	row #6	98	100	98	95	97.75

Rumsey Indiangrass Stm ct	**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**

(Stems per row foot)	**row #2**	83	129	98	95	101.25
	row #3	85	81	84	106	89
	row #4	107	72	116	76	92.75
	row #5	66	79	85	94	81
	row #6	76	82	124	73	88.75
Rumsey Indiangrass % Std		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
	row #2	100	100	100	100	100
	row #3	96	100	100	100	99
	row #4	100	100	100	95	98.75
	row #5	100	100	96	100	99
	row #6	100	100	100	100	100
Big Bluestem Stm ct		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
(Stems per row foot)	**row #2**	21	22	23	19	21.25
	row #3	14	12	18	18	15.5
	row #4	18	7	31	24	20
	row #5	24	20	27	33	26
	row #6	19	13	25	22	19.75
Big Bluestem % Std		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
	row #2	96	80	95	75	86.5
	row #3	92	70	98	65	81.25
	row #4	90	60	93	90	83.25
	row #5	97	100	94	85	94
	row #6	98	30	98	90	79
Miscanthus Stm ct		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
(Stems per Plant)	**row #2**	6	40	18	30	23.5
	row #3	5	28	12	20	16.25
	row #4	18	26	19	19	20.5
	row #5	43	25	34	23	31.25
	row #6	30	26	25	45	31.5
Miscanthus % Std		**Rep #1**	**Rep #2**	**Rep #3**	**Rep #4**	
	row #2	100	100	30	100	82.5
	row #3	100	100	20	100	80
	row #4	100	100	19	80	74.75
	row #5	80	100	23	40	60.75
	row #6	100	100	45	100	86.25

2008/09 Averages for Lodging and Biomass Quantity Table #3

	Lodging at Harvest 1=No Lodging 5=Extreme Lodging						Yield (Pounds/Acre)					
	Seed Maturity Cutting	2nd Cutting	3rd Cutting	4th Cutting	5th Cutting	Ave.	Seed Maturity Cutting	2nd Cutting	3rd Cutting	4th Cutting	5th Cutting	Ave.
Cave-In-Rock Switchgrass	1.3	1.3	1.4	1.5	1.5	1.4	9,944	10,177	11,628	6,749	6,880	9076
Big Bluestem 9083274 (Epic)	2.0	2.0	2.8	3.6	3.8	2.8	11,118	12,264	10,802	7,788	8,698	10134
Alamo Switch	3.7	2.8	1.9	2.0	1.5	2.4	15,894	15,818	12,944	12,879	12,514	14010
'Freedom' Miscanthus	1.3	1.0	1.1	1.0	1.0	1.1	21,630	24,388	23,619	29,011	24,515	24633
Kanlow Switch	2.3	2.3	3.4	2.1	1.6	2.3	15,835	15,124	15,869	12,182	12,624	14327
Rumsey Indiangrass	4.3	4.3	4.3	4.3	4.4	4.3	13,150	12,811	13,528	10,097	11,192	12156

2009/10 Averages for Lodging and Biomass Quantity Table #4

	Lodging at Harvest 1=No Lodging 5=Extreme Lodging						Yield (Pounds/Acre)					
	Seed Maturity Cutting	2nd Cutting	3rd Cutting	4th Cutting	5th Cutting	Ave.	Seed Maturity Cutting	2nd Cutting	3rd Cutting	4th Cutting	5th Cutting	Ave.
Cave-In-Rock Switchgrass	3.5	2.6	3.4	3.5	3.1	3.22	9,219	9,329	9,717	9,238	8,543	9,209
Big Bluestem 9083274 (Epic)	1.5	1.8	3.8	4.1	4	3.04	9,951	10,994	10,553	6,997	8,245	9,348
Alamo Switch	1.6	1.9	2.5	2.4	2.6	2.20	12,605	12,810	11,967	11,873	11,560	12,163
'Freedom' Miscanthus	1.1	1	1	1	1.1	1.04	22,756	27,880	18,434	25,780	23,271	23,624
Kanlow Switch	2.5	2.9	4	3.8	3.1	3.26	11,694	11,950	14,123	10,277	12,492	12,107
Rumsey Indiangrass	3.1	3.6	3.5	4.3	3.5	3.60	11,048	12,269	11,157	10,084	9,925	12,107

LSD All - Pairwise Comparison Tests for Harvest Date **Table #5**

Test of: adf

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	30-Mar	55.639	A
	5-Jan	54.524	A
	17-Feb	53.855	AB
	26-Nov	52.301	AB
	14-Oct	50.681	B
Big bluestem	24-Mar	57.072	A
	9-Feb	56.761	A
	30-Dec	55.467	A
	18-Nov	54.292	A
	6-Oct	49.376	B
Cave-in-Rock switchgrass	24-Feb	59.652	A
	12-Jan	58.556	A
	2-Dec	55.607	B
	21-Oct	48.528	C
	10-Sep	44.29	D
Indiangrass	9-Feb	56.689	A
	30-Dec	56.229	A
	24-Mar	55.669	A
	18-Nov	54.120	A
	6-Oct	49.779	B
Kanlow - switchgrass	26-Jan	55.301	A
	5-Nov	53.16	B
	17-Dec	52.87	B
	1-Oct	48.39	C
Miscanthus	30-Mar	64.703	A
	5-Jan	63.888	A
	17-Feb	63.678	AB
	26-Nov	60.49	B
	14-Oct	53.456	C

LSD All - Pairwise Comparison Tests for Harvest Date **Table #6**

Test of: ash

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	26-Nov	4.9827	A
	14-Oct	4.9414	A
	5-Jan	4.1785	AB
	17-Feb	3.6878	B
	30-Mar	3.2326	B
Big bluestem	6-Oct	4.7315	A
	18-Nov	3.8060	B
	30-Dec	3.7489	BC
	9-Feb	3.3331	BC
	24-Mar	2.8810	C
Cave-in-Rock switchgrass	10-Sep	5.1766	A
	21-Oct	4.9133	A
	2-Dec	3.7896	B
	24-Feb	3.1248	C
	12-Jan	2.8344	C
Indiangrass	6-Oct	7.1609	A
	18-Nov	6.8226	AB
	30-Dec	5.7877	BC
	24-Mar	5.494	C
	9-Feb	3.356	D
Kanlow - switchgrass	1-Oct	4.3667	A
	5-Nov	3.72	AB
	17-Dec	3.4192	AB
	26-Jan	3.164	B
Miscanthus	14-Oct	3.9713	A
	26-Nov	3.8251	A
	5-Jan	2.2902	A
	17-Feb	1.9681	A
	30-Mar	1.8321	B

LSD All - Pairwise Comparison Tests for Harvest Date **Table #7**

Test of: ndf

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	30-Mar	86.931	A
	17-Feb	85.749	A
	5-Jan	85.589	A
	26-Nov	81.657	B
	14-Oct	81.101	B
Big bluestem	24-Mar	86.276	A
	9-Feb	85.797	A
	30-Dec	84.199	A
	18-Nov	83.899	A
	6-Oct	78.742	B
Cave-in-Rock switchgrass	24-Feb	88.06	A
	12-Jan	87.918	A
	2-Dec	85.728	A
	21-Oct	77.782	B
	10-Sep	74.832	B
Indiangrass	9-Feb	87.248	A
	24-Mar	84.509	AB
	30-Dec	84.16	B
	18-Nov	82.592	B
	6-Oct	78.213	B
Kanlow - switchgrass	26-Jan	86.61	A
	17-Dec	85.431	A
	5-Nov	85.158	A
	1-Oct	80.313	B
Miscanthus	30-Mar	89.191	A
	17-Feb	88.551	A
	5-Jan	88.317	A
	26-Nov	87.394	A
	14-Oct	81.009	B

LSD All - Pairwise Comparison Tests for Harvest Date **Table #8**

Test of: p

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	14-Oct	0.1075	A
	26-Nov	0.0750	B
	5-Jan	0.0450	C
	17-Feb	0.0425	C
	30-Mar	0.0425	C
Big bluestem	6-Oct	0.0746	A
	9-Feb	0.0475	B
	30-Dec	0.0417	BC
	24-Mar	0.0400	BC
	18-Nov	0.0275	C
Cave-in-Rock switchgrass	10-Sep	0.1275	A
	21-Oct	0.0975	B
	2-Dec	0.0675	C
	24-Feb	0.0575	C
	12-Jan	0.0575	C
Indiangrass	6-Oct	0.0825	A
	18-Nov	0.0550	AB
	9-Feb	0.0550	AB
	24-Mar	0.0450	B
	30-Dec	0.0400	B
Kanlow - switchgrass	1-Oct	3.3446	A
	5-Nov	1.7496	B
	17-Dec	1.6349	B
	26-Jan	1.2268	B
Miscanthus	14-Oct	0.0825	A
	26-Nov	0.07	AB
	30-Mar	0.0425	ABC
	17-Feb	0.035	BC
	5-Jan	0.02254	C

LSD All - Pairwise Comparison Tests for Harvest Date **Table #9**

Test of: k

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	14-Oct	0.755	A
	26-Nov	0.2650	B
	5-Jan	0.1250	BC
	30-Mar	0.1175	BC
	17-Feb	0.0725	C
Big bluestem	6-Oct	0.6775	A
	18-Nov	0.4325	AB
	9-Feb	0.32	B
	24-Mar	0.275	B
	18-Nov	0.2179	B
Cave-in-Rock switchgrass	10-Sep	0.5800	A
	21-Oct	0.2525	B
	2-Dec	0.1500	C
	24-Feb	0.0800	CD
	12-Jan	0.0450	D
Indiangrass	6-Oct	0.6575	A
	18-Nov	0.4225	AB
	24-Mar	0.2375	BC
	9-Feb	0.1400	BC
	30-Dec	0.1275	C
Kanlow - switchgrass	1-Oct	0.6425	A
	5-Nov	0.1825	B
	17-Dec	0.0975	B
	26-Jan	0.0375	B
Miscanthus	14-Oct	0.5750	A
	26-Nov	0.2550	B
	30-Mar	0.1275	C
	17-Feb	0.1275	C
	5-Jan	0.0500	C

LSD All - Pairwise Comparison Tests for Harvest Date **Table #10**

Test of: s

Common Name	Harvest Date	Mean	Homogeneous Groups
Alamo	14-Oct	0.0400	A
	26-Nov	0.0150	B
	17-Feb	0.0100	B
	30-Mar	0.0100	B
	5-Jan	0.0100	B
Big bluestem	6-Oct	0.0200	A
	9-Feb	0.0150	AB
	18-Nov	0.0100	B
	24-Mar	0.0100	B
	30-Dec	0.0088	B
Cave-in-Rock switchgrass	10-Sep	0.0300	A
	21-Oct	0.0225	AB
	2-Dec	0.0150	BC
	12-Jan	0.0125	C
	24-Feb	0.0100	C
Indiangrass	18-Nov	0.0125	A
	9-Feb	0.0125	A
	24-Mar	0.0100	A
	30-Dec	0.0100	A
	6-Oct	0.0100	A
Kanlow - switchgrass	1-Oct	0.0275	A
	26-Jan	0.0175	AB
	17-Dec	0.0150	AB
	5-Nov	0.0100	B
Miscanthus	14-Oct	0.0175	A
	26-Nov	0.0175	A
	17-Feb	0.0100	A
	30-Mar	0.0100	A
	5-Jan	0.0100	A

Evaluation and Release of a Shade Tolerant Little Bluestem for Silvopasture

Study No. MOPMC-P-0717-PA, WL

National Project(s): Forestland 1.1

Study Leader: Doug Wallace, Jerry Van Sambeek, G. Garrett

Introduction: Little bluestem is one of the most widely distributed native grasses in North America. It will grow on a wide variety of soils but is very well adapted to well-drained, medium to dry, infertile soils. The plant has excellent drought and fair shade tolerance, and fair to poor flood tolerance. Little bluestem is considered less valuable for grazing due to its tussock growth form and perceived lower forage quality. In Missouri, it is often found growing as an understory plant in open woodlands, savannas, and transitional forested areas.

The Elsberry PMC initiated a little bluestem collection from the Ozark region (Missouri, Arkansas, and Oklahoma) in 1996 to develop an improved little bluestem that would be better adapted to this region. The collection effort resulted in an assembly of 130 little bluestem accessions.

There is limited information available on species selected for forage to be primarily used for savannas and silvopasture systems throughout Missouri.

Objective: An existing PMC little bluestem collection displays an amazing range of morphological and phonological characteristics – color, plant height, blade width, stem erectness, rust resistance, spring emergence, anthesis, etc. This collection has never been evaluated for shade attributes that might be valuable in silvopasture systems or with savanna restoration efforts. This study will select and evaluate for forage production in relation to shade tolerance.

Procedure: A randomized complete block design with three replications, five shade levels: full sun, 30% shade, 55% shade, 55% shade with sunflecks, and 80% shade will be used for the study.

Twenty-eight accessions of little bluestem are selected based on original collection site descriptions that indicated collections were associated with woodland conditions. These collections came from previous work (Study 29I141G) at the Elsberry PMC and will be assembled in 2008 at the University of Missouri Agroforestry Center (HARC). Additional varieties being evaluated are the little bluestem Northern region assembly and the bluestem Southern region assembly. Plants will be started in the greenhouse and planted in replicated plots the spring 2008.

Forty-five pots for each accession will be randomized within each treatment. Above ground dry weight, leaf weight, and forage quality (acid detergent fiber, neutral detergent fiber, crude protein) will be collected for each accession.**Potential Products:** Information Technology, Cultivar Release

Progress or Status:

2007
Collection reports from PMC study 29I141G were reviewed and 28 accessions were selected based on woodland site descriptions (Table #1). Two selections under evaluation at the PMC and two established cultivars will also be included.

2010
Doug Wallace, study leader, took a different position within NRCS, therefore no data has been reported for this study in the last two years. Data has been collected and the Elsberry PMC personnel are working with Jerry Van Sambeek, Forest Service, to compile the data.

2011-2012-2013
This study is finished and no additional data or conclusions are expected. The HARC area has been closed by the University of Missouri. This study is discontinued and no other data or conclusions will be presented.

Study MOPMC-P-0717-PA, WL				**Table #1**
PMC Accessions Selected For Shade Tolerance Evaluation				
		Location Description		
Accn No.	**State Code**	**Soil Type**	**County**	**Site**
9078847	IA-1	Gara	Clarke	Woods Edge (WE)
9078848	IA-2	Gara	Clarke	WE
9078850	IA-4	Monona	Woodbury	WE
9078852	IA-6	Hamburg	W. Pottawattamie	Woods (W)
9078858	IA-12	Haydon	Dallas	Open Woods (OW)
9078961	IA-27	Cresco	Scott	OW
9078873	IL-1	Rodman	Kane	W
9078875	IL-3	Miami Casco	Kane	OW
9078876	IL-4	Rozetta	Pike	WE
9078880	IL-8	Ashbury	Will	Ditch
9078882	IL-10	Hamburg	Henderson	W
9078887	IL-15	Bloomfield	Mason	OW
9078888	IL-16	Ava	Marion	W/G Lode
9078891	IL-19	SOGN	Calhoun	Glade
9078894	MO-1	Winnegan	Chariton	W
9078895	MO-3		Cape	
9078898	MO-6	Keswick	Putnum	OW
9078899	MO-7	Midco	Ripley	OW
9078902	MO-10	Captina	Carter	WE
9078905	MO-13	Clarksville	Butler	W (Row)
9078915	MO-23		Perry	
9078917	MO-25	Gorin	Monroe	OW
9078921	MO-29	Goss	Montgomery	
9078956	MO-64	-	Shannon	Glade
9078959	MO-67	-	Wayne	OW
9078960	MO-68	Keswick	Pike	WE
9083271			Composite Selection (South Region)	
9083317			Composite Selection (North Region)	
421553	'Aldous'	Kansas Flinthills		
421552	'Cimarron'	Eastern Kansas and Oklahoma		

Evaluation of the Flood Tolerance of Planted Oak Seedlings Derived from Different Seed Origins

Study No. MOPMC-T-0718-WE, WL

National Project(s): Critical Area 1.1; Forestland 1.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager; M. Coggshall, University of Missouri

Introduction: Many plant species exhibit wide amplitude in terms of their capacity to occupy a range of positions along a hydrologic gradient. The presence or absence of a particular tree species in a bottomland hardwood forest is primarily dependent upon soil moisture gradients, stream deposition patterns, and flooding season and duration (Hodges, 1997). In the Midwestern U.S., there is considerable interest in restoring native ecosystems on former bottomland sites that are now being devoted to marginal agriculture (Kruse and Groninger, 2003). Oak seedlings are a major component of these restoration efforts.

Little is known about whole tree responses to a variety of flooding treatments for different oak seedlings used in WRP and other wetland programs.

Objective: The specific objectives of the proposed research are: 1) to determine the effect of controlled flooding treatments, including inundation, on the survival and regrowth of planted oak seedlings in the Flood Laboratory located at the NRCS Plant Materials Center (PMC) in Elsberry, Missouri; 2) to contrast these flooding results with additional flood evaluations using planted seedlings in the Flood Tolerance Laboratory (FTL) at the Horticulture and Agroforestry Research Center (HARC) in New Franklin, Missouri; and 3) initiate a potted seedling study as a means to further expand our knowledge base of how plants respond to controlled flooding events.

Procedure: A total of 1,746 test trees were established as 1-0 bare root seedlings in the PMC Flood Laboratory (Field #4) in May 2007. Spacing was 4' x 10'. The entire test planting covers 1.60 acres. A total of seven different oak species were planted including: bur oak (12 seedlots), chinkapin oak (2 seedlots), pin oak (6 seedlots), northern red oak (9 seedlots), shumard oak (8 seedlots), swamp white oak (27 seedlots) and white oak (25 seedlots). Each seedlot contains 18 seedlings which were established in a series of 18 single tree plots. All seedlots planted in the PMC planting were also common to the FTL planting at HARC. The experimental design for this planting is a randomized complete block design with 18 replications. Replication boundaries were defined based on slope position within the Elsberry Flood Laboratory to the extent possible.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2007
Collection of first year seedling survival, height and diameter data in the PMC planting will be made in the winter of 2007/2008. Flooding treatments will coincide with the natural flooding for calendar year 2007 of the Mississippi River, based upon flood stage data from the nearest river gauging station to the Elsberry planting site. Survival data will be collected immediately following the end of the first flooding period and re-growth potential. Flooding will be assessed as a function of shoot growth in the year following. This data will be contrasted with results obtained from the flood treatments that are planned in the HARC FTL**,** which will be initiated following the completion of the first growth, flush in the spring 2008.

2008
In 2008, the PMC staff flooded the evaluation plot from 2 -24 inches. The water was left on the trees for 16 days, beginning the first part of April to mimic the flood stage of the Mississippi River

in 2007 at the Winfield Lock and Dam. Mark Coggeshall and students collected data in late summer.

2009
The wetland cell was saturated for most of the growing season and impossible to maintain. Mr. Coggeshall and his team did not make it to the PMC to do any further evaluations. In 2010, a decision will be made to determine whether to continue with the study or not.

2010
Mr. Coggeshall and his team from the University of Missouri cut the remaining material within the wetland cell and collected data. The PMC is working with Jerry Van Sambeek, Forest Service at the U. of Mo. HARC farm, to organize data collected from the evaluations that took place on the selected oak species. A final report will be organized for this study and documented.

2011-2012-2013
This study is discontinued and no other data or conclusions will be presented.

Evaluation and Release of Native Plants for Urban Landscaping

Study No. MOPMC-P-0820-UR

National Project(s): Urban 1.1 and 2.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Plants for urban landscaping have been an ever increasing market for many years. Recently the use of herbaceous native species is also increasing. This type of vegetation can be used for its aesthetics and also in areas to help control erosion, runoff and improve water quality.

There are few current varieties of little bluestem, big bluestem or broomsedge bluestem on the market that have been specifically selected for landscape purposes. There is demand in the nursery industry for this type of plant material and current collections already in place on the PMC can provide desirable germplasm.

Objective: The objective is to assemble, evaluate, develop and release adapted selections of little bluestem, big bluestem and broomsedge bluestem for landscape use in Missouri, Iowa, and Illinois.

Procedure: Native plants with desirable landscape and/or ornamental characteristics will be assembled and evaluated. Plants will be selected from existing assemblies at the PMC and also collected from native prairie remnants within the service area. Plants selected for evaluation will be collected vegetatively or by seed depending on the species and trait being selected for.

Existing assemblies of big and little bluestem will be evaluated for color, upright growth form, and stability during the dormant season. During the growing season colors may be deep and rich, or abnormally pale. Autumn colors will have reddish tints to leaves and elaborate seedheads.

Selected plants will be vegetatively collected, increased in the greenhouse, and transplanted into increase plots. Plants maintaining desired characteristics when mature will be divided (cloned) and made available to commercial growers as improved native landscape plants.

Seed will be collected of broomsedge bluestem (and other native species that naturally exhibit attractive characteristics for urban landscaping) and placed in the germinator. Selections will be made on quick germination. Selected plants will be placed in an evaluation nursery where undesirable plants will be culled. Remaining plants will remain for seed production to establish an increase field. This selection will be for color and quick establishment. Seed from the increase field will be made available to commercial growers.**Potential Products:** Information Technology, Cultivar Release

Progress or Status:

2008-2009
Plants of big and little bluestem in evaluation plantings at the PMC were visually evaluated for color and form. After going dormant, the plants were dug in the fall of 2008, divided into multiple plants and grown out in the greenhouse. These plants (approximately 700 little bluestem and 300 big bluestem) were put on three foot spacings in a block for each species. After a year establishment period, the better plants will be selected for increase.

Seed of broomsedge bluestem was collected from 17 locations throughout Missouri and placed in the seed germinator. Seed germinating within a seven day period was transplanted into plug flats and transplanted into a crossing block including plants from all locations.

2010
The little bluestem and big bluestem selections were placed in an evaluation nursery, where they were allowed to grow. There are concerns on how to handle this material, since it does not follow the program protocol for a typical release. There is very little data collected in order to make a release. A determination will be made as to whether or not this study will continue in 2011.

The selected broomsedge plants were planted in the fall of 2009, but did not survive the winter. Inferior root development could have been a possibility for poor survival. It has been determined that broomsedge will be discontinued.

2011-2012-2013
This study is discontinued and no other data or conclusions will be presented.

Evaluation and Release of an Iowa Source, stiff stemmed Indiangrass, Sorghastrum nutans, for Biofuel

Study No. MOPMC-P-0821-BF

National Project(s): Biomass/Biofuel 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: The Northern Germplasm, Central Germplasm, and Southern Germplasm production fields of Iowa Ecotype Indiangrass will be evaluated for biofuel potential. This study will develop a new selection of Indiangrass for Iowa that has high biomass production, lodging resistance, and is quick to establish.

Objective: Switchgrass (Panicum virgatum L.) and giant cane (Miscanthus giganticus) are commonly used in the evaluation of herbaceous species for biofuels. Another warm season species that is showing potential is Indiangrass (Sorghastrum nutans). The objective is to develop an Indiangrass that has the potential for use in the biofuel industry.

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2008
In March, 2008, plants were selected out of each zone from the Iowa Ecotype Study. The ecotype zones break the state of Iowa up into 3 separate zones. There is a northern, central, and southern zone. The PMC has production plots of each zone of Indiangrass and from these plots, 3 to 4 plants were selected. They were selected based on their visual robust, tall standing stature and ability not to lodge. These plants were separated into plugs and propagated in the greenhouse. There were 3 plants from the northern zone, 4 plants from the central zone, and 3 plants from the central zone. 40 plugs were started from each plant that was selected. An evaluation planting was established at Forrest Keeling Nursery with 10 plants per replication and 4 replications. The plants were allowed to cross pollinate and an equal amount of seed was taken off each plant. The seed will be used to start seedlings in the germinator and selections will be made based on how quick the seed germinates.

2009
An evaluation block was established using the seedlings that germinated within 7 days of entering the growth chamber. The seedlings were transplanted into conetainers and allowed to establish in the greenhouse and were then planted in the southeast corner of field #7F. There are 224 plants in the evaluation block. The plants will be evaluated individually for basal spread, height at seedhead, height of foliage, 5 random stem counts for diameter, and late winter evaluation for lodging and overall plant rating. Data will be collected at the beginning of spring to determine ratings for plant lodging and the overall plant rating. The plants will be analyzed and selections will be made from the data collected. The 2010 annual technical report will show collection data and selections made for the new crossing block.

2010
In the spring of 2010, the final evaluations were made for lodging and overall plant rating. The data that was collected in 2009 and 2010 was used in an arbitrary formula to weigh out the different plants in the 224 plant plot. Approximately the top 10 percent will be selected for superior growth characteristics. The emphasis of this study was to select an Iowa source Indiangrass with biofuel potential. Due to Agriculture Research Service and the Forest Service having primary responsibility for biomass/biofuel selections, the PMC will evaluate the potential for this selection as a possible benefit to wildlife and/or living snow fence or wind barrier. Selected plants have been isolated in a crossing block and seed should be available next year for a foundation block and field testing. Data collected is found in table #1.

2011-2012-2013

This study was discontinued and no other data or conclusions will be presented. Plant materials for this are archived to be available for potential future use.

Iowa Indiangrass Biofuel Study

11-2-2009 Evaluation

3-8-2010 Evaluation for Lodging and Overall Rating ONLY

1=Best and 5=Poor

	Basal Spread		Height		Stem Diameter Average							
Plant ID #	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Overall Rating	Selection Formula
	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
1009	9	8	85	38	0.249	0.211	0.205	0.229	0.224	0.2236	1	1	306
809	7	9	73	36	0.178	0.192	0.135	0.157	0.168	0.166	1	1	188
405	6	7	80	25	0.225	0.218	0.154	0.223	0.21	0.206	1	1	108
610	7	7	74	27	0.128	0.202	0.1	0.16	0.128	0.1436	1	1	95
1101	7	7	72	22	0.15	0.161	0.191	0.162	0.181	0.169	1	1	91
702	8	8	66	29	0.194	0.222	0.196	0.188	0.232	0.2064	1	3	64
202	9	9	67	28	0.199	0.181	0.116	0.151	0.181	0.1656	1	3	63
1007	7	8	72	26	0.225	0.207	0.231	0.232	0.25	0.229	1	3	56
302	8	9	63	23	0.166	0.222	0.215	0.176	0.192	0.1942	1	3	54
1309	8	7	74	26	0.188	0.189	0.132	0.202	0.184	0.179	3	1	43
1509	8	7	77	26	0.167	0.227	0.099	0.172	0.209	0.1748	3	1	42
109	7	5	75	38	0.175	0.231	0.156	0.177	0.205	0.1888	3	1	42
909	7	8	72	27	0.164	0.15	0.181	0.168	0.167	0.166	3	1	42
806	7	7	68	28	0.114	0.178	0.17	0.214	0.202	0.1756	3	1	40
1107	7	7	69	26	0.189	0.16	0.202	0.193	0.2	0.1888	1	3	40
614	7	6	71	26	0.228	0.199	0.18	0.208	0.199	0.2028	1	3	37
1411	7	7	69	24	0.181	0.131	0.223	0.173	0.198	0.1812	1	3	36
310	7	7	80	25	0.204	0.131	0.159	0.158	0.2	0.1704	3	1	35
410	6	7	74	26	0.198	0.178	0.203	0.159	0.186	0.1848	3	1	34
1105	7	7	64	22	0.199	0.163	0.182	0.201	0.131	0.1752	3	1	31
1514	6	7	60	25	0.198	0.161	0.181	0.219	0.116	0.175	1	3	31
1111	6	6	79	28	0.232	0.113	0.142	0.204	0.196	0.1774	1	3	30

											1=Best and 5=Poor		
	Basal Spread		Height		Stem Diameter Average							Overall	
	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
Plant ID #	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
209	7	6	73	26	0.118	0.189	0.208	0.143	0.141	0.1598	1	3	29
902	7	7	63	21	0.176	0.138	0.162	0.218	0.132	0.1652	1	3	28
1102	6	7	67	22	0.182	0.167	0.196	0.173	0.173	0.1782	1	3	27
808	6	7	66	21	0.161	0.195	0.171	0.203	0.2	0.186	3	1	27
1014	7	7	72	22	0.208	0.116	0.124	0.135	0.153	0.1472	1	3	26
1609	7	7	64	22	0.102	0.164	0.149	0.153	0.139	0.1414	3	1	25
912	5	6	75	31	0.132	0.082	0.203	0.199	0.131	0.1494	1	3	23
409	6	6	72	23	0.181	0.175	0.157	0.154	0.161	0.1656	1	3	23
1304	8	7	65	17	0.174	0.092	0.166	0.12	0.148	0.14	1	3	22
1314	5	5	64	25	0.197	0.149	0.097	0.153	0.202	0.1596	1	3	17
501	6	6	59	18	0.163	0.166	0.164	0.157	0.104	0.1508	1	3	16
203	7	5	62	19	0.126	0.146	0.166	0.138	0.156	0.1464	1	3	16
505	8	8	68	25	0.202	0.232	0.165	0.168	0.118	0.177	3	3	16
1607	7	7	72	27	0.254	0.145	0.213	0.166	0.227	0.201	3	3	15
714	7	7	71	24	0.225	0.156	0.212	0.232	0.225	0.21	3	3	14
1613	7	7	62	19	0.187	0.148	0.132	0.112	0.157	0.1472	1	5	14
914	7	8	59	24	0.207	0.177	0.163	0.208	0.147	0.1804	3	3	13
901	6	7	72	28	0.19	0.2	0.23	0.182	0.206	0.2016	3	3	13
1311	7	6	71	32	0.206	0.187	0.135	0.146	0.195	0.1738	3	3	13
807	7	6	69	25	0.198	0.227	0.214	0.218	0.243	0.22	3	3	13
512	6	5	67	25	0.204	0.153	0.216	0.15	0.126	0.1698	1	5	13
1114	6	6	59	21	0.189	0.144	0.168	0.145	0.19	0.1672	1	5	13
1401	7	7	69	25	0.126	0.185	0.204	0.172	0.23	0.1834	3	3	12
1512	7	7	77	24	0.227	0.172	0.16	0.197	0.196	0.1904	3	3	12
709	7	8	68	24	0.195	0.193	0.119	0.156	0.169	0.1664	3	3	12
814	6	6	60	18	0.236	0.132	0.215	0.153	0.216	0.1904	1	5	12
1209	7	7	73	22	0.201	0.172	0.208	0.205	0.211	0.1994	3	3	12
805	7	6	75	26	0.209	0.189	0.169	0.181	0.194	0.1884	3	3	11
908	7	7	66	21	0.182	0.153	0.23	0.215	0.219	0.1998	3	3	11

											1=Best and 5=Poor		
	Basal Spread		Height		Stem Diameter Average							Overall	
	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
Plant ID #	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
1508	7	6	70	24	0.194	0.227	0.161	0.221	0.213	0.2032	3	3	11
1513	7	7	61	22	0.218	0.178	0.19	0.167	0.196	0.1898	3	3	11
1409	8	7	65	21	0.136	0.116	0.164	0.19	0.248	0.1708	3	3	11
1412	6	6	64	24	0.255	0.188	0.247	0.245	0.222	0.2314	3	3	11
1611	7	7	61	24	0.112	0.191	0.2	0.169	0.162	0.1668	3	3	11
802	9	8	61	22	0.157	0.19	0.21	0.225	0.249	0.2062	3	5	11
813	6	6	64	20	0.171	0.149	0.076	0.18	0.18	0.1512	1	5	11
601	5	5	55	18	0.16	0.177	0.12	0.106	0.146	0.1418	1	3	11
1511	7	7	74	24	0.142	0.156	0.169	0.184	0.161	0.1624	3	3	11
604	7	7	54	25	0.124	0.178	0.139	0.165	0.168	0.1548	3	3	11
102	6	6	67	28	0.18	0.23	0.171	0.202	0.156	0.1878	3	3	11
211	7	8	66	24	0.158	0.16	0.207	0.096	0.081	0.1404	3	3	10
1105	6	7	72	24	0.166	0.177	0.133	0.226	0.221	0.1846	3	3	10
707	6	6	59	25	0.191	0.214	0.196	0.208	0.219	0.2056	3	3	10
210	7	6	67	25	0.18	0.168	0.145	0.198	0.183	0.1748	3	3	10
1407	6	6	78	26	0.168	0.205	0.173	0.224	0.19	0.192	3	3	10
1605	6	7	68	19	0.248	0.208	0.144	0.272	0.224	0.2192	3	3	10
306	6	8	79	22	0.188	0.195	0.149	0.158	0.134	0.1648	3	3	10
1207	6	7	64	20	0.187	0.206	0.222	0.168	0.247	0.206	3	3	10
108	7	7	70	21	0.235	0.149	0.092	0.153	0.201	0.166	3	3	9
110	6	7	65	23	0.176	0.195	0.186	0.152	0.167	0.1752	3	3	9
1507	6	7	72	20	0.241	0.191	0.207	0.126	0.239	0.2008	3	3	9
609	6	6	70	25	0.173	0.177	0.178	0.226	0.182	0.1872	3	3	9
1504	8	8	63	19	0.129	0.14	0.159	0.14	0.106	0.1348	3	3	9
811	7	6	62	24	0.106	0.19	0.179	0.172	0.148	0.159	3	3	9
1214	7	6	66	22	0.175	0.183	0.123	0.194	0.184	0.1718	3	3	9
1313	7	6	66	22	0.225	0.129	0.204	0.097	0.2	0.171	3	3	9
1213	6	6	67	23	0.184	0.186	0.198	0.167	0.209	0.1888	3	3	9
907	5	5	66	19	0.197	0.122	0.213	0.205	0.168	0.181	1	5	9

											1=Best and 5=Poor		
	Basal Spread		Height		Stem Diameter Average							Overall	
	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
Plant ID #	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
911	6	6	71	24	0.233	0.212	0.177	0.117	0.129	0.1736	3	3	8
106	5	6	60	18	0.098	0.172	0.192	0.174	0.133	0.1538	1	5	8
1106	6	6	75	23	0.185	0.154	0.19	0.2	0.171	0.18	3	3	8
1003	7	7	60	18	0.2	0.173	0.111	0.142	0.203	0.1658	3	3	8
1510	6	7	70	24	0.154	0.123	0.123	0.149	0.175	0.1448	3	3	8
1109	6	6	63	22	0.207	0.163	0.189	0.169	0.174	0.1804	3	3	8
407	6	6	65	20	0.151	0.232	0.243	0.167	0.17	0.1926	3	3	8
703	7	7	50	21	0.144	0.171	0.128	0.126	0.102	0.1342	3	3	8
504	6	6	72	21	0.188	0.21	0.184	0.167	0.146	0.179	3	3	8
1310	7	7	72	21	0.211	0.226	0.21	0.202	0.231	0.216	3	5	7
301	5	6	66	24	0.237	0.173	0.119	0.196	0.193	0.1836	3	3	7
510	6	6	70	22	0.212	0.204	0.167	0.119	0.111	0.1626	3	3	7
213	6	7	60	24	24	0.178	0.16	0.185	0.189	0.127	3	3	7
112	6	6	66	24	0.157	0.153	0.191	0.15	0.084	0.147	3	3	7
1201	7	6	66	19	0.176	0.174	0.202	0.19	0.047	0.1578	3	3	7
303	6	7	60	23	0.091	0.193	0.085	0.138	0.139	0.1292	3	3	7
708	6	6	63	21	0.152	0.182	0.2	0.133	0.148	0.163	3	3	7
1307	6	7	68	21	0.234	0.241	0.225	0.252	0.141	0.2186	3	5	6
207	5	6	61	24	0.156	0.167	0.186	0.157	0.096	0.1524	3	3	6
1408	6	5	67	18	0.182	0.204	0.151	0.242	0.227	0.2012	3	3	6
1108	6	6	70	24	0.18	0.242	0.182	0.242	0.201	0.2094	3	5	6
1414	5	4	68	23	0.143	0.154	0.129	0.118	0.098	0.1284	1	5	6
905	5	7	68	18	0.167	0.225	0.141	0.161	0.149	0.1686	3	3	6
1608	6	7	71	20	0.206	0.237	0.175	0.164	0.258	0.208	3	5	6
1306	7	6	70	20	0.19	0.234	0.183	0.219	0.202	0.2056	3	5	6
1208	5	6	73	22	0.128	0.15	0.184	0.131	0.175	0.1536	3	3	6
1203	6	7	49	17	0.157	0.133	0.118	0.106	0.19	0.1408	3	3	6
413	6	6	59	18	0.185	0.135	0.129	0.166	0.157	0.1544	3	3	6
1211	6	6	63	26	0.165	0.164	0.171	0.164	0.224	0.1776	3	5	6

												1=Best and 5=Poor		
	Basal Spread		Height		Stem Diameter Average								Overall	
	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average		Lodging	Rating	Selection Formula
Plant ID #	~to the nearest inch~				~to the nearest thousandth of an inch~							1 - 3 - 5 Rating		
1606	5	5	67	23	0.133	0.167	0.191	0.189	0.15	0.166		3	3	5
1010	6	7	66	23	0.21	0.129	0.123	0.184	0.174	0.164		3	5	5
705	5	5	68	23	0.194	0.154	0.157	0.141	0.178	0.1648		3	3	5
304	6	6	63	19	0.157	0.16	0.145	0.127	0.096	0.137		3	3	5
1301	6	7	56	23	0.169	0.158	0.176	0.141	0.163	0.1614		3	5	5
305	6	5	73	20	0.108	0.18	0.169	0.187	0.127	0.1542		3	3	5
1103	7	7	46	16	0.147	0.086	0.091	0.106	0.157	0.1174		3	3	5
1505	6	7	68	17	0.207	0.208	0.241	0.217	0.179	0.2104		3	5	5
1008	5	5	73	24	0.18	0.166	0.125	0.099	0.162	0.1464		3	3	5
1604	7	7	58	18	0.22	0.133	0.126	0.196	0.128	0.1606		3	5	5
801	6	6	63	18	0.245	0.175	0.205	0.197	0.265	0.2174		3	5	5
1413	6	6	61	21	0.201	0.181	0.137	0.219	0.182	0.184		3	5	5
208	5	6	60	25	0.201	0.194	0.193	0.163	0.163	0.1828		3	5	5
1308	6	6	64	23	0.128	0.15	0.201	0.172	0.176	0.1654		3	5	5
1506	6	6	72	23	0.198	0.147	0.226	0.137	0.105	0.1626		3	5	4
204	6	5	63	20	0.116	0.136	0.166	0.115	0.134	0.1334		3	3	4
1013	7	6	56	17	0.16	0.193	0.182	0.205	0.194	0.1868		3	5	4
1302	6	7	63	19	0.168	0.161	0.193	0.172	0.135	0.1658		3	5	4
1205	7	6	64	18	0.172	0.199	0.154	0.153	0.183	0.1722		3	5	4
313	6	6	59	19	0.187	0.183	0.227	0.139	0.213	0.1898		3	5	4
1303	6	7	63	18	0.18	0.163	0.176	0.151	0.184	0.1708		3	5	4
906	6	6	66	19	0.239	0.207	0.215	0.104	0.176	0.1882		3	5	4
904	7	7	62	19	0.094	0.117	0.137	0.199	0.144	0.1382		3	5	4
1602	6	8	58	19	0.082	0.167	0.149	0.155	0.127	0.136		3	5	4
1012	6	6	65	23	0.144	0.148	0.162	0.138	0.147	0.1478		3	5	4
1305	6	6	67	18	0.205	0.19	0.229	0.103	0.208	0.187		3	5	4
1410	6	6	72	22	0.097	0.169	0.174	0.108	0.195	0.1486		3	5	4
810	5	6	65	20	0.182	0.193	0.189	0.249	0.159	0.1944		3	5	4
1212	7	6	77	15	0.234	0.128	0.171	0.174	0.202	0.1818		3	5	4

	Basal Spread		Height		Stem Diameter Average						1=Best and 5=Poor	Overall	
Plant ID #	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
1004	6	7	61	15	0.157	0.182	0.204	0.221	0.122	0.1772	3	5	4
1404	7	6	68	18	0.129	0.081	0.209	0.192	0.119	0.146	3	5	4
502	7	6	66	15	0.181	0.18	0.171	0.177	0.165	0.1748	5	3	4
910	6	5	68	19	0.17	0.193	0.243	0.228	0.129	0.1926	3	5	4
711	6	6	58	18	0.169	0.185	0.175	0.175	0.116	0.164	3	5	4
412	5	5	74	23	0.199	0.191	0.168	0.177	0.184	0.1838	3	5	4
803	6	7	59	20	0.143	0.124	0.136	0.12	0.105	0.1256	3	5	4
1406	5	6	55	17	0.211	0.145	0.206	0.247	0.222	0.2062	3	5	4
1011	6	5	69	19	0.204	0.175	0.171	0.171	0.19	0.1822	3	5	3
1610	6	6	59	20	0.154	0.164	0.11	0.116	0.173	0.1434	3	5	3
602	6	5	54	22	0.165	0.118	0.176	0.16	0.155	0.1548	3	5	3
1210	5	5	63	23	0.164	0.217	0.2	0.142	0.162	0.177	3	5	3
701	6	6	54	19	0.156	0.145	0.138	0.135	0.166	0.148	3	5	3
205	5	5	79	22	0.167	0.19	0.169	0.181	0.198	0.181	5	3	3
913	6	6	63	21	0.152	0.128	0.12	0.106	0.146	0.1304	3	5	3
1202	5	7	56	12	0.209	0.176	0.234	0.228	0.242	0.2178	3	5	3
613	6	5	66	19	0.176	0.156	0.154	0.195	0.116	0.1594	3	5	3
1001	5	5	65	17	0.21	0.136	0.232	0.242	0.236	0.2112	3	5	3
1402	6	7	63	14	0.14	0.14	0.148	0.177	0.145	0.15	3	5	3
403	6	6	57	18	0.148	0.133	0.144	0.124	0.127	0.1352	3	5	3
1612	6	6	72	24	0.135	0.172	0.185	0.173	0.159	0.1648	5	5	3
1405	6	6	66	19	0.164	0.207	0.226	0.219	0.211	0.2054	5	5	3
804	6	6	57	18	0.126	0.179	0.137	0.116	0.092	0.13	3	5	3
611	5	5	60	18	0.166	0.242	0.149	0.162	0.202	0.1842	3	5	3
1502	5	6	49	17	0.134	0.178	0.169	0.159	0.141	0.1562	3	5	3
607	5	6	58	16	0.207	0.177	0.182	0.137	0.121	0.1648	3	5	3
503	5	5	73	22	0.165	0.183	0.089	0.128	0.152	0.1434	3	5	3
608	5	5	60	16	0.204	0.158	0.169	0.251	0.179	0.1922	3	5	3
506	6	5	63	16	0.189	0.107	0.183	0.158	0.158	0.159	3	5	3

													1=Best and 5=Poor		
		Basal Spread		Height		Stem Diameter Average								Overall	
Plant ID #		N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
		~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
513		5	5	64	19	0.173	0.185	0.173	0.147	0.125	0.1606	3	5	3
606		5	5	66	18	0.159	0.134	0.148	0.201	0.202	0.1688	3	5	3
1503		7	7	56	20	0.158	0.108	0.089	0.134	0.143	0.1264	5	5	2
309		5	5	63	18	0.179	0.195	0.152	0.145	0.106	0.1554	3	5	2
111		6	6	56	18	0.187	0.181	0.198	0.196	0.135	0.1794	5	5	2
509		5	5	57	17	0.181	0.131	0.207	0.165	0.126	0.162	3	5	2
404		5	6	56	16	0.169	0.146	0.107	0.167	0.118	0.1414	3	5	2
1603		7	6	64	20	0.151	0.1	0.134	0.07	0.212	0.1334	5	5	2
201		5	4	63	21	0.165	0.125	0.187	0.121	0.154	0.1504	3	5	2
107		5	6	52	21	0.183	0.138	0.214	0.15	0.148	0.1666	5	5	2
704		6	4	52	17	0.15	0.119	0.128	0.176	0.174	0.1494	3	5	2
1002		5	6	59	17	0.242	0.15	0.225	0.19	0.165	0.1944	5	5	2
308		5	4	60	21	0.182	0.124	0.161	0.13	0.098	0.139	3	5	2
903		5	5	59	21	0.171	0.154	0.18	0.253	0.15	0.1816	5	5	2
1501		6	6	54	16	0.156	0.17	0.212	0.181	0.103	0.1644	5	5	2
212		5	5	56	22	0.162	0.24	0.168	0.131	0.124	0.165	5	5	2
612		4	7	67	14	0.136	0.103	0.15	0.093	0.168	0.13	3	5	2
1006		5	6	62	17	0.173	0.181	0.11	0.15	0.165	0.1558	5	5	2
1113		5	5	59	20	0.145	0.166	0.148	0.12	0.192	0.1542	5	5	2
406		5	5	56	18	0.165	0.189	0.18	0.163	0.123	0.164	5	5	1
713		6	6	30	16	0.158	0.08	0.129	0.142	0.109	0.1236	5	5	1
103		5	6	40	11	0.1	0.125	0.138	0.123	0.15	0.1272	3	5	1
1312		5	6	61	13	0.202	0.193	0.205	0.21	0.067	0.1754	5	5	1
1403		5	5	66	16	0.116	0.11	0.139	0.233	0.212	0.162	5	5	1
311		4	5	57	20	0.192	0.138	0.183	0.153	0.097	0.1526	5	5	1
603		4	4	63	26	0.206	0.144	0.13	0.145	0.106	0.1462	5	5	1
812		5	5	39	14	0.174	0.173	0.191	0.126	0.17	0.1668	5	5	1
1601		5	5	43	17	0.12	0.145	0.112	0.131	0.137	0.129	5	5	1
712		5	5	33	14	0.141	0.134	0.144	0.104	0.203	0.1452	5	5	1

											1=Best and 5=Poor		
	Basal Spread		Height		Stem Diameter Average							Overall	
	N-S	E-W	Seedhead	Foliage	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5	Average	Lodging	Rating	Selection Formula
Plant ID #	~to the nearest inch~				~to the nearest thousandth of an inch~						1 - 3 - 5 Rating		
206	5	4	68	14	0.23	0.183	0.182	0.149	0.155	0.1798	5	5	1
710	5	5	47	12	0.175	0.158	0.194	0.149	0.127	0.1606	5	5	1
508	4	5	56	15	0.14	0.131	0.15	0.215	0.162	0.1596	5	5	1
1206	5	5	42	15	0.109	0.127	0.14	0.104	0.103	0.1166	5	5	1
1204	4	4	47	14	0.152	0.179	0.162	0.138	0.192	0.1646	5	5	1
1112	5	5	46	14	0.097	0.127	0.094	0.098	0.087	0.1006	5	5	1
1104	5	4	46	15	0.118	0.119	0.105	0.11	0.112	0.1128	5	5	1
307	4	4	44	18	0.151	0.121	0.117	0.133	0.123	0.0988	5	5	1
605	4	5	52	12	0.14	0.103	0.097	0.094	0.089	0.1046	5	5	1
101	3	4	34	9	0.169	0.125	0.116	0.078	0.077	0.113	3	5	0
104	4	4	41	12	0.143	0.101	0.084	0.094	0.06	0.0964	5	5	0
1110	4	3	47	10	0.12	0.14	0.115	0.158	0.146	0.1358	5	5	0
408	3	3	40	10	0.121	0.097	0.141	0.082	0.117	0.1116	5	5	0
105	3	3	45	8	0.149	0.095	0.078	0.107	0.081	0.102	5	5	0
401	dead									0			
402	lodged									0	5	5	
706	dead									0			
507	very	small								0	5	5	
411	dead									0			
511	dead									0			
312	dead									0			
113	dead									0			
114	dead									0			
214	dead									0			
314	dead									0			
414	dead									0			
514	dead									0			
1614	dead									0			

Inter Center Strain Trial – Yield and Persistence of 11 Big Bluestem Sources in Kansas, Missouri, Arkansas, and Mississippi

Study No. MOPMC-P-0822-PA,WL

National Project(s): Pasture/Hayland 2.1; Wildlife 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Introduction: Big bluestem cultivars developed by NRCS and ARS, and NRCS prevarietal releases and selections will be evaluated for yield and persistence in replicated plots in Booneville, AR; Coffeeville, MS; Elsberry, MO and Manhattan, KS. There have been several prevarietal releases of big bluestem made in recent years by Booneville, AR and Elsberry, MO PMCs. Comparative evaluations of these prevarietal releases and a selection from the Manhattan, KS PMC are needed to further document their performance and adaptation in other geographical regions. Information gained from these plantings may be used to provide data to support elevating lower class releases (e.g. source id and selected class) to a higher release category (e.g. tested class or cultivar).

In addition to these releases, standard big bluestem cultivars commonly used in NRCS conservation plantings and programs will be included in the trial along with other cultivars developed by the USDA-ARS, Lincoln, NE.

Objective: Evaluate big bluestem pre-variety releases across locations for potential upgrade in class of release.

Procedure: Big bluestem entries will be established in 6-ft x 9-ft plots at PMCs in Booneville, AR; Elsberry, MO; Coffeeville, MS; and Manhattan, KS in 2008. All PMCs, except Coffeeville, will send a packet of seed of their respective entry to participating PMCs (see table 1). Participating PMC will start seed in the greenhouse and grow out approximately 100 seedlings of each entry. Plants will be transplanted in the field in late spring or early summer using the same plot layout on page 6.

Elsberry will provide live propagules of Refuge germplasm for each location (72 plants x 4 locations = 288 plus 15 -25 extras per location for replacements).

Evaluations will start when 50% of the first entry reaches the late boot stage (1st seed head emerging) of growth. Height measurements will be recorded from the center 4 plants from each of the four replications. Yield will be determined by sampling four plants from the center of each row with a cutting height of 8 inches. The average plot weight (average weight of the 4 plants) will be determined for each big bluestem entry by replication and a grab sample collected for dry matter. After harvest, all remaining plants will be cut and removed from the plot. A second harvest will be made within 2-4 weeks after the first killing frost. The average plant height of entry in each of the four replications from the center 4 plants will be measured and recorded. Means were tested using a repeated-measures analysis of variance followed by an LSD post-hoc test ($p<0.05$).

Potential Products: Information Technology, Cultivar Release

Progress or Status:

2008
In the spring of 2008, the 4 Plant Materials Centers provided plant material of the big bluestem that they were working with or were responsible for. Seedling plugs were provided in most cases. In 2008, the evaluation plot was given a year to establish and evaluations are to start in 2009.

2009
The big bluestem ICST plot was fertilized with 50 lb. per acre (8 lb. bulk for the plot) and 100 lb. of pellet lime on April 21, 2009. On July 31 and November 3, the plots were cut and 4 plants were weighed and calculated to determine the amount of forage per acre. Grab samples were taken to determine dry matter yield. The July 31 represents the first cutting and November 3 represents the amount of re-growth. Also on those dates, the plots were evaluated for plant height, vigor, and disease and insect resistance. See table 2 for a summary of the evaluations for 2009 at the Elsberry PMC.

2010
On July 13 and November 15, the plots were cut and 4 plants were weighed and calculated to determine the amount of forage per acre. Grab samples were taken to determine dry matter yield. The July 13 represents the first cutting and November 15 represents the amount of re-growth. Also on those dates, the plots were evaluated for plant height, vigor, and disease and insect resistance. See table 3 for a summary of the evaluations for 2010 at the Elsberry PMC.

2011
On July 12 and December 8, the plots were cut and 4 plants were weighed and calculated to determine the amount of forage per acre. Grab samples were taken to determine dry matter yield. The July 12 represents the first cutting and December 8 represents the amount of re-growth. Also on those dates, the plots were evaluated for plant height, vigor, and disease and insect resistance. See table 4 for a summary of the evaluations for 2011 at the Elsberry PMC.

Conclusion
Above ground biomass (dry material), vigor, height, insect resistance, and disease resistance for all eleven accessions of big bluestem were not significantly different from one another (table 5). By having two harvest dates in each year there is enough re-growth for the plants to persist through the winter. Based on the results of this study in Lincoln County Missouri for the period of 2009-2011, all of the eleven accessions are not significantly different from one another in any parameter that was measured to recommend any particular accession over another for conservation practices.

Table 1. Big bluestem sources and origin.

Source	Accession No.	Origin	Distribution of seed
Hampton Germplasm	9056854	AR, MO, and OK	Booneville PMC
OZ-70 Germplasm	9078831	73 accessions from AR, MO, and OK	Elsberry PMC
Refuge Germplasm	9078832		Elsberry PMC
MO 9083274	9083274	Logan Co., AR	Elsberry PMC
Northern MO Ecotype	9079000	Northern MO counties	Elsberry PMC
Rountree	474216	Monona County, IA	Elsberry PMC
Kaw	421276	Flint Hills south of Manhattan, KS	Manhattan PMC
KS 483446	483446	south central KS and eastern OK	Manhattan PMC
Pawnee	9005159	Pawnee County, NE	Stock Seed
Bonanza	641701	derived from Pawnee	Stock Seed
Goldmine	641702	derived from Kaw	Sharp Bros.

Table 2. Summary means for Big Bluestem Inter-Center Strain Trial for 2009

Release Name	Accession	Dry Material (ton/acre)			Vigor		Height (ft)		Insect Resistance		Disease Resistance	
		7/31/2009	11/3/2009	Total	7/31/2009	11/3/2009	7/31/2009	11/3/2009	7/31/2009	11/3/2009	7/31/2009	11/3/2009
Northern	9079000	4.9	0.3	5.17	2.5	3.5	7.7	1.2	1	3	2	3
OZ-70	9078831	4.8	0.3	5.12	2.0	1.5	6.9	1.7	1.5	3	3	3
Bonanza	641701	4.7	0.2	4.96	3.0	5.0	6.9	0.9	1	3	3	3
Hampton	9056854	4.4	0.2	4.61	1.0	4.5	7.1	1.1	2	3	2.5	3
	9083274	4.2	0.3	4.55	2.0	2.5	6.7	1.6	2	3	3.5	3
Goldmine	641702	4.2	0.2	4.37	1.5	4.5	6.8	1.0	1	3	2	3
Rountree	474216	4.1	0.2	4.29	4.0	3.5	7.7	1.1	1	3	3	3
Kaw	421276	4.1	0.2	4.29	3.0	3.5	6.4	1.1	1	3	2.5	3
	483446	3.6	0.2	3.80	2.5	4.0	6.0	1.2	1	3	2.5	3
Refuge	9078832	2.9	0.1	3.01	1.5	3.5	5.9	1.1	1	3	1.5	3
Pawnee	9055679	2.5	0.2	2.72	4.0	5.0	6.6	0.9	1.5	3	3	3

Vigor, insect resistance, and disease resistance ratings 1=Excellent 3=Good 5=Fair 7=Poor

Table 3. Summary means for Big Bluestem Inter-Center Strain Trial for 2010

Release Name	Accession	Dry Material (ton/acre)			Vigor		Height (ft)		Insect Resistance		Disease Resistance	
		7/13/2010	11/15/2010	Total	7/13/2010	11/15/2010	7/31/2010	11/15/2010	7/13/2010	11/15/2010	7/13/2010	11/15/2010
Northern	9079000	3.9	1.4	5.33	2.0	3.0	4.4	2.1	2.5	1	3.5	1.5
OZ-70	9078831	2.4	1.7	4.09	2.0	2.0	3.9	2.1	2	1	3.5	1.5
Bonanza	641701	2.9	0.6	3.47	5.0	4.0	3.5	1.8	3	1	5	3
Hampton	9056854	2.8	1.2	4.02	2.0	1.5	3.8	6.9	1	1	2.5	2.5
	9083274	2.0	1.3	3.35	2.0	1.0	3.6	2.5	1	1	3.5	2
Goldmine	641702	3.2	1.4	4.61	1.5	3.0	3.8	2.1	1.5	1	2.5	1
Rountree	474216	3.1	0.9	4.06	4.0	2.5	4.2	2.0	3	1	4.5	3
Kaw	421276	1.6	0.7	2.32	3.5	5.0	3.3	1.4	3	1	3	1.5
	483446	2.2	1.3	3.52	4.5	3.0	3.3	2.2	3	1	3.5	2
Refuge	9078832	3.3	0.8	4.08	1.0	1.0	4.2	2.0	2	1	2.5	1
Pawnee	9055679	1.6	0.4	2.03	4.5	4.0	3.5	1.7	3.5	1	5	2

Vigor, insect resistance, and disease resistance ratings 1=Excellent 3=Good 5=Fair 7=Poor

Table 4. Summary means for Big Bluestem Inter-Center Strain Trial for 2011

Release Name	Accession	Dry Material (ton/acre)			Vigor		Height (ft)		Insect Resistance		Disease Resistance	
		7/12/2011	12/8/2011	Total	7/12/201	12/8/2011	7/12/201	12/8/2011	7/12/201	12/8/2011	7/12/201	12/8/2011
Northern	9079000	3.6	0.3	3.91	3.0	3.0	3.0	2.8	1	1	1.4	1.3
OZ-70	9078831	2.6	0.5	3.13	2.1	1.9	2.9	2.7	1	1	1.3	1.6
Bonanza	641701	1.8	0.5	2.25	4.1	3.9	2.6	2.3	1	1	3.0	3.1
Hampton	9056854	2.1	0.6	2.65	1.3	1.6	2.8	2.7	1	1	2.7	2.4
	9083274	2.8	0.2	3.04	1.0	1.0	3.0	2.9	1	1	1.6	1.7
Goldmine	641702	2.1	0.4	2.55	2.7	3.0	2.8	2.6	1	1	1.0	1.0
Rountree	474216	3.3	0.4	3.76	2.7	2.1	3.3	3.1	1	1	2.9	2.9
Kaw	421276	1.8	0.4	2.23	5.0	5.0	2.3	2.1	1	1	1.6	1.6
	483446	1.8	0.5	2.29	2.9	2.9	2.6	2.6	1	1	1.7	2.0
Refuge	9078832	2.8	0.3	3.03	1.0	1.0	2.8	2.6	1	1	1.0	1.0
Pawnee	9055679	2.1	0.4	2.48	3.9	4.1	2.6	2.3	1	1	2.1	1.9

Vigor, insect resistance, and disease resistance ratings 1=Excellent 3=Good 5=Fair 7=Poor

Table 5. Big bluestem accession comparison for combined 2009 - 2011.

Release Name	Accession	Dry Material (ton/acre)	Vigor*	Height (ft)	Insect Resistance*	Disease Resistance*
Northern	9079000	4.8	2.8	3.5	1.6	2.1
OZ-70	9078831	4.1	1.9	3.4	1.6	2.3
Bonanza	641701	3.6	4.2	3.0	1.7	3.4
Hampton	9056854	3.8	2.0	4.0	1.5	2.6
	9083274	3.6	1.6	3.4	1.5	2.5
Goldmine	641702	3.8	2.7	3.2	1.4	1.8
Rountree	474216	4.0	3.1	3.6	1.7	3.2
Kaw	421276	2.9	4.2	2.8	1.7	2.2
	483446	3.2	3.3	3.0	1.7	2.5
Refuge	9078832	3.4	1.5	3.1	1.5	1.7
Pawnee	9055679	2.4	4.3	2.9	1.8	2.8
$LSD_{(0.05)}$ 1/		NS 2/	NS 2/	NS 2/	NS 2/	NS 2/

1/ Least significant difference at P<0.05

2/ Not significant at P<0.05

* ratings 1=Excellent 3=Good 5=Fair 7=Poor

Using Biological Approach (Sheep/Goats) to Control Invasive Species with Emphasis on Bush Honeysuckle, *Lonicera maackii,* and Buckthorn, *Rhamnus cathartica*

Study No. MOPMC-T-1124, NA

National Project(s): Natural Areas 1.1; Forestland 1.1

Study Leader: Ron L. Cordsiemon, PMC Manager

Cooperators: Dr. Charlotte Clifford-Rathert, Lincoln University; Harry Cope, Producer (2011)

Introduction: Bush honeysuckle (*Lonicera maackii*, Rupr.) is very well adapted to several different growing conditions. It is native to Asia and introduced to the United States in 1896. It readily grows in zones 3 to 8. In forests the plant can adversely affect populations of native members of the community. It can spread rapidly due to the seeds being dispersed by birds and mammals. It can form a dense understory thicket which can restrict native plant growth and tree seedling establishment.[1 USDA-Forest Service] Bush honeysuckle plants commonly are found growing under tall shrubs or trees that act as perch areas for birds. It is suspected that bush honeysuckles may produce alleopathic chemicals that enter the soil and inhibit the growth of other plants, preventing native plants from competing with the shrub. Shading by bush honeysuckle may also limit the growth of native species. Bush honeysuckles leaf out before many native species and hold their foliage until November.[2 Smith] In 1978, the Elsberry Plant Materials Center released Cling Red bush honeysuckle. Selection criteria for Cling Red bush honeysuckle, a selected class release, were based on plant vigor, ability to maintain seeds into the winter months and growth characteristics.

Common buckthorn is a shrub or small tree in the buckthorn family (Rhamnaceae) that can grow to 22 feet in height with a 10-inch wide trunk. Common buckthorn prefers lightly shaded conditions. An invader mainly of open oak woods, deadfall openings in woodlands, woods edges, roadsides, prairies and open fields. It is tolerant of many soil types, well drained sand, clay, poorly drained calcareous, neutral or alkaline, wet or dry. Common buckthorn is reported invasive in the following states: CO, CT, IA, IL, IN, MD, MA, MI, MN, MO, MS, ND, NH, NJ, NY, PA, RI, SD, TN, VA, VT, WI, and WY. Dense thickets form, crowding and shading out native shrubs and herbs, often completely eradicating them. Dense seedlings prevent native tree and shrub regeneration. In fire-adapted ecosystems such as savannas and prairies, the lack of vegetation under buckthorn prohibits fires.[3 USDA Forest Service] Common buckthorn produces fruit that is readily eaten by birds. The severe laxative effect of the fruits readily distributes seeds. The shrub easily re-sprouts from cut or damaged stems.[4 Smith]

Both bush honeysuckle and common buckthorn were introduced to the United States and they compete heavily against native vegetation. Many different control measures have been used to keep these two species' in check.

Mechanical control, or cutting or digging of the plant is an effective way to remove honeysuckle and buckthorn. The drawback to using a mechanical method is that it can become expensive and, in most cases, there will still need to be follow-up applications to completely control honeysuckle and buckthorn populations.

Chemical control is another way to suppress or eradicate unwanted vegetation. It can also become expensive and require follow-up applications to be successful.

Biological control or the use of animals to control brush has the potential to be a viable alternative to controlling or eradicating honeysuckle and buckthorn. Sheep/goats grazing is an ideal brush-control tool. Managing brush and woody plants with sheep/goats benefits the environment by eliminating the use of herbicides and benefits land managers by minimizing the need for costly

mechanical clearing. Sheep are a natural, low-cost means of managing forests and rangelands, even as they produce important resources, such as wool, meat, and lanolin.

Objective: The purpose of this study is to address the invasive species' in the understory of woodland areas and areas not easily accessible with motorized equipment and/or herbicide applications. The use of a biological control agent, in this case using sheep and/or goats to control bush honeysuckle (*Lonicera maackii*) and common buckthorn (*Rhamnus cathartica*), may be a viable alternative to suppressing or eliminating the invasive species' competition, while promoting native plant vegetation. Evaluation of beneficial or more desirable plant species will be monitored, as well as the health of the sheep or goats.

Procedure: Areas of honeysuckle and buckthorn infestation will be identified at the Elsberry Plant Materials Center. These identified areas will be enclosed using a 7-strand, high-tensile, electric fence. Random points within the paddocks will be identified (approximately 3-5 points per paddock) and the vegetation at those points will be documented. A photo will be taken in each direction (north, west, south and east) prior to the sheep/goats entering the treatment areas. Invasive species' (honeysuckle and buckthorn), as well as native species', will be accounted for and evaluated for percent coverage at each photo point. At the end of the treatment period and growing season, evaluations at each photo point will again be determined.

Initial – In the fall of 2010, evaluation points will be made in each paddock and the existing vegetation surrounding each point will be documented. The vegetation will be given a subjective rating on the percentage of understory that each species represents, whether it is invasive or beneficial.

Photos will be taken at each point, once in the fall 2010, again in the spring and at the end of the treatment period (Oct. – Nov.). The spring following each treatment, both the honeysuckle and buckthorn will be given a survival rating based of the number of plants that survive. April 2010, 45-50 Katahdin hair sheep will enter the first paddock to start the treatment at the PMC. In subsequent treatments, the possibly of using only goats or goats and sheep together may need to be explored.

Evaluations will be made at the end of this study to determine whether the biological treatment (sheep and/or goats) have made a detrimental impact on the honeysuckle and buckthorn population. Evaluations will also be made to determine the health of the native vegetation. Forester, wildlife biologist and agronomist will evaluate the paddocks to determine the overall health of the tree and shrub population, wildlife habitat and soil health. The project will also evaluate the health of the sheep and/or goats, as well as the economic potential.

Potential Products: Technical note, peer reviewed papers, poster and oral presentations

Progress or Status:

2011:

On 20 April 2011, 49 pregnant Katahdin hair sheep were brought to the Plant Materials Center (PMC) in Elsberry, Missouri to be rotationally grazed through 19.2 acres that is divided into three paddocks infested with AH and CB. The ewes began lambing about 5 days later. All sheep were removed from the PMC on 13 June, to give the paddocks a re-growth period and so the lambs could be identified and ear tagged. Eight ewes and their 16 lambs were brought back on 22 June and rotationally grazed through the three paddocks. All of the sheep were removed 18 August because the sheep had grazed what they could up to a height of about 4.5 feet (1.4 m). The stocking rate was approximately 1.1 Animal Unit Month/Acre (AUM/ac).

Approximately every 21 days and when they were moved, each animal was evaluated for weight, body condition, FAMACHA®, and fecal egg count (nematodes and coccidia). The FAMACHA® system is a method that estimates the degree of infection of the *Haemonchus contortus* parasite.

The score is a range from 1-5, with 1 being that the eyelid membrane color is a dark red and indicates no significant anemia caused by the parasite, while a score of 5 indicates a white eyelid membrane and severe anemia.

Permanent vegetation monitoring points were established in all of the paddocks before the animals were brought in. Before and after the grazing season, pictures were taken and estimates of woody plant overstory basal area, cover, and species present were taken.

The ewe and lamb results are summarized in tables 1 and 2. There was not an apparent difference in species composition of the understory species at any of the monitoring points within any of the pastures by the end of the 2011 grazing season.

The negative ADG and total gain of the ewes is not unexpected, due to the fact that they lambed, and most ewes lose some weight during that time. The body condition and FAMACHA scores suggest that the Katahdin breed were resilient to the stresses of this study. However, the amount of weight that was lost may be of concern. The lambs gained weight throughout the season which suggests that grazing AH and CB may negatively alter ewe performance but may not negatively impact lamb performance.

Analysis of the vegetation monitoring points suggests that there was little, if any, change in the species composition after one year of browsing. It is expected that it will take at least 3 years of grazing to see a significant impact on the vegetation species composition.

Table 1. Mean results of Katahdin ewes.

	Total Gain (lbs)	Average Daily Gain (ADG) (lbs)	Body Condition Score	FAMACHA Score	Coccidia spp. count (#/g)	Fecal Egg (eggs/g)
Mean	-12.5	-0.37	3	2	-647	485
Standard Error	1.99	0.07	0.12	0.16	877	198

Table 2. Mean results of lambs.

	Total Gain (lbs)	Average Daily Gain (ADG) (lbs)	Birth Weight (lbs)	End Weight (lbs)
Mean	16.8	0.4	13.4	30.3
Standard Error	0.93	0.01	0.37	0.92

For the 2012 grazing season, we expect to use Spanish goats instead of hair sheep. Spanish goats are touted as being more resistant to parasites and better able to control brush species than Katahdin sheep. Drift fence will also be used within each paddock to better control the intensity of grazing on the target brush species.

2012:

Project Update:

The NRCS Elsberry Plant Materials Center and Lincoln University began working together in an effort to use small ruminants as way to control unwanted invasive understory plants from woodlands. Over the past 70+ years the Elsberry PMC and surrounding area has become infested with invasive woody species such as honeysuckle and buckthorn. One way to combat the continued progression of these species' was to introduce small ruminants into these infested woodlands.

Lincoln University, under the guidance of Dr. Charlotte Clifford-Rathert, began working with the PMC in 2011, monitoring the health of 40+ sheep that were used to control the understory. This first year provided limited success and the determination to use goats instead of sheep was made.

The PMC with guidance and support from Missouri and Illinois state grassland specialist's conducted several hands on training fencing workshops with fencing material purchased by Lincoln University. The product resulted in five constructed individual paddocks that encompass some of the more heavily infested wooded areas on the center. On March 26, 2012, Lincoln University, after entering into an agreement with NRCS, provided 15 goats to the Elsberry PMC. Lincoln University delivered an additional 15 goats to the PMC on May 3, 2012. This allowed for a manageable herd that provided a stocking rate that could accomplish the goal of defoliating unwanted vegetation. The herd was rotated around the PMC as they depleted the available forage in each paddock. The staff of the PMC monitors the effectiveness of control with regards to the honeysuckle and buckthorn as well as the beneficial species'. After evaluating the first full year of using goats as a way to control the unwanted vegetation, visual ratings would suggest that multiple years of intense grazing/browsing would be needed. The first year of using goats has shown significant progress as the goats were able to browse the vegetation up to 66 inches, 14 inches higher than sheep in the previous year.

There have been additional methods used to supplement the control of the honeysuckle and buckthorn. Two of these methods were "bullhogging" and "hinge cutting" the vegetation. Bullhogging is the process of using a flail-type cutter on the front of a skid loader that is capable of cutting woody vegetation up to 10 inches in diameter. With this process, vegetation is totally removed and the goats are able to completely control the re-sprouting vegetation, but access with this type of machinery is limited to primarily flat terrain and can be quite expensive. Hinge cutting refers to the process of using a hand saw and cutting approximately half way through the live stem of honeysuckle or buckthorn and pushing the top over to the ground. This allows for easy access for the goats and at this point, they are capable of controlling the entire shrub/tree. This process can be extremely labor intensive and cutting limbs in a manner to provide food to the goats can be time consuming.

As the goats entered the winter months, it has been noted that their desire to continue feeding on the woody species' has not stopped. Although, the goats have been supplied hay and supplemental feed they have fed heavily on the bark of honeysuckle, locust and several other shrubby species. If the health of these animals can be maintained during the winter months, pushing the animals into this type of intense browsing might serve as a viable option to eradicate any unwanted vegetation. As of right now, it appears the goats have girdled a large portion of the shrubby understory that they are currently overwintering in. This girdling could potentially kill the tree and be another way to manage this type of vegetation.

The health of the animals has been monitored on a regular basis, usually once a month or when the goats are moved to another paddock. FAMACHA scores, body conditioning scores, weight and evaluations for parasites are looked at upon each visit by LU personnel to make sure the health of the goats were maintained. The health of the animals is a valuable part of this study. If the goats can show a reasonable weight gain while also serving as a conservation tool for invasive species control, this practice should be an economical way to entice landowners to graze small ruminants on their property. The biological control study at the Elsberry PMC is scheduled for an additional 2-5 years.

2013:

Goats were maintained over the winter at the PMC. They were giving hay and grain to have enough food over the winter. The goats were on the PMC from January to November 20th, 2013. They were transferred to Lincoln University Busby Farm for the winter and are planned to be back at the PMC in May-June of 2014.

Due to the nature of having live animals on a project, this study has ended up to take on characteristics of a demonstration instead of a study. However, this project will maintain its status as a study for the purposes of this technical report. Data and results are planned to be presented as they are analyzed.

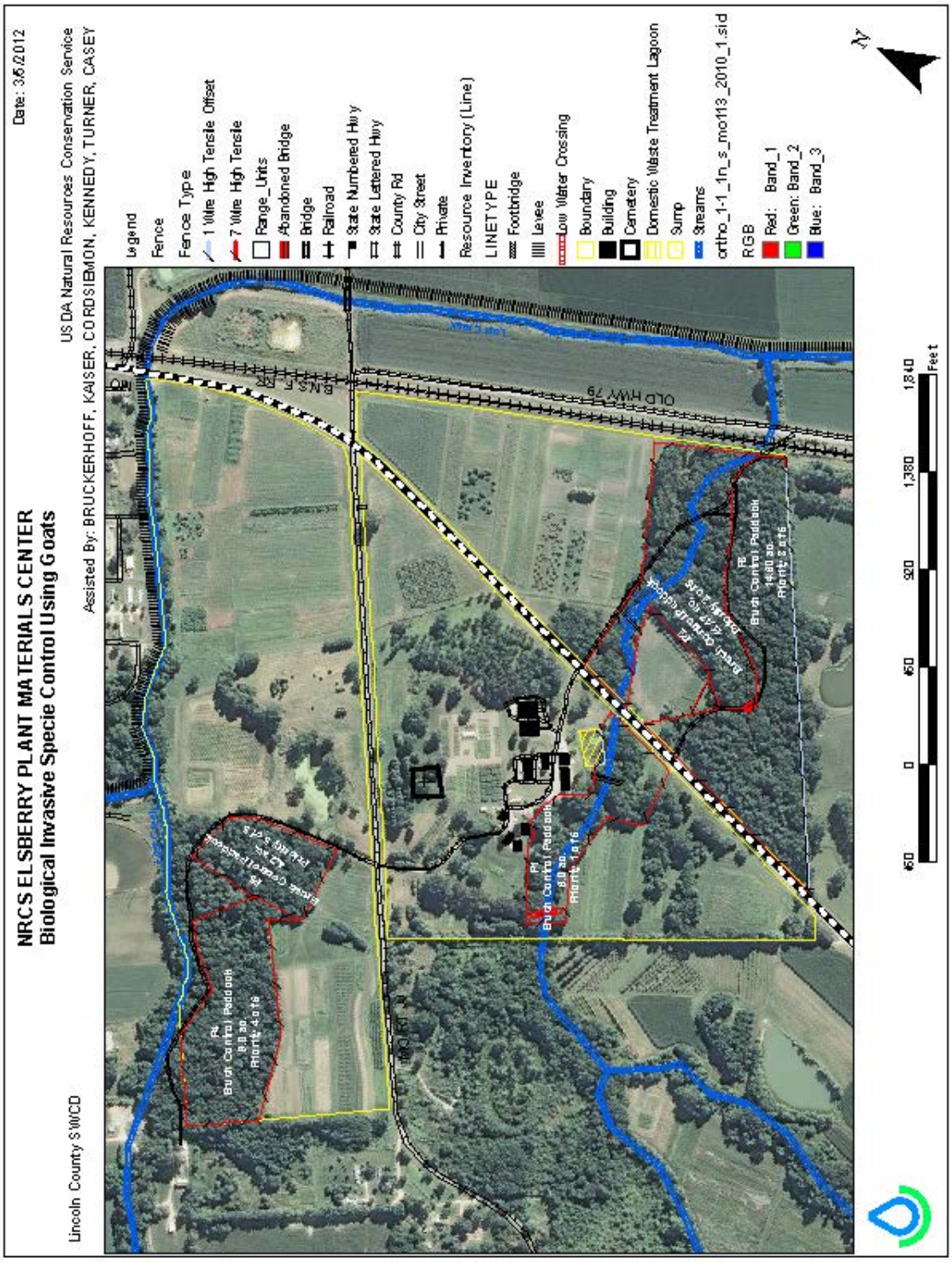
Literature Cited:

[1] USDA Forest Service, Forest Health Staff, Newtown Square, PA http://www.na.fs.fed.us/fhp/invasive_plants/weeds/amur-honeysuckle.pdf

[2] Missouri Vegetation Manual, Tim Smith, Missouri Department of Conservation, 1997, p.22

[3] USDA Forest Service, Forest Health Staff, Newtown Square, PA http://www.na.fs.fed.us/fhp/invasive_plants/weeds/common-buckthorn.pdf

[4] Missouri Vegetation Manual, Tim Smith, Missouri Department of Conservation, 1997, pp. 33-36


NRCS ELSBERRY PLANT MATERIALS CENTER
Biological Invasive Specie Control Using Goats
Lincoln County SWCD
USDA Natural Resources Conservation Service
Assisted By: BRUCKERHOFF, KAISER, CORDSIEMON, KENNEDY, TURNER, CASEY
Date: 3/5/2012
Legend
Fence
Fence Type
1 Wire High Tensile Offset
7 Wire High Tensile
Range_Units
Abandoned Bridge
Bridge
Railroad
State Numbered Hwy
State Lettered Hwy
County Rd
City Street
Private
Resource Inventory (Line)
LINETYPE
Footbridge
Levee
Low Water Crossing
Boundary
Building
Cemetery
Domestic Waste Treatment Lagoon
Sump
Streams
ortho_1-1_1n_s_mo113_2010_1.sid
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
OLD HWY 79
B N S F RR
Feet

Collection of Plant Attributes from Plantings of Giant Miscanthus for RUSLE2

Study No. MOPMC-T-1126, NA

National Project(s): Biomass/Biofuel 1.1, Cropland 1.1 and 3.1

Study Leader: Allen Casey, Soil Conservationist

Cooperator(s): Dr. Seth Dabney – USDA-ARS, Joel Douglas- USDA-NRCS-CNTC

Introduction: Giant miscanthus (Miscanthus x giganteus) is a large perennial grass hybrid. The parent species are Miscanthus sinensis and Miscanthus sacchariflorus. Giant miscanthus is has been developed primarily for use as a biomass stock in the production of energy. There is a need to collect scientific data on plant attributes of giant miscanthus for inclusion into the Revised Universal Soil Loss Equation 2 (RUSLE2) model. Currently RUSLE2 does not have any data about giant miscanthus. Giant miscanthus is starting to be planted extensively for use as a biofuel or biomass product to meet the energy needs of the United States and Europe. NRCS policy is for fields that are receiving subsidies to meet a minimum standard of soil loss. NRCS field staff use the RUSLE2 model to determine the soil loss that is occurring in a particular field by including data such as past and current tillage practices, rotations, and crops. Without the vegetation file of giant miscanthus included in RUSLE2, field office staff does not have a relatively quick and scientifically base method to determine if a field falls within the erosion compliance standards.

Objective: This study will take measurements of giant miscanthus (*Miscanthus x giganteus*) growth habits and parameters. The data collected will be included in the Revised Universal Soil Loss Equation 2 model (RUSLE2), which is used by NRCS field offices to determine the soil erosion of fields using plant management information. Data collected will include characters such as height, width of crown, surface residue, above ground biomass, and other data as required for inclusion into the model. Data that is collected will be delivered as required to the Agricultural Research Service (ARS) for inclusion into the model.

Procedure: Experimental design will be after the USDA Natural Resources Conservation Service Plant Materials Evaluation Protocols: Revised January 2012. The protocols for data collection will be modified and adjusted based on the needed information required by the RUSLE2 model.

The existing giant miscanthus stand will be used to document an established stand. A new stand of giant miscanthus will be planted in 2011 and 2012 to get data during the establishment year and for the 2nd year of growth. These new plots will be planted using rhizomes from the established plots and planting them 3ft apart. Herbicides will be used to control weeds as necessary.

For all plots the sampling protocol was to cut to 8” tall to sample above ground biomass. Stubble residue was measured by cutting the plants from 8” down to 4”. Surface residue was measured by collecting any fallen leaves or stems that were from the current year’s growth. Surface canopy was measured using a line transect at three different angles through the plots.

The plots that were established in 2007 were sampled by using a 1m2 quadrat to sample the above ground biomass. Within that quadrat, two 0.25m2 quadrats were used to sample the stubble residue and the surface residue.

The plots that were planted in 2011 and 2012 were sampled by measuring 8 plants from a particular row within the stand during that growth season. Rows were only sampled once during any year.

Under advisement from the ARS, each type of stand was sampled for two years, meaning that the stand that was established in 2007 was sampled for two years, the stand that was planted in

2011 was sampled during the establishment year and the following year. The stand that was planted in 2012 was sampled in 2012 and in 2013. This will give 2 data sets for an "established stand", "2nd year growth stand", and "establishment year growth stand."

Potential Products: Vegetation file for the RUSLE2 model, peer-reviewed journal article, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides

Progress or Status:

2011:

Planted 2007 - Established Plots: These plots were established on 19 April 2007 and were used in the study MOPMC-T-0716-BF In-field Weathering Effects on Biomass Yield and Biofuel Quality of Warm Season Grasses. The established plots were sampled according to the protocol on 1 Sept, 29 Sept, 25 Oct, 21, and 21 Nov.

Planted 2011 –Establishment Year: The plot was planted on 18 April using rhizomes obtained from the boarder plants of the established plots. Rhizomes were plated on 3' centers in a 60ft x 120ft plot. The plot was sprayed with Atrazine 4L at 48oz./ac. Rate (1.5# actual ingredient) with an added 32oz./ac. Crop oil on 19 April. The plants were sampled according to the protocol on 2 June, 6 July, 3 Aug, 30 Aug, 25 Oct, and 21 Nov.

2012:

Data from the 2007 plots that was collected in 2011 was provided to Seth Dabney of the Agriculture Research Service to be analyzed. Seth Dabney then submitted the compiled data to Linda Scheffe of NRCS to be incorporated in the RUSLE2 model. There was a slight protocol change after the data from the 2007 planting was analyzed for RUSLE2. The canopy cover transects were changed to only include one of the replications and that replication is not to be sampled for above ground biomass and other data to prevent that replication from being trampled for the canopy cover measurement. This was changed by June of 2012.

Planted 2007: Plots were treated with 2.5 quarts/acre Paraquat and 2 pints/acre 2,4-D on 3 April 2012. Plots were sampled according to the protocol on 19 Mar, 8 Aug, 11 Sept, 10 Oct, and 8 Nov. Replication 1 was decided to be measured only for canopy cover and not for other data.

Planted 2011: Plots were treated with 2.5 quarts/acre Paraquat and 2 pints/acre 2,4-D on 3 April 2012. The plot was sampled on 9 Mar, 8 Aug, 11 Sept, 10 Oct, and 8 Nov. Replication 4 was decided to be measured only for canopy cover and not for other data.

Planted 2012- Establishment Year: The plot was planted on 10 April using rhizomes obtained from boarder plants of the plots that were established in 2007. Rhizomes were plated on 3' centers in a 60ft x 120ft plot. The plot was sprayed with Harness Xtra® at 2.6 pints/ac. rate and 2.0 pints/acre of 2,4-D on 18 May 2012l. The plants were sampled on 8 Aug, 11 Sept, 10 Oct, and 8 Nov. Replication 4 was decided to be measured only for canopy cover and not for other data.

2013:

Planted 2007: The plots were not sampled.

Planted 2011: The plots were not sampled.

Planted 2012: The plots were sampled according to the protocol on 23 May, 28 June, 25 July, and 19 Nov.

The plot that was planted in 2012 will be sampled in spring 2014, for the final harvest.

Table 1. Mean summary of Giant Miscanthus that was planted in 2007.

Date Sampled	Mean Height (ft)	Mean Total Surface Residue (Tons/acre)	Mean Total above-ground biomass (Tons/acre)
3-May-11	1.61	1.54	0.29
6-Jun-11	7.15	2.05	4.26
7-Jul-11	9.44	0.28	6.85
4-Aug-11	11.35	0.20	12.33
1-Sep-11	12.14	0.28	7.67
29-Sep-11	11.51	0.47	12.88
25-Oct-11	12.00	0.50	10.05
21-Nov-11	12.05	1.24	6.30
19-Mar-12	10.43	1.62	5.35
14-Jun-12	7.72	1.98	5.72
11-Jul-12	9.17	2.10	8.78
8-Aug-12	11.05	1.25	14.24
11-Sep-12	12.31	1.79	9.98
10-Oct-12	12.02	1.96	11.47
8-Nov-12	12.23	2.08	11.49

Table 2. Mean summary of Giant Miscanthus that was planted in 2011.

Date Sampled	Mean Height (ft)	Mean Total Surface Residue (Tons/acre)	Mean total above-ground biomass (Tons/acre)
2-Jun-11	1.30	0.00	0.01
6-Jul-11	2.97	0.00	0.22
3-Aug-11	4.32	0.00	1.07
30-Aug-11	6.37	0.00	1.92
28-Sep-11	6.49	0.00	2.23
25-Oct-11	5.75	0.00	2.75
21-Nov-11	5.91	0.09	2.77
9-Mar-12	4.33	0.19	0.41
6-Apr-12	1.80	0.03	0.53
17-May-12	2.13	0.00	1.29
14-Jun-12	2.94	0.00	5.67
11-Jul-12	3.61	0.00	5.92
8-Aug-12	6.21	0.21	7.02
11-Sep-12	7.26	0.19	7.38
10-Oct-12	7.43	0.36	8.75
8-Nov-12	7.50	0.32	3.95

Table 3. Mean summary of Giant Miscanthus that was planted in 2012.

Date Sampled	**Mean Height (ft)**	**Mean Total Surface Residue (Tons/acre)**	**Mean total above-ground biomass (Tons/acre)**
14-Jun-12	1.43	0.00	26.29
11-Jul-12	1.91	0.00	53.69
8-Aug-12	3.88	0.00	0.55
11-Sep-12	6.19	0.00	1.10
10-Oct-12	6.52	0.00	0.99
8-Nov-12	6.57	0.00	1.83
23-May-13	4.02	0.00	1.06
28-Jun-13	8.62	0.00	5.08
25-Jul-13	9.14	0.00	4.83
6-Sep-13	9.67	0.00	9.27
19-Nov-13	9.63	1.38	6.95

Termination Timing of Selected Cover Crops Using a Roller Crimper

Study No. MOPMC-T-1227, CP

National Project(s): Cropland 1.1

Study Leader: Ron Cordsiemon, PMC Manager

Introduction: Growers are always looking for effective and lower cost options to produce their crops. As cover crop use increases, their management becomes an important component of many farming systems. Timing and method of termination are the two most important factors of cover crop management6. Cover crops represent a cropping practice that has the potential to reduce herbicide reliance and minimize tillage while improving soil fertility, reducing soil erosion, sequestering soil carbon, increasing soil water infiltration and storage, and suppressing weeds.

Objective: Selected winter cover crops will be compared in replicated plots to evaluate their effective termination using a roller crimper. The selected cover crops will also be evaluated for their ability to maintain moisture in the soil, biomass production and weed suppression.

Procedure: Select cover crops (see chart below) typical to the Midwest region of Iowa, Illinois and Missouri will be planted by seed into plots that measure 96 feet by 100 feet (0.22ac). The plots will be divided into 3 subplots that will represent 3 different termination dates. Termination dates using a roller crimper will be defined as follows; an early termination, recommended termination, and late termination. VNS Cereal Rye, 'Gulf' Annual Ryegrass and a check plot will be treated with a non-selective herbicide using the same format for termination dates. Plots will be planted October 2011 using a 10' Great Plains no-till drill.

Species Recommended	Planting Rate	Actual Planting Rate
VNS (Variety Not Stated) Cereal Rye	45 PLS/Acre	37.53 PLS/Acre
'Gulf' Annual Ryegrass	9 PLS/Acre	7.37 PLS/Acre
Pioneer 25R39 Wheat	60 PLS/Acre	60.0 PLS/Acre
VNS (Variety Not Stated) Hairy Vetch	11 PLS/Acre	11.0 PLS/Acre
'Aroostok' Cereal Rye	45 PLS/Acre	45.0 PLS/Acre

(Reason for difference in recommended rates and actual planting rates was due to seed availability)

Evaluations

Soil moisture and temperature will be tracked using soil moisture probe and data logger.

Nitrogen readings will be taken prior to termination of the cover crop to determine nitrogen uptake of the cover crop.

Biomass cuttings will be taken using meter^2 samples to determine amount of biomass produced.

A line transect will be ran and counts of plant composition will be made in each subplot during the cover crop growing period.

Ceptometer measurements will be used as a comparison to canopy cover and biomass measurements.

Subplots will be evaluated 2 and 4 weeks after termination treatments for percent "kill".

Soybean collections will be made in meter 2 collections at the end of the growing season to determine soybean yields

Progress or Status:

2011:
Some minimal data was collected; however, data was not complete or necessarily accurate. There were issues with the stands of cover crops. Early in the spring much of the study area became flooded. During the summer there was drought which hurt the soybeans enough to not get a stand. Data is not presented for 2011.

2012:
Plantings established well but were not very tall (<6" tall). Snow geese migrated through on March 1, 2013 and decimated all of the wheat plots and about 50% of the cereal rye plots. Much of the rest of the study became flooded also and harmed the plots. Data is not presented for 2012.

This study has had many issues that were mostly environmental in nature. A study like this has potential for great information but the area and species that were used will need to be rethought and reapproved. This study is discontinued and no other data or conclusions will be presented.

National Study: Effect of Mixed Species Cover Crops on Soil Health

Study No. MOPMC-T-1228, CP

National Project(s): Cropland 1.1

Study Leader: Allen Casey, Soil Conservationist

Introduction: The NRCS's National Soil Health and Sustainability Team and Plant Materials Program are working together to improve our knowledge of using cover crop mixes to produce healthy soils. Three seeding rates and three seed mixes are being evaluated to observe their impact on soil health. At multiple times during the life of the cover crop, the PMC will collect above-ground data to determine the consequences of treatments on plant cover, species composition, and total biomass.

Cover crop attributes are systematically sampled at intervals to accommodate required parameters in water and wind erosion field assessment tools, RUSLE2 and WEPS, respectively. Percent canopy cover, canopy height and productivity of the cover crop mixes by seeding rate will be provided to NRCS crop and soil database manager for updating the national crop and soil management database

Data will be compiled and provided to field office to use to recommend particular cover crop species and mixes in areas around the country. It will also be able to demonstrate the changes in soil health through the use of cover crops in rotation. Dr. Larry West with NRCS's Kellogg Soil Survey Laboratory and Dr. Rick Haney with the ARS Grassland Soil and Water Research Laboratory will provide analysis on fertility, soil properties, and biological activity.

Objective: Determine the effect of 2, 4, and 6 cover crop mixes planted at three different seeding rates consisting of 20, 40 and 60 seed ft^2 on l soil health.

Procedure: Experimental design and sampling procedure follows the USDA Natural Resources Conservation Service Plant Materials Program Sampling Methods for Soil Health Study. Two, four, and six species mixes will be planted, with treatments of 20, 40, and 60 seeds per square foot. The amount that each species makes up of each mix is shown in Table 1. Plots are 20ft x 30ft arranged in a randomized complete block design with four replications. Each plot is divided into subplots that will get sampled once in the three year period.

Potential Products: Vegetation file for the RUSLE2 or WEPS model, peer-reviewed journal article, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides

Progress or Status:

2012: On 14 May 2012, Dave Skaer, NRCS Soil Scientist, sampled the area for this study and did a soil description of the area. On 2 Oct 2012, soybeans were harvested off of the study site. On 3 Oct 2012, the area was disked and culti-mulched to be the same as the other PMC's that were involved with the study. On 4-5 Oct 2012, the field's soils were sampled for bulk density, biological assessment, compaction, and other, as per the study protocol. The cover crop treatments were planted on 10 Oct 2012. Sampling of plant cover was done 30 and 60 days after planting (DAP).

2013: On 22 Apr 2013, which were 194 DAP; the treatments were sampled for biomass, plant and residue cover, botanical compositions, and others as per the study protocol. All treatments were sprayed with glyphosate and 2, 4-D on 22 Apr 2013. On 14 May 2013, the soils were sampled for biological assessment and field corn was planted. On 11 Sep 2013, a webinar with

the other involved Plant Materials Centers was held to show parts of the preliminary data from the first year of sampling. On 17 Oct 2013, field corn was sampled for yield and harvested off of the area. On 21-24 Oct 2013, the treatment plots were sampled as per the protocol. On 25 Oct 2013 the plots were planted with the appropriate cover crop treatment. On 7 Nov 2013, the study area was discussed and shown as part of a Soil Health and Cover Crop workshop where approximately 100 people were in attendance. On 26 Nov 2013, canopy cover and height was sampled from the treatment plots.

Summary: The field corn yield ranged from 124 to 151 bu/ac in the cover crop treatment plots compared to 186 bu/ac in the control plot (Figure 1). , Corn yield from 20, 40, and 60 seeds/ft^2 seeding rates of two- and four-species cover crop mixes and the 20 seeds/ft^2 rate of 6-species cover crop mixes were not significantly different. The control treatment had significantly higher yield than the cover crop treatments, except for 40 and 60 seeds/ft^2 seeding rates of six-species mix.

The percent mean total ground cover in the cover crop treatments generally increased as the seeding rate increased (Figure 2). The percent mean total ground cover also generally increased from 30 to 60 days after planting (DAP) and at termination at 194 DAP (Figure 2). At termination on 22 April 2014 (194 DAP) there were no planted forbs present and planted grass made up the greatest percent of the cover in the cover crop mixes (Figure 3). Fewer weeds were present in the cover crop treatments than in the control treatment (Figure 3). Of the grass components, cereal rye made up the majority of the cover with oats making up 1% or less in the six-species cover crop mix for all seeding rates (Figure 4). Some crimson clover survived the winter of 2012-2013 and was present in all of the cover crop treatments at termination. In the two species mixes crimson clover made up between 5and 10% of the cover (Figure 5). In the four-species and six-species cover crop plots crimson clover made up less than 5% of the cover (Figure 5). Hairy vetch was not planted in the two-species mix but accounted for 30to 43% of the cover obtained with the 4 and 6 species mix at termination (Figure 5). Canola and radish did not survive the winter and therefore, they did not account for any percent cover in any of the cover crop treatment plots at termination in April 2013. The total above ground dry biomass at termination ranged from 1900 to 2800 lb/ac for the cover crop treatment plots compared to 735 lb/ac in the control, which were primarily weeds (Figure 6). .

Mean soil bulk density sampled before cover crops were planted in October of 2012 and October 2013 changed minimal from the first year to the next year at either 0-2 or 2-4 inch soil depth (Figure 7). The mean soil water content sampled at the same time as the soil bulk density showed little change from the first year to the next (Figure 8). Mean soil resistance was measured at three soil depths(0-6, 6-12, 12-18 inches) at the same time as was the bulk density and soil water content. There were no changes in the soil resistance from the first year to the second year (Figure 9). The mean percent soil volumetric water content at cover crop planting was less in year 2 (2013) than in year 1 (2012) for all plots including the control treatments (Figure 10). The mean soil temperature at cover crop planting tended to be lower in year 2 (2013) than in year 1 (2012) for all plots including the control treatments (Figure 11). The mean percent soil volumetric water content at cover crop termination in April 2013 ranged from a high of 38.5% to a low of 36.5% in the control plots (Figure 12). The mean soil temperature at termination ranged from a high of 25°C in the two-species planted at 40 seed/ft^2 to a low of 24 °C in the six-species planted at 60 seeds/ft^2 (Figure 13).

Table 1. Cover crop mixes for the Effect of Mixed Species Cover Crops on Soil Health Study at the Missouri Plant Materials Center.

Mix	Grass	Legume	Forb
2-species	50% cereal rye	50% crimson clover	NA
4-species	45% cereal rye	22.5% crimson clover 22.5% hairy vetch	10% Tillage® radish
6-species	22.5% cereal rye 22.5% oats	22.5% crimson clover 22.5% hairy vetch	5% Tillage® radish 5% canola

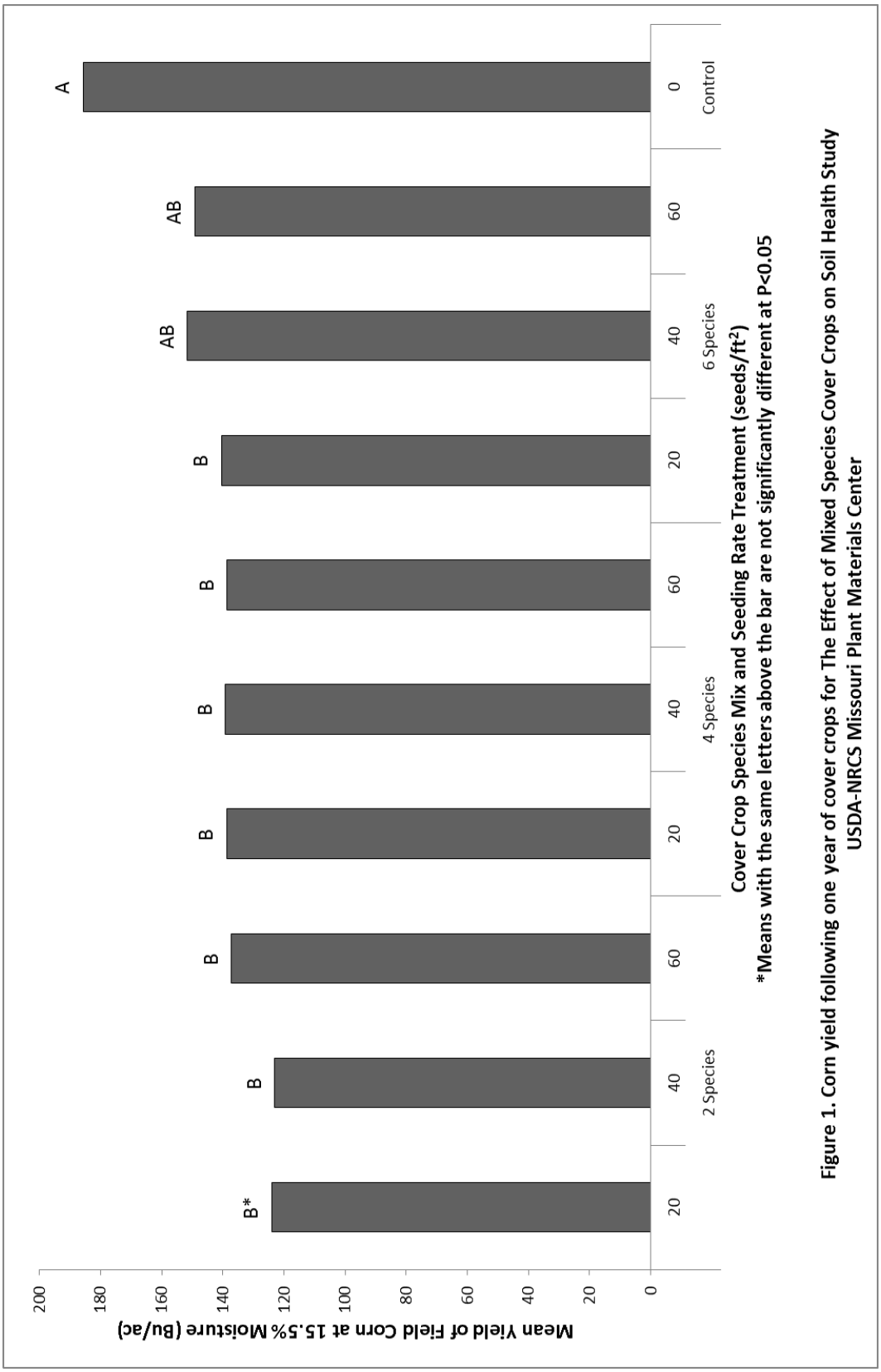


Figure 1. Corn yield following one year of cover crops for The Effect of Mixed Species Cover Crops on Soil Health Study

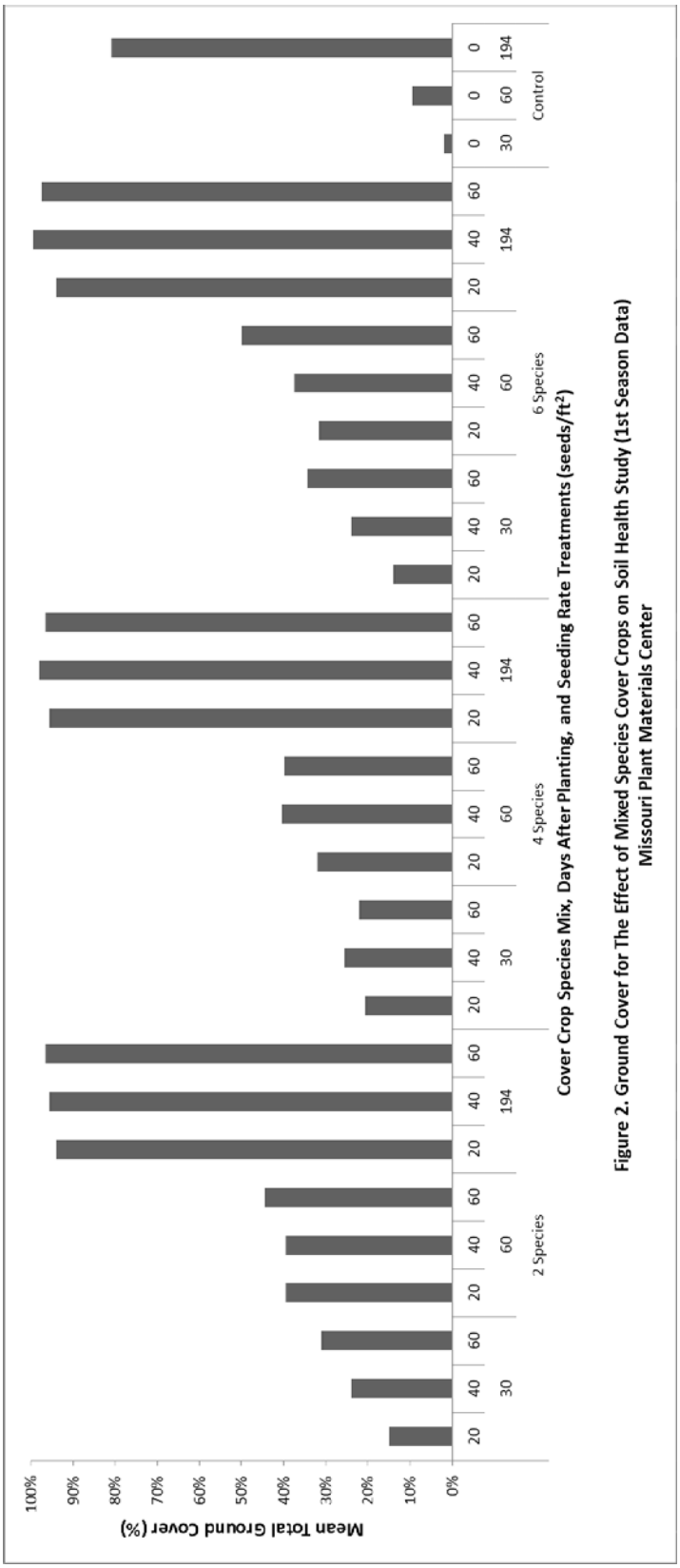


Figure 2. Ground Cover for The Effect of Mixed Species Cover Crops on Soil Health Study (1st Season Data) Missouri Plant Materials Center

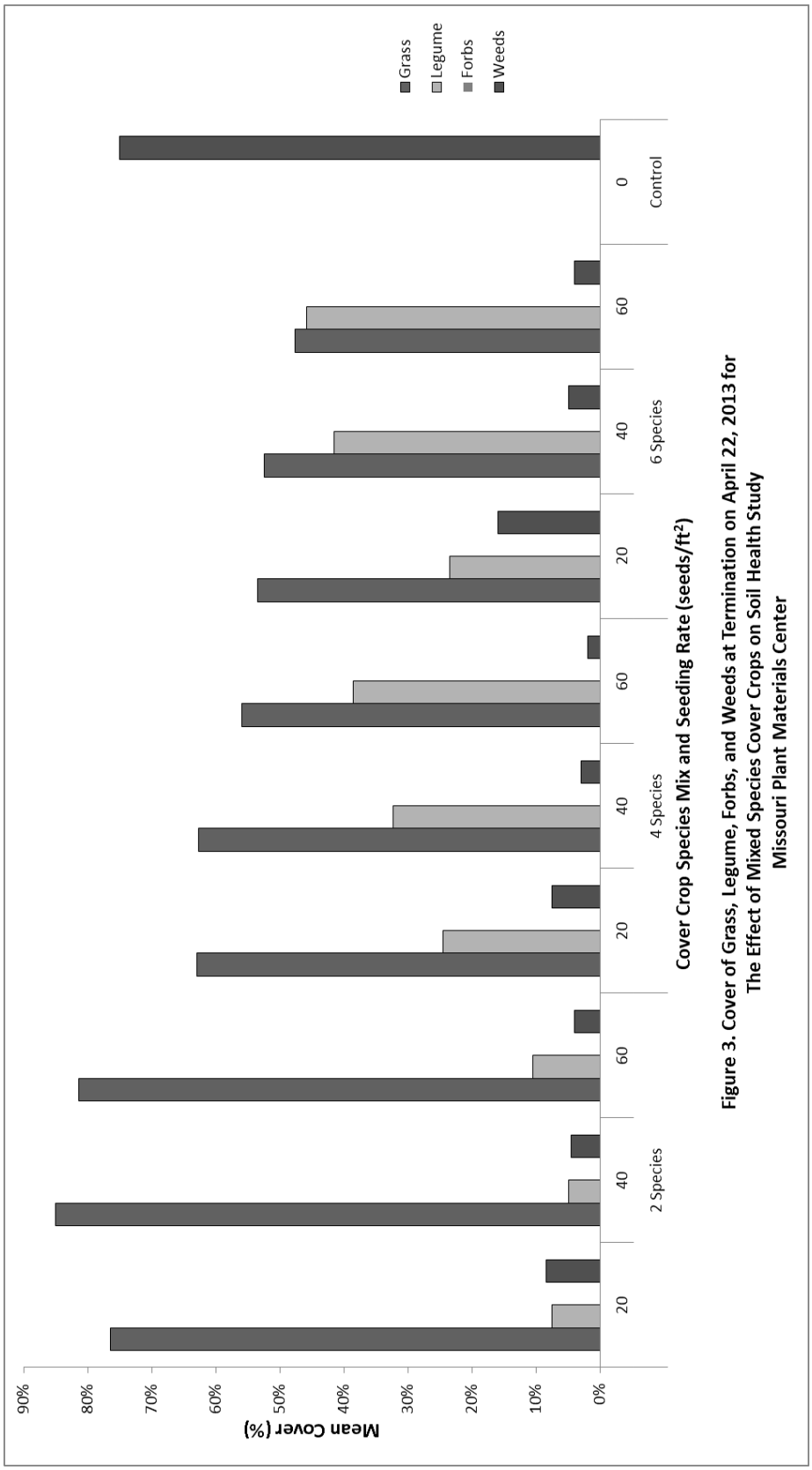


Figure 3. Cover of Grass, Legume, Forbs, and Weeds at Termination on April 22, 2013 for The Effect of Mixed Species Cover Crops on Soil Health Study Missouri Plant Materials Center

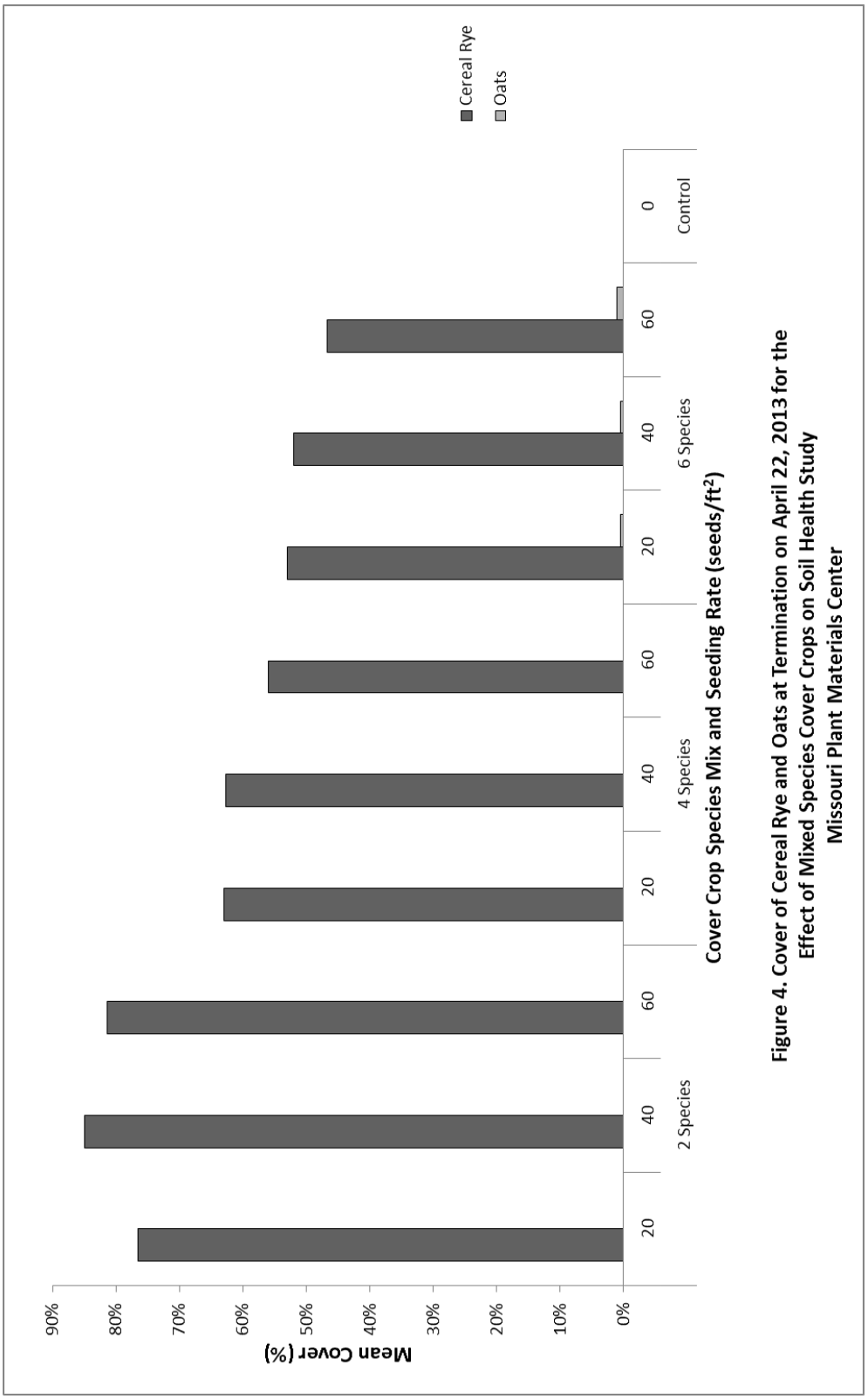


Figure 4. Cover of Cereal Rye and Oats at Termination on April 22, 2013 for the Effect of Mixed Species Cover Crops on Soil Health Study Missouri Plant Materials Center

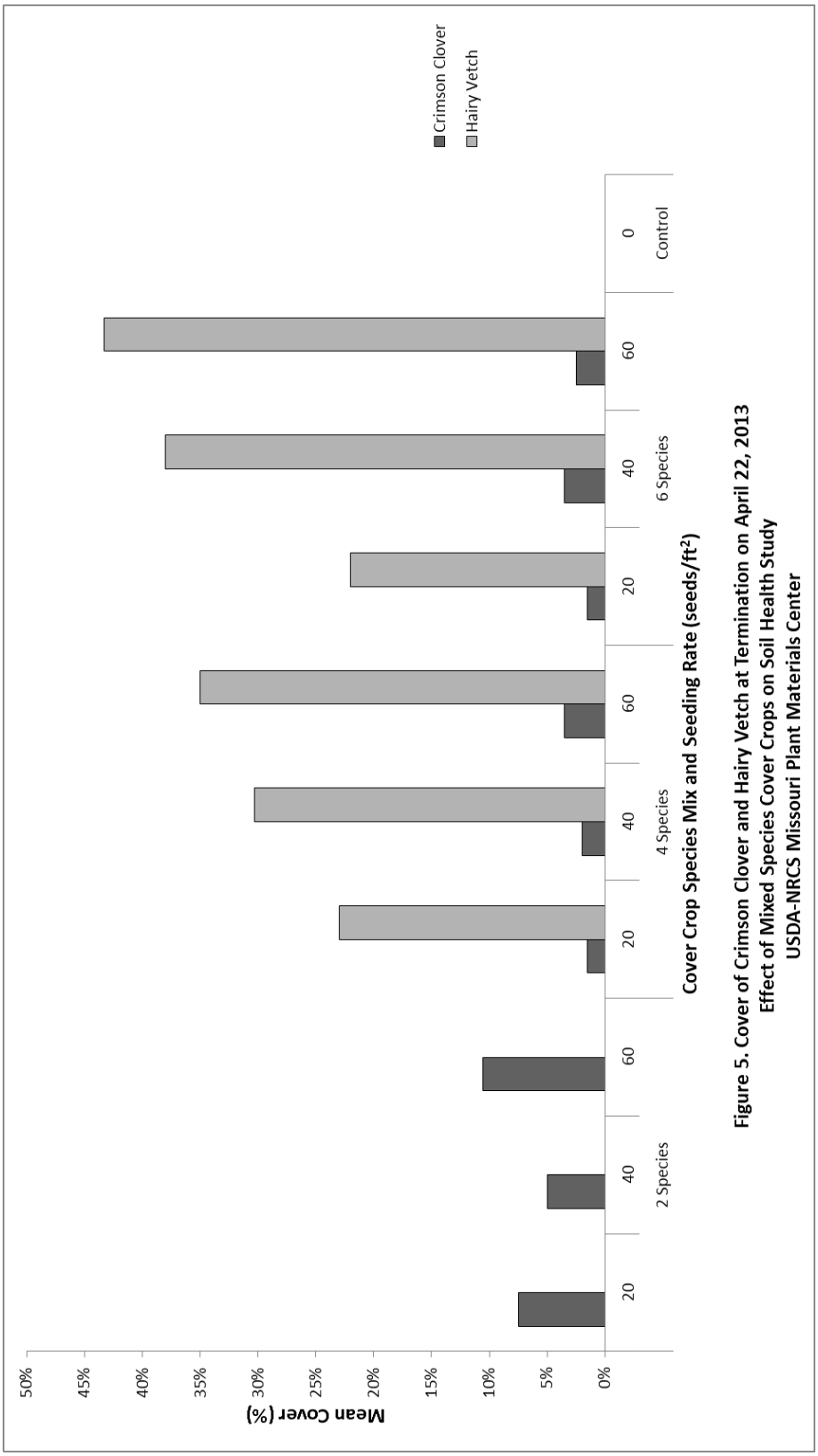


Figure 5. Cover of Crimson Clover and Hairy Vetch at Termination on April 22, 2013
Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

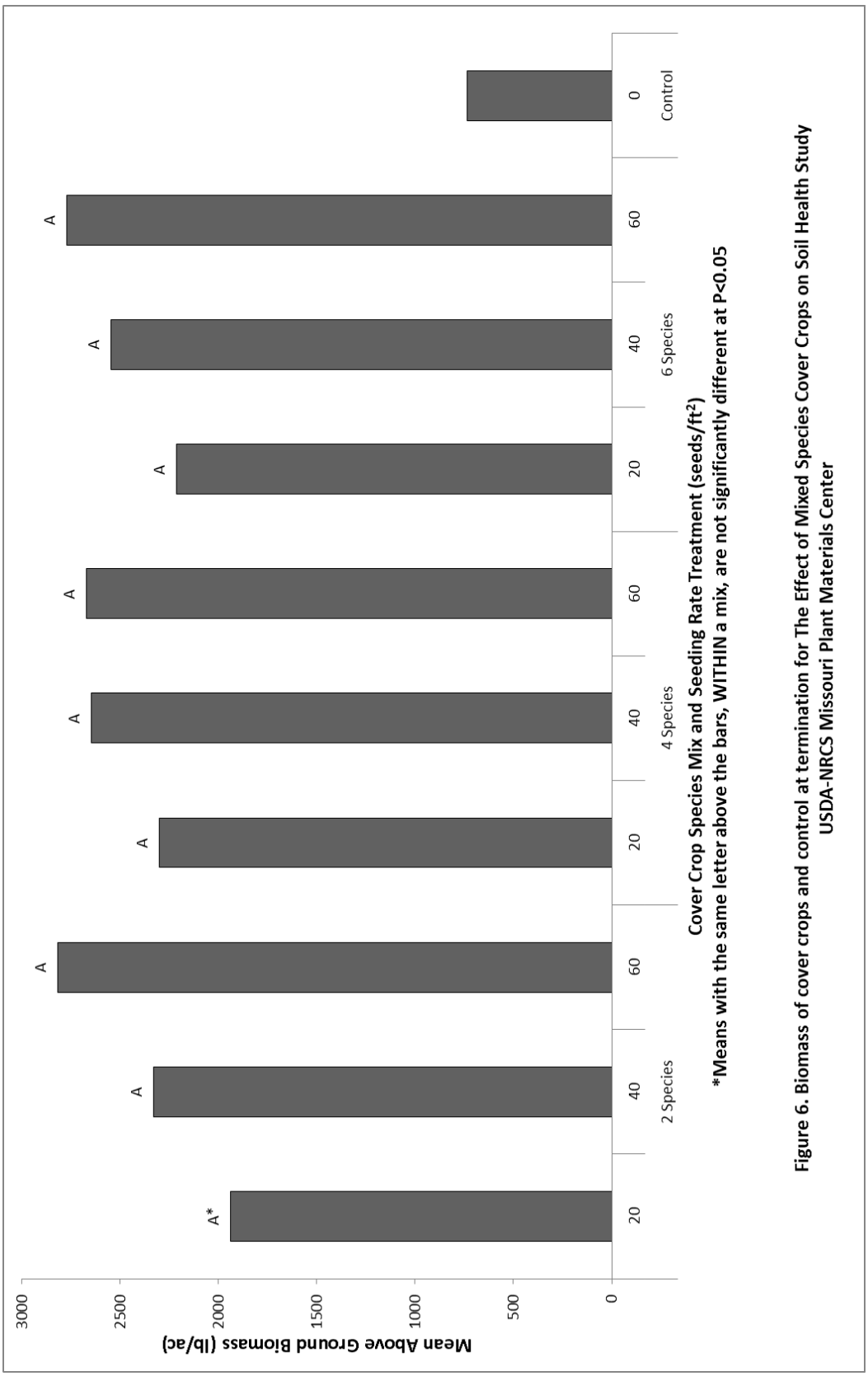


Figure 6. Biomass of cover crops and control at termination for The Effect of Mixed Species Cover Crops on Soil Health Study USDA-NRCS Missouri Plant Materials Center

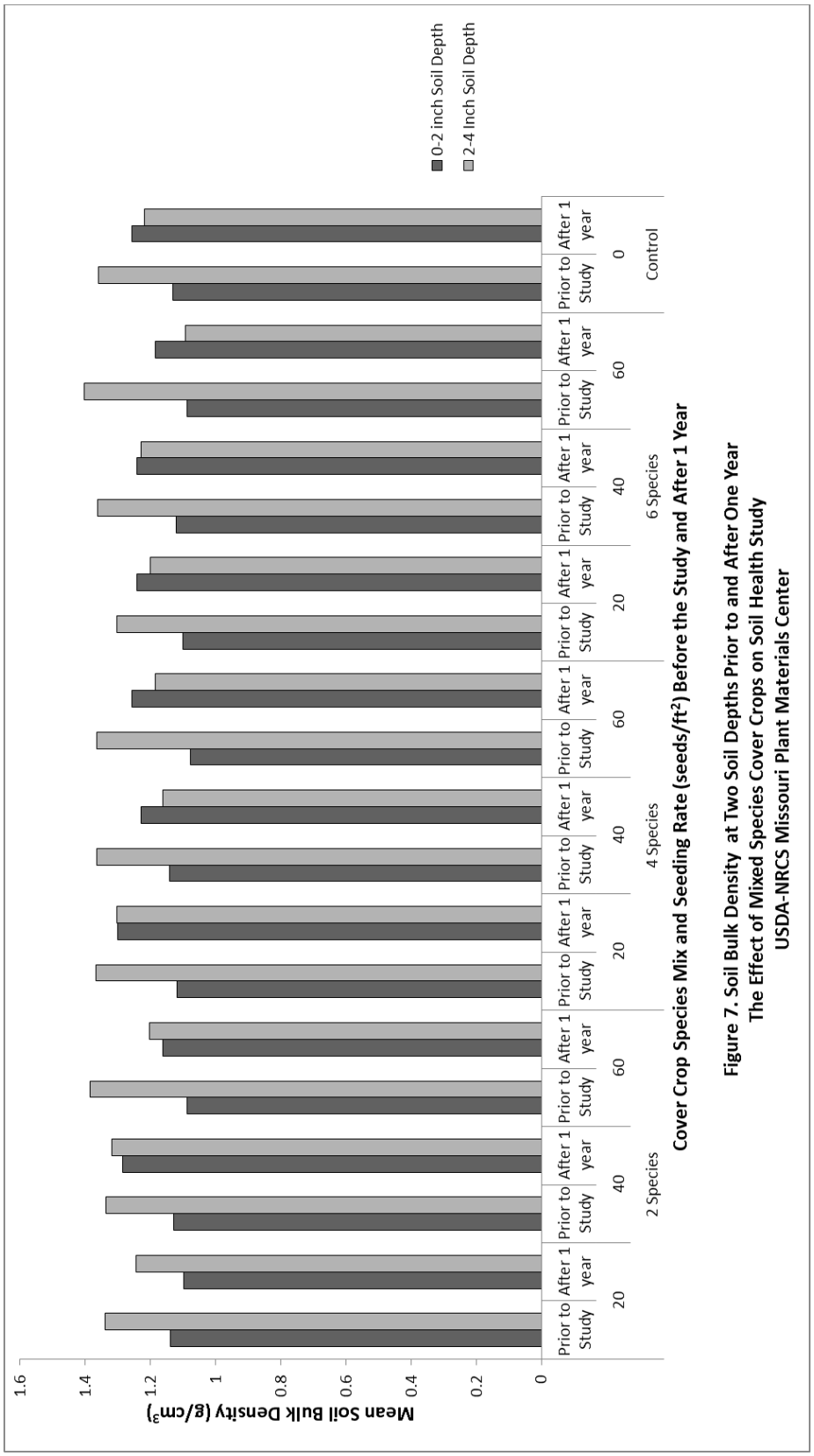


Figure 7. Soil Bulk Density at Two Soil Depths Prior to and After One Year
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

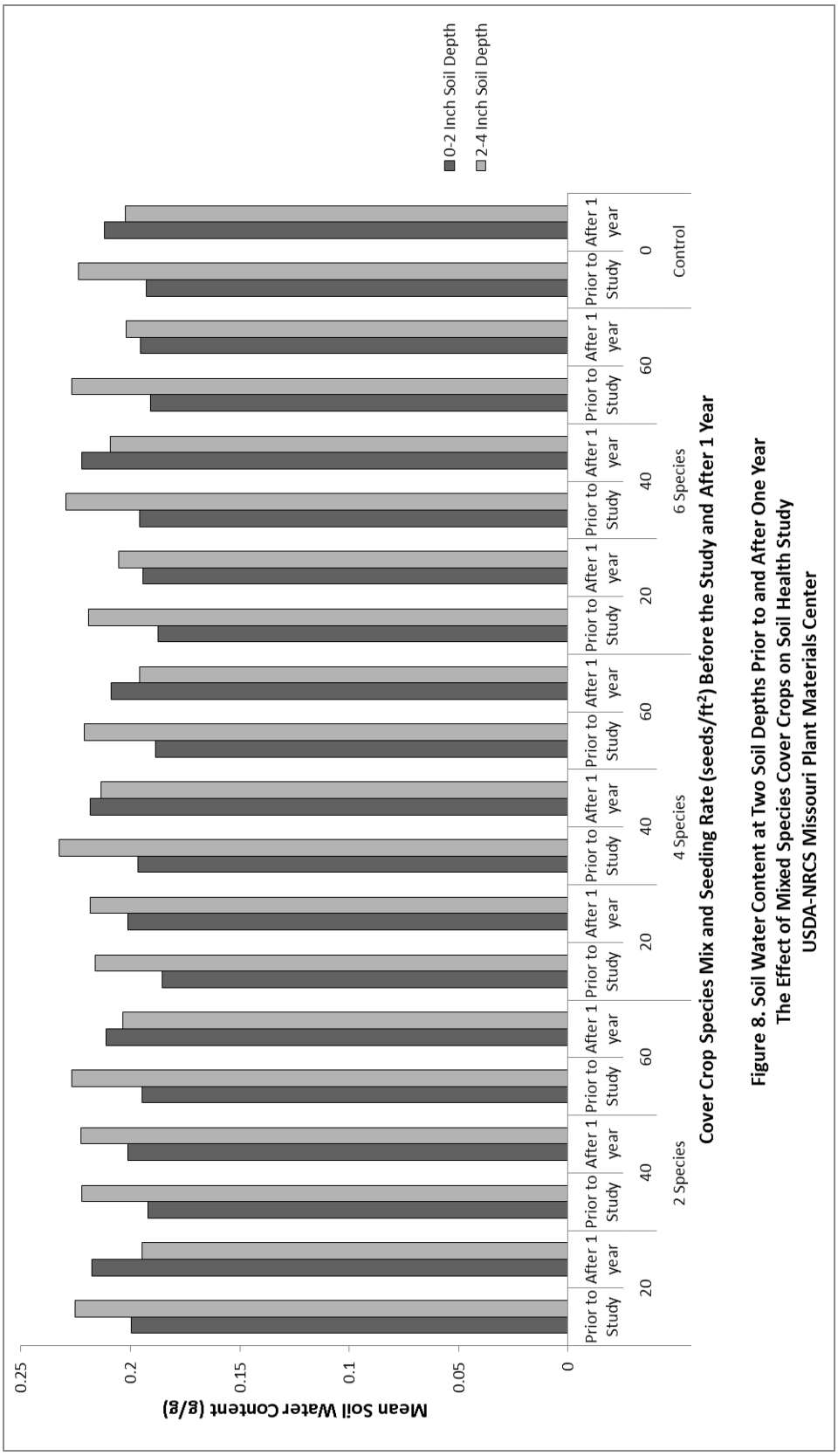


Figure 8. Soil Water Content at Two Soil Depths Prior to and After One Year
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

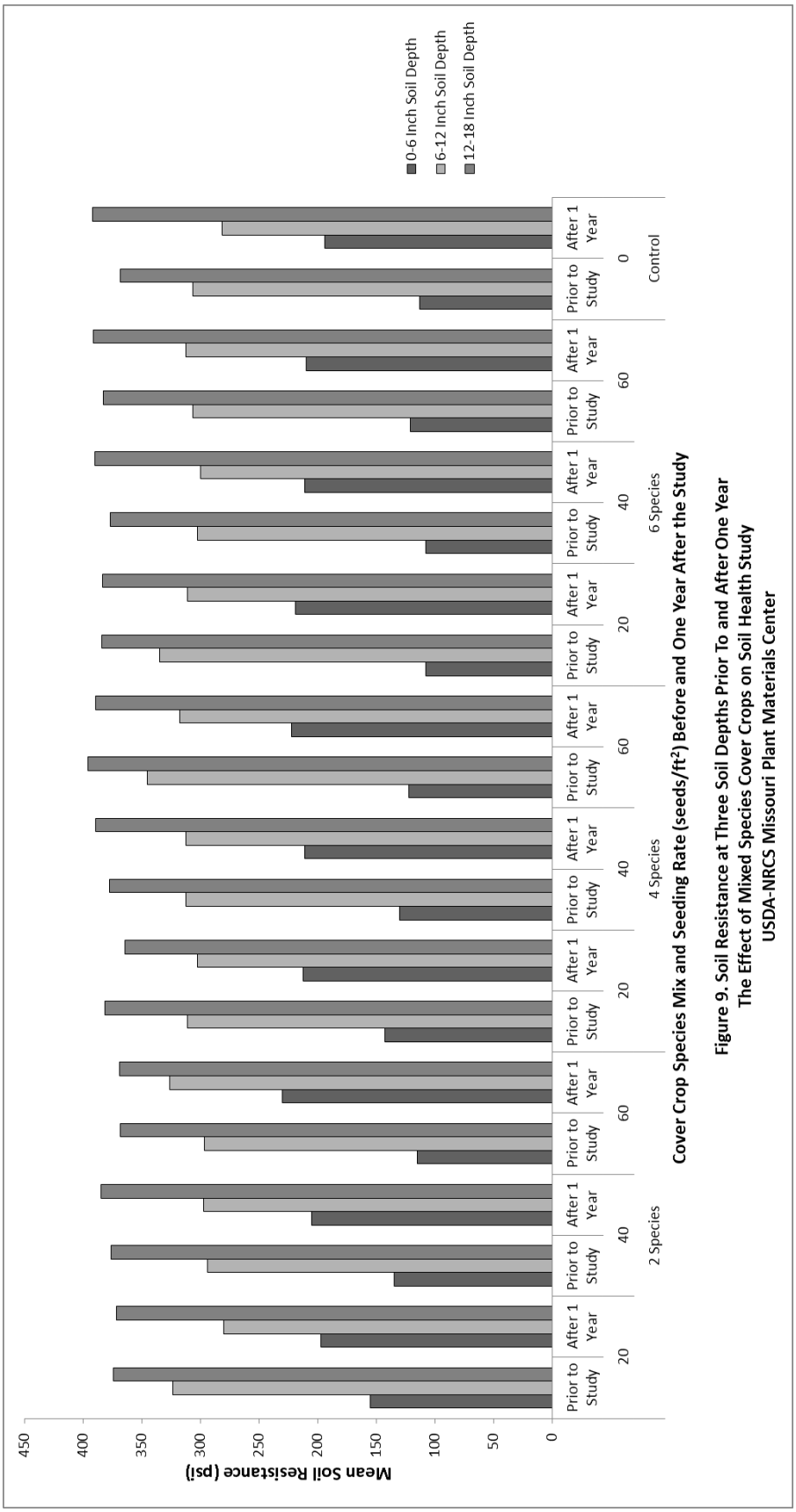


Figure 9. Soil Resistance at Three Soil Depths Prior To and After One Year
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

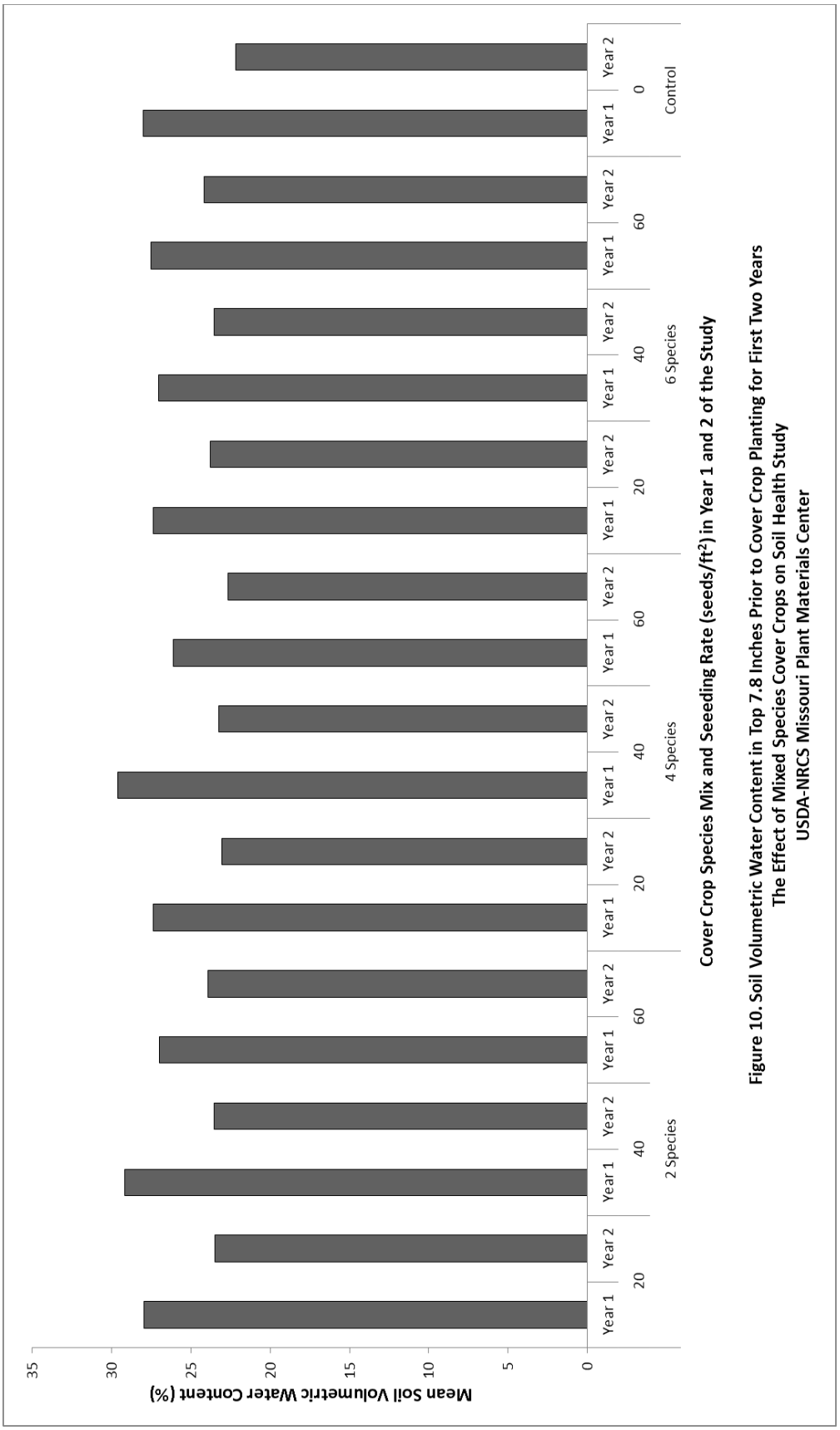


Figure 10. Soil Volumetric Water Content in Top 7.8 Inches Prior to Cover Crop Planting for First Two Years
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

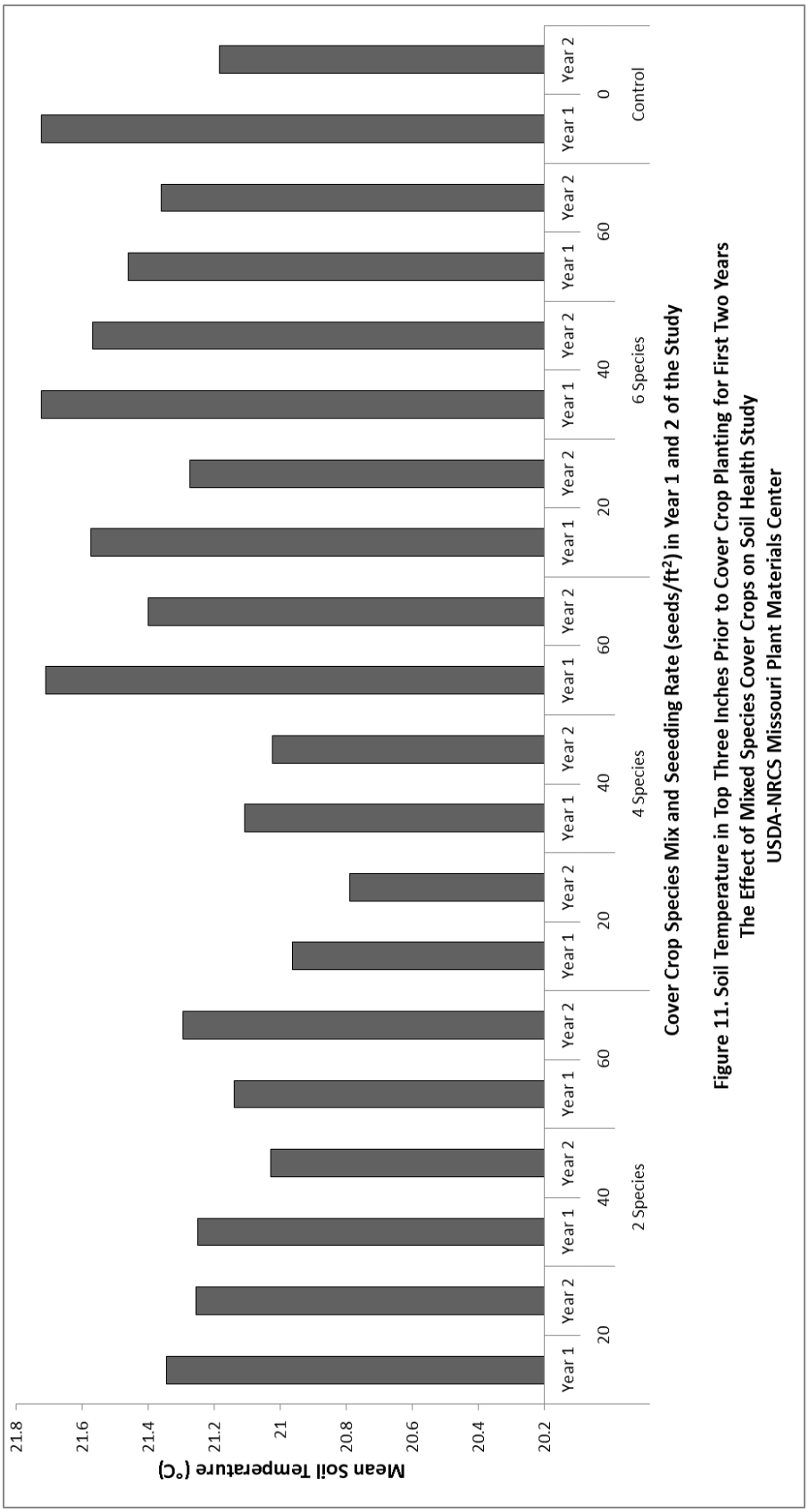


Figure 11. Soil Temperature in Top Three Inches Prior to Cover Crop Planting for First Two Years
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

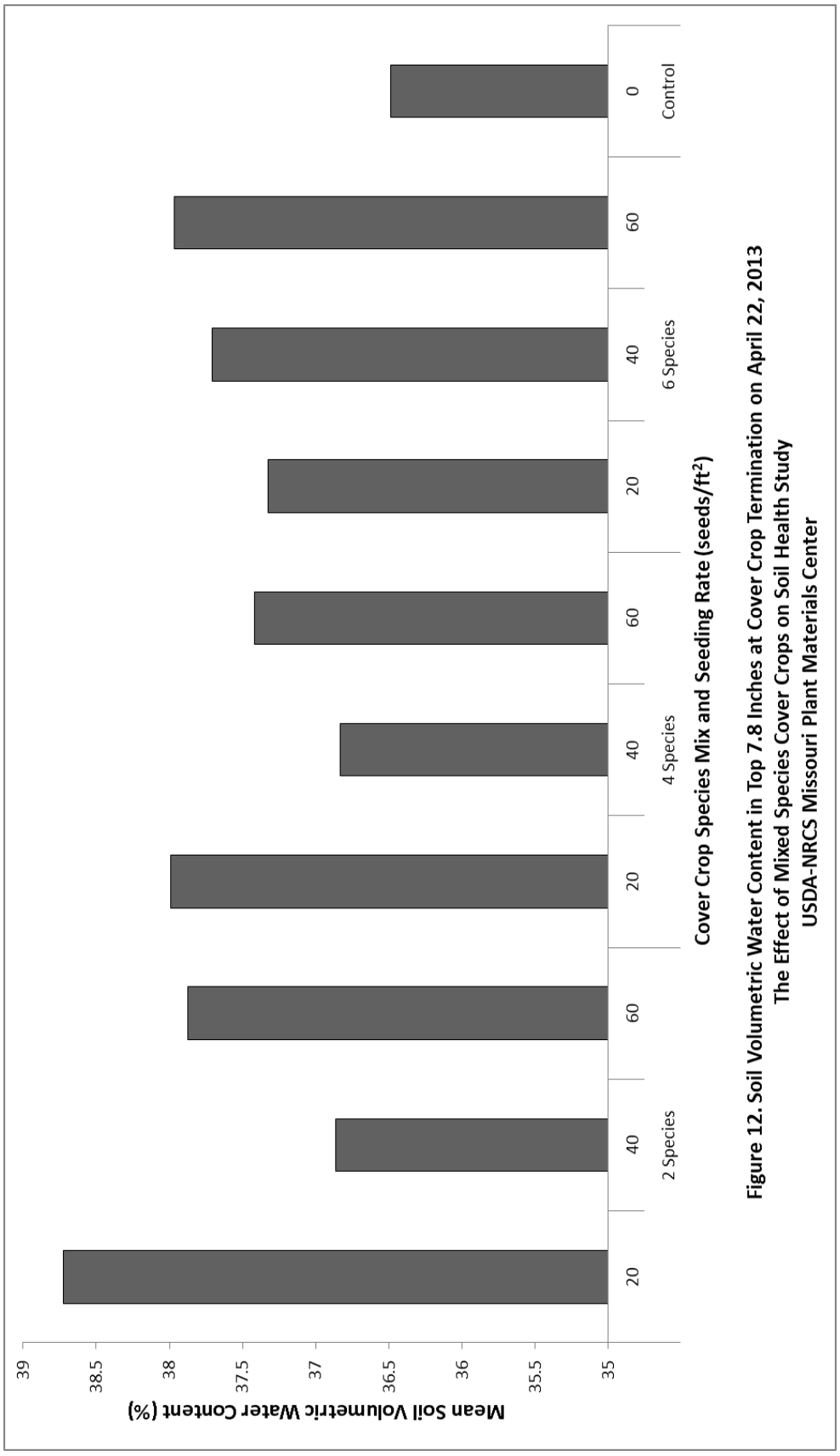


Figure 12. Soil Volumetric Water Content in Top 7.8 Inches at Cover Crop Termination on April 22, 2013
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

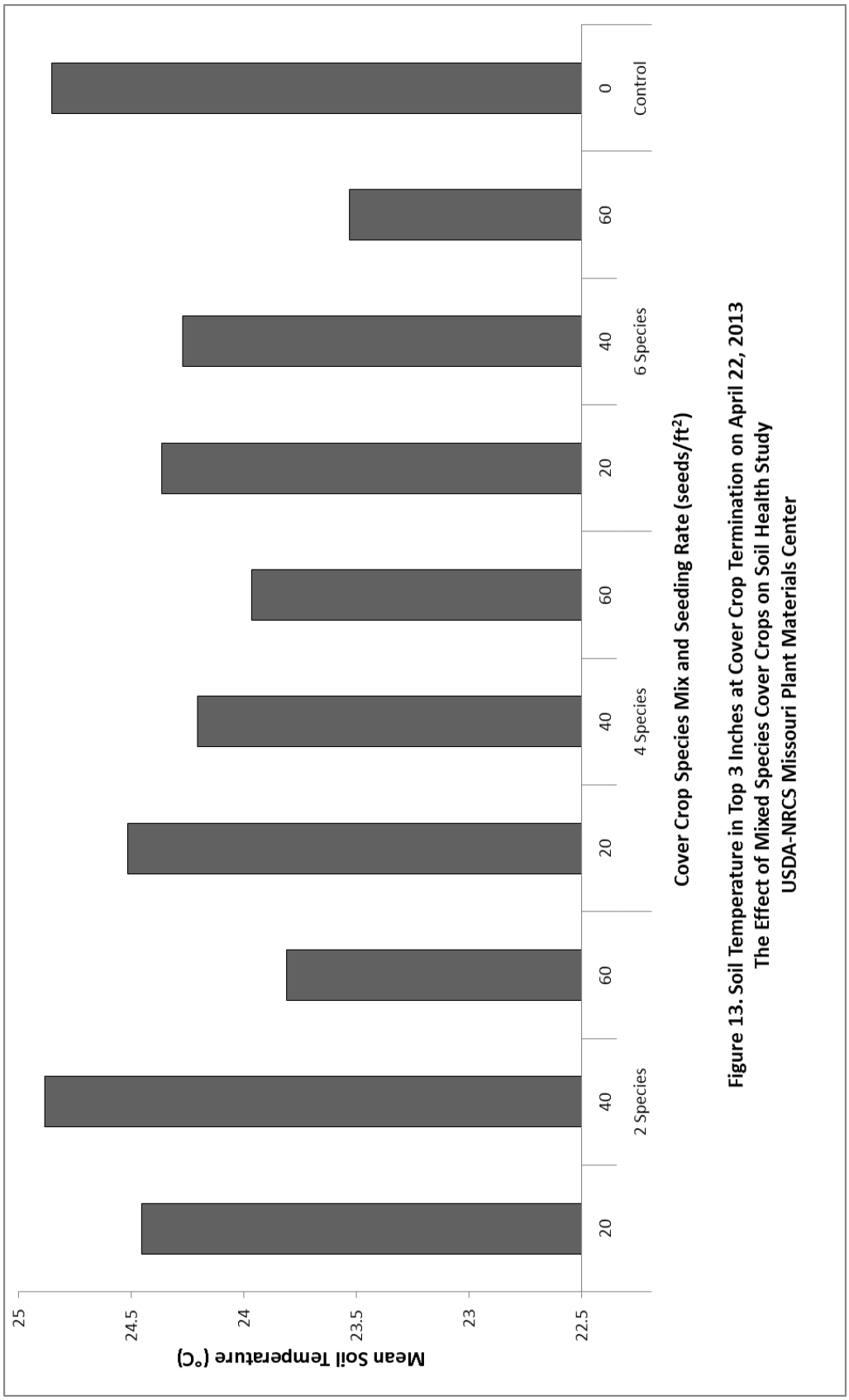


Figure 13. Soil Temperature in Top 3 Inches at Cover Crop Termination on April 22, 2013
The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

Cool and Warm Season Cover Crop Evaluation

Study No. MOPMS-T-1125

National Project(s): Cropland 1.1

Study Leader: Jerry U. Kaiser, Plant Materials Specialist

Introduction: The need for the cover crop study is to collect data for these 12 species of warm and cool season species in the planned mixes, by evaluating percent cover during the growing season, how much dry matter yield is produced, and timing of cover crop termination prior to establishment of the subsequent cash crop. The objective is to have cover after summer and fall cash crops so that the cover crop will perform multiple benefits for the resource base (e.g. soil protection). Cover crops can improve soil health by reducing compaction, improving organic matter, and decreasing runoff and erosion. Cover crops can improve water quality by sequestering nitrogen before it leaches into the ground water. A concern is on timing of cover crop termination prior to planting the cash crop. The study will demonstrate different termination dates for control of the cover crops.

Annual ryegrass has an extensive root system that tolerates compacted soils and makes it an effective cover crop for excess nitrogen (Bjorkman et al., 2009). Radishes are excellent at breaking up shallow layers of compacted soils, earning them the nicknames “biodrills” or “tillage radishes.” A thinner extension of the tap root can penetrate deeper layers of compaction. The roots die over the winter and leave channels so that the soil dries and warms up faster in the spring (Bjorkman et al., 2009). Sorghum sudangrass provide abundant root biomass, which is useful for increasing soil organic matter (Bjorkman et al, 2009).

Non-legume species such as rye, oats, wheat, forage turnips, oilseed radish, sudangrass, and buckwheat recycle existing soil nitrogen and other nutrients and can reduce leaching losses. (Sundermeier et al., 1999)

Certain broad-leaved plants are noted for their ability to accumulate minerals at high concentrations in their tissue (Sullivan et al, 2003).

Studies have shown that legume cover crops can replace a portion of the fertilizer nitrogen requirements of the subsequent crop. The economic value of these nitrogen replacements can be calculated by using a local nitrogen price. These costs can then be compared to cover crop seed and planting costs. These simple nitrogen cost comparisons do not take into account the benefits of improved soil tilth and increased water infiltration resulting from cover crops (Sullivan et al,2003).

Timing of burn down chemicals is important when terminating a spring growing cover crop. Ideally, cover crops should be allowed to grow as long as possible in the spring to add additional nutrients to the soil and suppress weeds. However, the longer the cover crop is growing the more moisture it removes and could potentially affect the growth and development of the subsequent crop, especially if drought conditions exists (Sundermeier et al, 1999).

Objective: Cool and warm season cover crops will be evaluated for their suitability and performance following wheat (warm season) and soybean production system (cool season). . Evaluation parameters for characterizing cover crop response are percent canopy cover, biomass, and cover crop termination success (refer to materials and methods section for specifics on planting, management, data collection dates, etc.

Procedure: Species (see list below) from appropriate sources will be planted by seed into plots containing 7.5 inch row, 10 ft x 30 ft (Actual plot size planted will be 10’X50’) per plot. See attachment 1 for plot layout design.

In 2011-2013 and aerial application of the cool season mixtures listed below (simulated by cyclone seeder) was applied over a set of 10'X 50'plot before soybean harvest, during leaf yellowing and before leaf drop. No fertilizer or supplemental water was applied during the study.

Experimental design is a randomized complete block with 4 replications.

a. 'Aroostook'cereal rye
b. 'Aroostook'cereal rye, VNS oats, 'Appin' forage radish
c. 'Gulf'(11) 'Bounty'(12) annual rye grass, 'Appin' forage radish
d. 'Aroostook'cereal rye, VNS (11) 'Purple Bounty' (12) hairy vetch
e. Gulf'(11) 'Bounty'(12)annual ryegrass, VNS ladino clover
f. 'Aroostook'cereal rye, 'Dixie' crimson clover
g. Soybean residue No cover crop

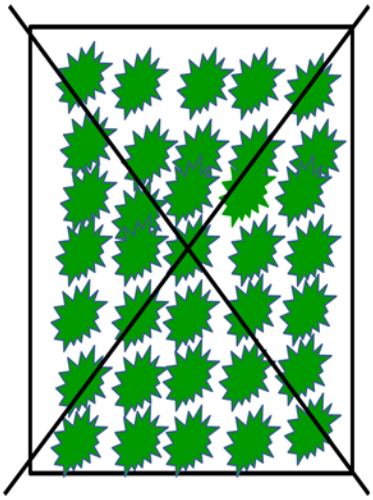
Following soybean harvest in 2011-2013 the following cool season cover crops and mixes were drilled into 10' x 50' plots at the Elsberry PMC. No fertilizer or supplemental water was applied during the study. Experimental design was a randomized complete block with 4 replications.

h. Aroostook'cereal rye
i. Aroostook'cereal rye, VNS oats, 'Appin'forage radish
j. 'Gulf'(11) 'Bounty'(12) annual ryegrass, 'Appin forage radish
k. 'Aroostook'cereal rye, VNS (11) 'Purple Bounty' (12) hairy vetch
l. Gulf'(11) 'Bounty'(12)annual ryegrass, VNS ladino clover
m. 'Aroostook'cereal rye, 'Dixie' crimson clover
n. Soybean residue No cover crop

Prior to the first killing frost, stand counts were determined for each of the cover crops using the frequency grid and photographs to document early growth of the cover crop species.

Percent canopy cover measurement was determined using the line transect method.

Transects were taken March 1, April 1, May 1 to construct a RUSLE 2 growth curve. Percent canopy cover was measured by placing the line transects in a "X" pattern across the plot.



Line transect will be laid in an "X" pattern for percent canopy cover measurements.

Total dry matter yield was determined by taking 1 m^2 sample from random locations in plots 10' x 10' (10' x 30' original plot size)

Cover Crop with annual ryegrass yield dates was scheduled for March 15, March 30th, and April 15th.

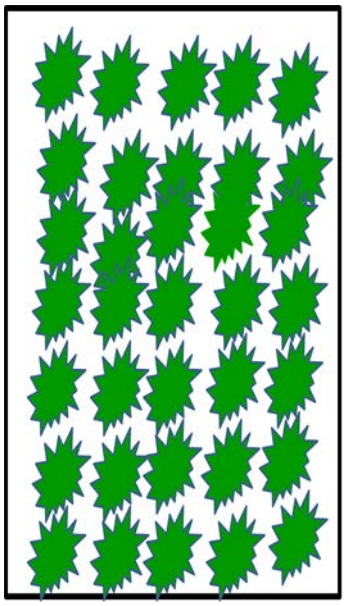
Cover Crop with Cereal rye yield dates was scheduled for April 15, May 1 and May 15. Subsamples were collected for dry matter determination at (55-60°C for 16-24 hours or until dry).

Timing of Cover Crop Termination was determined by applying glyphosate at the recommended rate for burn down of cover crops. Cover Crop with Annual ryegrass use glyphosate with citric acid to correct for water pH for termination scheduled for March 15, March 30th, and April 15th. Cover Crop with Cereal rye used glyphosate with citric acid applied April 15, May 1, and May 15. The termination application was completed by doing 3' strips across the plots marking the areas with different colors of flags to apply the herbicide for the selected date. Visual rating of burn down success was determined 2 and 4 weeks after application.

Warm-season cover crops

In 2011-2012 following June wheat harvest the warm season cover crops and mixes were drilled into 10' x 30' plots at the Elsberry PMC. No fertilizer or supplemental water was applied during the study. Experimental design was a randomized complete block with 4 replications.

a. pearl millet, crimson clover, sorghum sudangrass, buckwheat, cow peas
b. pearl millet, sorghum sudangrass, bobwhite soybean
c. pearl millet, sorghum sudangrass, bobwhite soybean and sun hemp
d. teff, forage radish
e. commercial soybeans
f. pearl millet, crimson clover, sorghum sudangrass, buck wheat, cow peas, bobwhite soybeans, forage radish, sun hemp
g. Wheat stubble residue no cover crop



10' x 30' plots divided into equal subplots for dry matter yield and herbicide timing evaluations.

Total dry matter yield was determined by taking a 1 m^2 sample from a random location in each plot approximately 1 week prior to the average first killing frost for Elsberry, Missouri.

Percent residue canopy cover was determined using the line transect method following the same procedure as the cool season cover crop study. Measurements were made May 1.

Potential Products: Progress report, technical report, peer-review journal article, technical notes, poster presentations, and oral presentations.

Literature Cited:

Bjorkman T, Cornell University, New York State Agricultural Experiment Station, Cover Crops in soil health, www.hort.cornell.edu/bjorkman/lab/covercrops/soil-health.php

Sullivan P, National Center for Appropriate Technology, Overview of Cover Crops and Green Manures, http://attra.ncat.org/attra-pub/covercrop.html

Sundermeiier A, Ohio State University, Department of Horticulture and Crop Science, Cover Crop Fundamentals, http://ohioline.osu.edu/agf-fact/0142.html

Progress or Status:

2011:

In June after wheat harvest the warm season mixtures of cover crops plots were planted in field 7. In September completed evaluation rating for the warm season mixtures, average height, and percent stand of mixtures.

Table 1 has the 2011 plot layout for the warm season mixtures.

Table 2 has fall 2011 data for percent stand and height. First week in October 2011 harvest 1 meter sq. from each of the warm season cover crop mixtures for dry matter yield before the first average killing frost (October 10th).
Table 2 A has the biomass data for the warm season mixtures.

In May an early group 3.1 soybeans was planted to allow for an early harvest for establishing the cool season cover crops mixtures for plots in field 11. September 20 aerial seeding completed (cyclone seeder) before all leaf drop of soybeans in field 11for the cool season species mixtures. Below normal rainfall and dry conditions exist at the time of seeding. September 26 harvest soybeans and drilled cool season mixtures were completed with plot seeder. October completed an emergence check on cool season species in drilled plots showed cereal rye and forage turnips, only cereal rye developed in aerial plots. December evaluated cool season species for rating emergence, average height, and percent stand.

Table 3 has plot layout for the different combination of cool season mixtures.

Table 4 for cover crop heights, percent stand by December 2011 for the aerial application completed on September 20, 2011.

Table 5 for cover crop heights, percent stand by December 2011 for the drilled application completed on September 26, 2011.

2012:
In Field 11 the cool season mixtures cover crops in both drilled and aerial plots; the annual ryegrass mixtures and cereal rye mixtures consisted of those species as the base for the mixture with a combination of a legume and/or broadleaf species.

Table 6 illustrates drilled cool season cover crop mixtures. The data provides the amount of canopy cover measurements and the percentage by month of canopy cover.

Table 7 illustrates the aerial cool season cover crop mixtures starting the first of March 2012. The second canopy cover measurements were first of April and a final count the first of May.

Canopy cover was measured by performing transect from each corner of the plots at a 45 degree angle across the plots with the completion of a figure X. The total counts were 50 for each plot at every 1 foot mark. A hit was recorded if the vegetation of the planted species was directly under or over the point at the foot mark on the measuring line.

Charts 3 and 4 illustrates total dry matter yield in tons/ acre for the cool season cover crop mixtures for drilled and aerial plots. Dry matter yield and termination time was changed to a month early on March 13th because of the warm winter for both the aerial and drilled replicated plots. The plots with annual ryegrass mixtures started dry matter yield on March 13 following every two weeks with completion the third dry matter yield on April 12. The cereal rye mixtures started dry matter yield on March 27 for the cereal rye plots every two weeks the third and final dry matter yield was April 25.
Total dry matter yield was measured by clipping all planted species in a 3 sq. ft. circle. The clippings were done randomly within that treatment/ rep/plot for that time period.

Tables 8 and 9 rates the termination success of the cool season cover crop mixtures for drilled and aerial plots. The ratings are based on using the herbicide glyphosate at a rate of 2 quarts/ acre and 4oz. of citric acid to 100 gallons of water to reduce the pH level of the water mixed with the herbicide. Within the plots three different treatments of the herbicide were scheduled on a two week interval.

The first termination time for the plots annual ryegrass mixtures was March 13th.A two week interval was the procedure for the evaluation rating starting on March 26th the annual ryegrass mixtures evaluation ratings were completed for the three glyphosate treatments on May 15th. The cereal rye mixtures 1st started termination with glyphosate on March 27th following with a two week evaluation 1st evaluation on April 12th. The cereal rye mixtures evaluation ratings were completed for the three glyphosate treatments on May 30th

The cool season cover crop mixtures were evaluated by the effects of glyphosate herbicide and rated based on a number system. The visual rating 1=Dead, 3=severe damage, 5=moderate damage, 7=fair damage, 9= No damage.

In May 2012 an early 3.1 soybean was planted in field 7 with cool season cover crop mixtures to be planted in fall 2012. September 10 2012 aerial seeding of cool season cover crops plots was completed before final leaf drop. September 24 2012 drilling of cool season cover crop plots was completed after harvest of soybeans.
The same plot layout and mixtures of species used in field 11 were duplicated in field 7 for the 2013 data. The only change was different varieties were selected for annual ryegrass (Bounty) and hairy vetch (Purple Bounty) for the fall 2012 plantings.

Table 10 for cover crop heights, percent stand by December 12, 2012 for the aerial application was completed on September 10, 2012.

Table 11 for cover crop heights, percent stand by December 12, 2012 for the drilled application was completed on September 24, 2012.

2013:

Charts 7 and 8 provides the amount of percent canopy cover measurements for the aerial and drilled plots starting the March 15th; followed by April 17th for the final count. Canopy cover was measured by performing transect from each corner of the plots at a 45 degree angle across the plots with the completion of a figure X. The total counts were 50 for each plot @ every 1 foot mark. A hit was recorded if the vegetation of the planted species was directly under or over the point at the foot mark on the measuring line.

Charts 9 and 10 show total dry matter yields in tons/ acre. The dates changed because of the wet spring for both the aerial and drilled cover crop mixtures. The cover crop mixtures first dry matter cuttings were April 9th 2013 and the final dry matter cuttings was April 25th 2013.
Total dry matter yield was measured by clipping all planted species (cover crop mixture and weeds) in a 1 sq. ft. circle. Weeds were separate and weighted for each dry matter clipping for each cover crop mixture. The clippings were done randomly within that treatment/ rep/plot for that

time period. The table provides the amount of total dry matter for each cover crop mixture and weeds in tons/ acre. The tables list the cover crop mixtures in tons/acre for the drilled plots and the aerial plots. The weeds contained within the cover crop mixture sampled are listed separately within the charts in tons/ acre.

2013 Termination times and evaluation ratings

First termination date was April 13th 2013 with first treatment 3' strip with yellow flags. The herbicide was Poast Plus (sethoxydim) 2 quarts/acre, 2 pts./acre crop oil and 2#AMS for controlling the grasses in the cover crop mixtures and leaving the legumes to develop. On April 26th 2013 evaluation rating was completed on the treatment with the yellow flags.

2nd termination date was April 29th 2013 with 2nd treatment 3' strip with blue flags. The herbicide was Sencor DF (metribuzin) 5.3 oz./acre,16 oz./acre of Poast Plus(sethoxydim) and 2#AMS. On May 8th two week evaluation was done on the blue flag treatment and the 4 week evaluation done on the yellow flag treatment.

Because of the wet spring, all plots were treated on May 8th, 2013 the herbicide (glyphosate) plus sprayed at a rate of 2 quarts/ acre, 1pt. 2,4-D/acre, AMS and 4oz. of citric acid to reduce the pH level of the water mixed with the herbicide. Two week window was needed before planting the corn since 2,4-D was applied for control on the hairy vetch. Corn was planted on May 23, 2013.

The final evaluation for all treatments was completed on June 11th, 2013; however because of the wet rainy spring season and various herbicides treatments, the data collected was not reliable on the effects using the 1st and 2nd treatments of herbicides for control of the cover crop species during the rating period in April and May. The final evaluation of the herbicide control of cover crop species was documented as 1= dead on June 11th, 2013 except for Annual Ryegrass a rating of 9= No damage in all plots Aerial and Drilled. The wet spring and late planting resulted in a need for a second application of glyphosate to control the annual ryegrass.

Table 1. Cover crop plot layout for species and mixtures following wheat residue.

		10'					
	500 sq.' .01 acre	S.Sudan	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep1		C.Clover	Teff	PL Millet	PL Millet	PL Millet	Residue
50'	Soybeans	Buckwheat	Forage	C Clover	S.Sudan	S.Sudan	Wheat
	Double	Cow Peas	radish	S.Sudan	Bob Soybe	Bob Soybe	No cover
	Crop	Bob Soybe		Buckwheat	Sun Hemp		crop
		F.Radish		Cow Peas			
		Sun Hemp					
		PL Millet					
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	S.Sudan	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep 2		PL Millet	PL Millet	C.Clover		Residue	PL Millet
50'	Teff	C Clover	S.Sudan	Buckwheat	Soybeans	Wheat	S.Sudan
	Forage	S.Sudan	Bob Soybe	Cow Peas	Double	No cover	Bob Soybe
	radish	Buckwheat		Bob Soybe	Crop	crop	Sun Hemp
		Cow Peas		F.Radish			
				Sun Hemp			
				PL Millet			
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	
Rep 3	Residue			PL Millet	PL Millet	PL Millet	S.Sudan
50'	Wheat	Soybeans	Teff	S.Sudan	C Clover	S.Sudan	C.Clover
	No cover	Double	Forage	Bob Soybe	S.Sudan	Bob Soybe	Buckwheat
	crop	Crop	radish	Sun Hemp	Buckwheat		Cow Peas
					Cow Peas		Bob Soybe
							F.Radish
							Sun Hemp
							PL Millet
	500 sq.' .01 acre	500 sq.' .01 acre		500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep 4	Teff	PL Millet	S.Sudan	PL Millet	Residue	PL Millet	
50'	Forage	S.Sudan	C.Clover	S.Sudan	Wheat	C Clover	Soybeans
	radish	Bob Soybe	Buckwheat	Bob Soybe	No cover	S.Sudan	Double
			Cow Peas	Sun Hemp	crop	Buckwheat	Crop
			Bob Soybe			Cow Peas	
			F.Radish				
			Sun Hemp				
			PL Millet				

Table 2. 2011 Evaluations													
Rating 1-Excellent -9 very poor 0-none		Date Planted	Evaluation Date										
Average Height		7/1/2011		8/11/2011									
% estimate of stand													
Summer	Cover Crop Mixtures	Seeding Rate /ac.	Rep 1			Rep 2			Rep 3			Rep 4		
Treatments	following Wheat	by species in mix												
Plot size/ac.	.011 (50'X 10')X4 reps		Rating.	Ht.,	% stand	Rating.	Ht.,	% stand	Rating.	Ht.,	% stand	Rating.	Ht.,	% stand
1	Sorghum Sudangrass	3.1#	1	48"	50%	3	42"	60%	3	40"	40%	3	40"	60%
	Crimson Clover	1.5#	3	12"	3%			0			0			0
	Buckwheat	5.6#	3	30"	5%	1	24"	5%	3	24"	3%	3	24"	3%
	Cow Peas	5.0#	1	24"	10%	1	24"	3%	1	12"	3%	1	24"	5%
	Bobwhite Soybean	1.0#	3	16"	5%	3	18"	3%	3	15"	3%	3	15"	3%
	Forage Turnip	0.5#	3	10"	10%	5	7"	3%	5	5"	3%	5	5"	3%
	Sum Hemp	5.0#	3	36"	15%	3	36"	5%	3	36"	5%	1	36"	5%
	Pearl Millet	1.25#	?			?								
		22.95#/ac				Weeds		21%	Weeds 13%		Resid30%	weeds 21%		
2	Teff	3.0#	3	24"	20%	3	24"	25%	1	35"	55%	3	24"	9 %
	Forage Turnip	2.0#	3	12"	40%	3	7"	10%	3	10"	25%	7	3"	1%
		5.0#/ac												
			Weeds		40%	Weeds		65%	Residue		20%	Weeds/Residue		90%
3	Pearl Millet	2.0#												
	Crimson Clover	2.4#	7	4"	3%	3	12"	10%			0			0
	Sorghum Sudangrass	5.0#												
	Buckwheat	9.0#	3	30"	5%	3	24"	10%	1	24"	10%	1	30"	10%
	Cow Peas	8.0#	1	24"	5%	1	30"	5%	1	24"	10%	1	30"	10%
		26.4#/ac												
4	Pearl Millet	2.5#												
	Bobwhite Soybean	2.25#	3	24"	5%	3	24"	5%				3	24"	1%
	Sorghum Sudangrass	6.25#												
	Sum Hemp	10.0#	1	55"	25%	3	50"	10%				1	36"	5%
		21.00#/ac				Residue		35%				Weeds		14%
5	Pearl Millet	3.3#												
	Sorghum Sudangrass	8.3#												
	Bobwhite Soybean	3.0#	3	30"	5%	3	15"	15%	1	15"	15%	3	24"	3%
		14.6#/ac												
6	Soybeans	45#/ac	5	20"	75%	3	24"	85%	3	20"	75%	5	16"	40%
			Residue		25%	Residue		15%	Residue		25%	Weeds/residue		60%
7	Wheat residue	No seeding residue	Weeds 30% Res70%			Weeds 50% Res50%			Weeds 75% Res25%			Weeds 15% Res85%		

Table 2A. Summer Cover Crop Mixtures		Sample meter square					Sample meter square				Dy wt	Dy wt
		Green wt#, Green wt kg					Dry wt#, dry wt kg				Av. Rep	#/acre
		Rep 1	Rep 2	Rep 3	Rep 4	Mixtures	Rep 1	Rep 2	Rep 3	Rep 4		
1	Sorghum Sudangrass											
Forage dryer list Mix2	Crimson Clover											
	Buckwheat											
	Cow Peas											
	Bobwhite Soybean											
	Forage Turnip											
	Sum Hemp											
	Pearl Millet					**1**						
Total wt for mixture		**5.8**	**5.7**	**7.2**	**4.8**		**1.9**	**1.8**	**2**	**1.5**	**1.8**	**7303#**
2	Teff											
Forage dryer mix 3	Forage Turnip					**2**						
Total wt for mixture		**1.6**	**1.8**	**2.7**	**2.7**	**2**	**0.5**	**0.7**	**1**	**0.9**	**.78#**	**3165#**
3	Pearl Millet											
Forager dry mix 4	Crimson Clover											
	Sorghum Sudangrass											
	Buckwheat											
	Cow Peas					3						
Total wt for mixture		**8.5**	**7.4**	**4.7**	**4**		**3**	**2.4**	**1.4**	**1.2**	**2#**	**8114#**
4	Pearl Millet											
Forager dryer mix 5	Bobwhite Soybean											
	Sorghum Sudangrass											
	Sum Hemp					4						
Total wt for mixture		**6.1**	**4.7**	**5.6**	**4.7**		**1.9**	**1.4**	**1.7**	**1.5**	**1.63**	**6694#**
5	Pearl Millet											
Forager dryer mix 6	Sorghum Sudangrass											
	Bobwhite Soybean					5						
Total wt for mixture		**5.3**	**8.6**	**6.8**	**7.1**		**1.7**	**2.7**	**2.2**	**2.2**	**2.2**	**8925#**
Forage dryer mix 1 6	Soybeans					6						
Total wt for mixture		**4**	**3.8**	**4.7**	**1.7**		**1.3**	**1.1**	**1.4**	**0.6**	**1.1**	**4463#**
						7						
Total wt for residue only7	Wheat residue	**1.3**	**0.5**	**0.2**	**0.4**		**1.2**	**0.4**	**0.2**	**0.2**	**0.5**	**2029#**
Total wt for green mat only7	Wheat residue	**1.2**	**0.7**	**2**	**1.2**		**0.3**	**0.3**	**0.7**	**0.4**	**0.4**	**1724#**
Tallest species meters 1	**Sorghum Sudangrass**	**3.72**	**2.82**	**2.83**	**2.84**							
Tallest species meters 2	**Teff**	**0.85**	**0.94**	**0.75**	**0.75**							
Tallest species meters 3	**Sorghum Sudangrass**	**3.15**	**3.08**	**2.84**	**2.8**							
Tallest species meters 4	**Sorghum Sudangrass**	**3.11**	**2.52**	**2.68**	**2.85**							
Tallest species meters 5	**Sorghum Sudangrass**	**3.16**	**3.27**	**3.01**	**2.87**							
Tallest species meters 6	**Soybeans**	**0.72**	**0.87**	**0.85**	**0.66**							

Table 3. Cover crop layout for species and mixtures before harvest of soybeans and following fall harvest soybean residue

		10'					
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep1 50'	Residue Soybeans No cover Crop	Cereal Rye Hairy Vetch	Cereal Rye Crimson Clover	Cereal Rye Oats Forage Radish	Annual Ryegrass Ladino Clover	Cereal Rye	Annual Ryegrass Forage Radish
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep 2 50'	Cereal Rye Oats Forage Radish	Annual Ryegrass Ladino Clover	Cereal Rye	Cereal Rye Crimson Clover	Residue Soybeans No cover Crop	Cereal Rye Hairy Vetch	Annual Ryegrass Forage Radish
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep 3 50'	Annual Ryegrass Forage Radish	Cereal Rye Oats Forage Radish	Cereal Rye	Annual Ryegrass Ladino Clover	Cereal Rye Crimson Clover	Residue Soybeans No cover Crop	Cereal Rye Hairy Vetch
	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre	500 sq.' .01 acre
Rep 4 50'	Residue Soybeans No cover Crop	Cereal Rye Crimson Clover	Cereal Rye Oats Forage Radish	Annual Ryegrass Forage Radish	Cereal Rye Hairy Vetch	Cereal Rye	Annual Ryegrass Ladino Clover

Table 4. 2011 Fall Evaluations.

Fall	Cover Crop Mixtures	Seeding Rate /ac.	Rating. Ht., % stand	Rating. Ht., % stand	Rating. Ht., % stand	Rating. Ht., % stand
Treatments	following Leaf drop of soyb	by species in mix	Evaluation date 12-1-2011			
Plot size/ac.	.011 (50'X 10')X4 reps		REP 1	REP 2	REP 3	REP 4
1	Cereal ryegrass	22.5#	9 3" <5%	7 4" 20%	7 4" 10%	9 4" 10%
	Hairy Vetch	7.5#	9 1" <5%	9 1" 10%	9 1" <5%	9 3" <5%
		30#/ac				
2	Cereal ryegrass	22.5#	9 3" <5%	9 3" 10%	7 3" 20%	7 4" 15%
	Crimson clover	6.0#	0 0 0	5 1" 20%	7 1" 20%	7 2" 10%
		28.5#/ac				
3	Cereal ryegrass	15.0#	9 3" <5%	9 4" 5%	7 3" 20%	7 4" 15%
	Oats	11.6#	9 3" <5%	9 3" 5%	7 3" 10%	9 4" <5%
	Forage Turnip	1.3#	9 3" <5%	9 3" <5%	9 4" <5%	9 4" 10%
		27.9#/ac				
4	Annual ryegrass	4.5#	0 0 0	9 4" 5%	9 3" 10%	9 4" 10%
	Ladino clover	1.5#	0 0 0	0 0 0	0 0 0	0 0 0
		6.0#				
5	Cereal ryegrass	45.0#	9 3" <5%	5 4" 40%	5 4" 45%	5 5" 40%
6	Annual ryegrass	4.5#	9 3" <5%	9 4" 10%	9 4" 10%	9 5" 10%
	Forage Turnip	2.0#	9 4" <5%	9 4" <5%	9 3" <5%	9 7" 10%
		6.5#				

Table 5. 2011 Evaluations.																
Fall	**Cover Crop Mixtures**	**Seeding Rate /ac.**	**Rating. Ht., % stand**			**Rating. Ht., % stand**			**Rating. Ht., % stand**			**Rating. Ht., % stand**		
Treatments	**following soybeans harvest**	**by species in mix**	**Evaluation date 12-1-2011**											
Plot size/ac.	**.011 (50'X 10')X4 reps**		**REP 1**			**REP 2**			**REP 3**			**REP 4**		
1	Cereal ryegrass	22.5#	3	3"	70%	3	4"	60%	3	4"	70%	3	4"	70%
	Hairy Vetch	7.5#	9	1"	<5%	7	1"	<5%	7	1"	<5%	9	1"	<5%
		30#/ac												
2	Cereal ryegrass	22.5#	3	3"	60%	3	4"	70%	5	3"	55%	3	4"	70%
	Crimson clover	6.0#	3	2"	30%	3	2"	25%	5	1"	10%	3	1"	15%
		28.5#/ac												
3	Cereal ryegrass	15.0#	3	4"	45%	5	3"	40%	5	4"	30%	3	4"	50%
	Oats	11.6#	7	4"	5%	5	3"	<5%	7	3"	5%	5	3"	<5%
	Forage Turnip	1.3#	5	5"	20%	3	4"	50%	5	4"	10%	3	5"	15%
		27.9#/ac												
4	Annual ryegrass	4.5#	5	3"	35%	5	4"	35%	5	3"	20%	3	3"	55%
	Ladino clover	1.5#	9	0.5"	<5%	0	0	0	0	0	0	0	0	0
		6.0#												
5	Cereal ryegrass	45.0#	3	5"	70%	1	4"	80%	1	4"	70%	1	4"	70%
6	Annual ryegrass	4.5#	5	4"	30%	5	4"	20%	5	4"	25%	3	4"	30%
	Forage Turnip	2.0#	5	5"	20%	3	7"	30%	5	5"	40%	3	5"	45%
		6.5#												

Chart 1

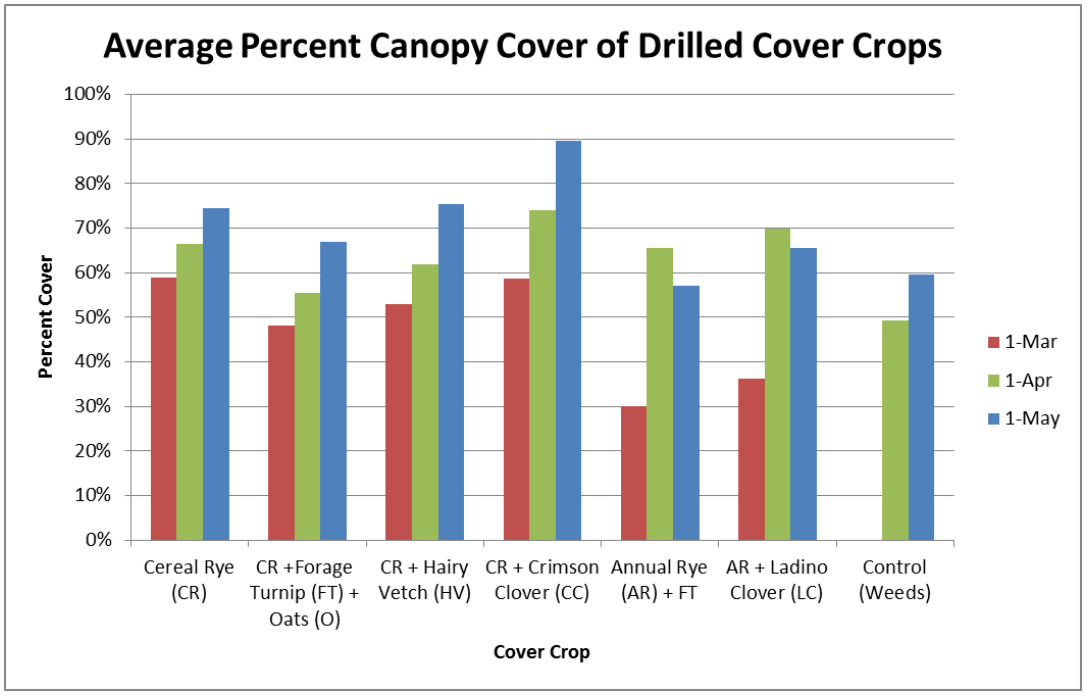


Table 6

Average Percent Canopy Cover of Drilled Cover Crops			
(Drilled 9/26/11)			
Cover Crop	1-Mar	1-Apr	1-May
Cereal Rye (CR)	59%	67%	75%
CR +Forage Turnip (FT) + Oats (O)	48%	56%	67%
CR + Hairy Vetch (HV)	53%	62%	76%
CR + Crimson Clover (CC)	59%	74%	90%
Annual Rye (AR) + FT	30%	66%	57%
AR + Ladino Clover (LC)	36%	70%	66%
Control (Weeds)	N/A	49%	60%

Chart 2

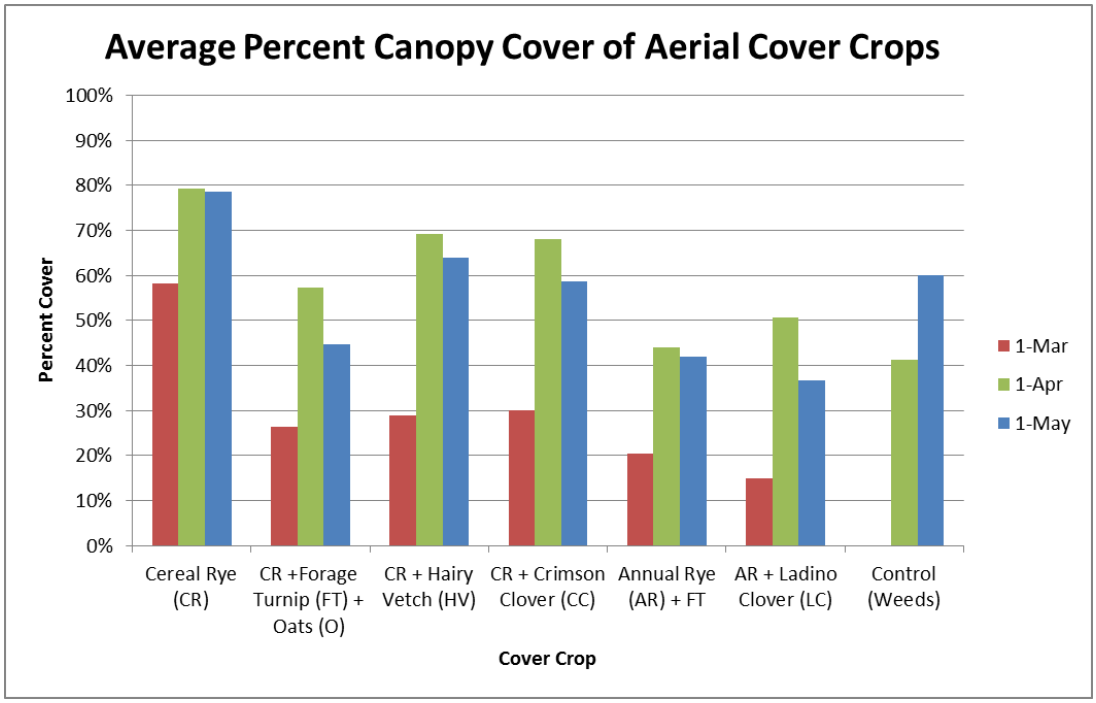


Table 7

Average Percent Canopy Cover of Aerial Cover Crops			
(Aerial Broadcast 9/20/11)			
Cover Crop	1-Mar	1-Apr	1-May
Cereal Rye (CR)	58%	79%	79%
CR +Forage Turnip (FT) + Oats (O)	26%	57%	45%
CR + Hairy Vetch (HV)	29%	69%	64%
CR + Crimson Clover (CC)	30%	68%	59%
Annual Rye (AR) + FT	20%	44%	42%
AR + Ladino Clover (LC)	15%	51%	37%
Control (Weeds)	N/A	41%	60%

Chart 3

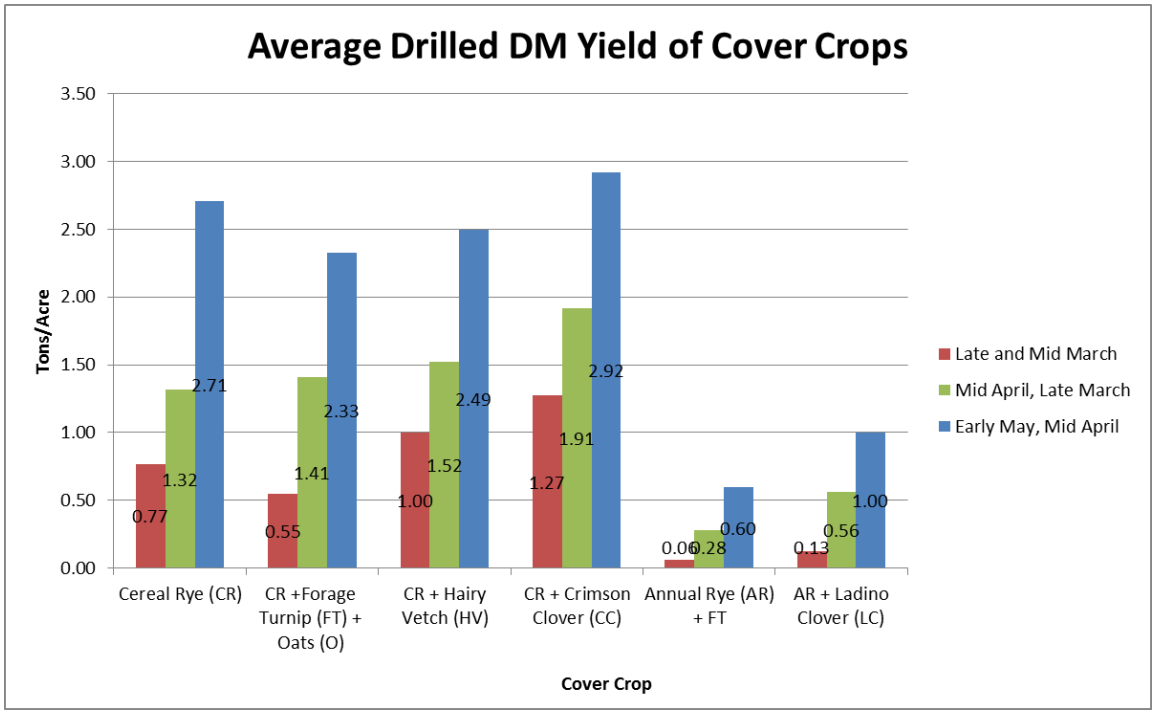


Chart 4

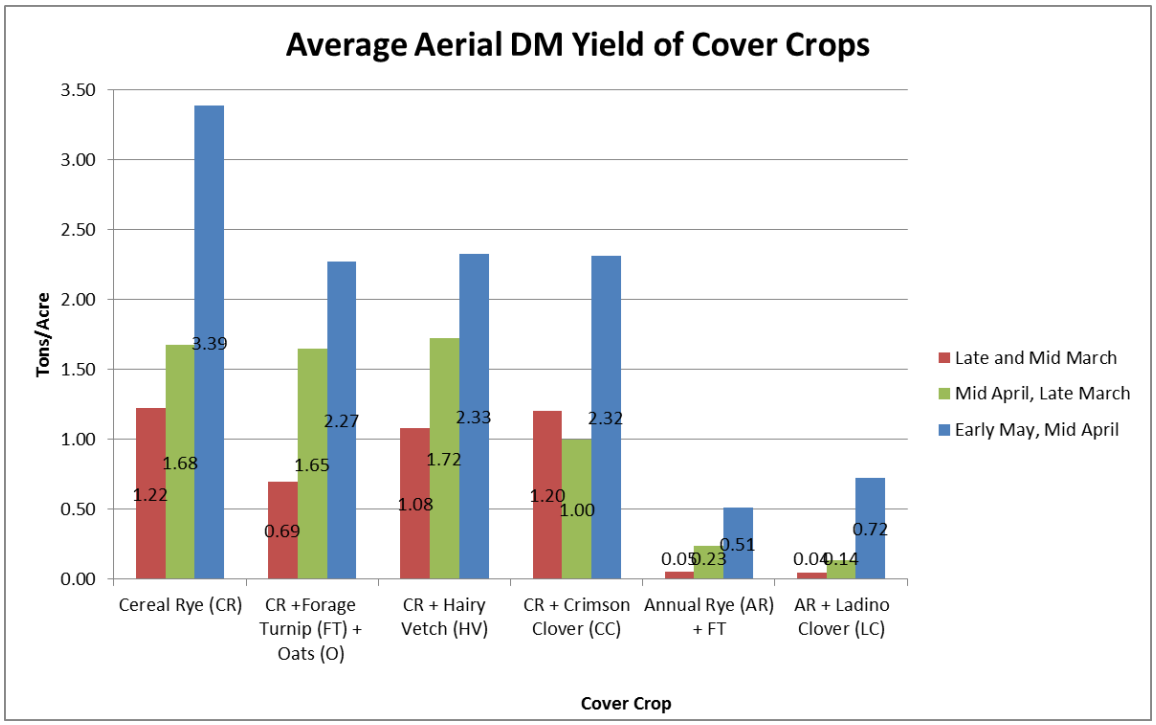


Table 8

Average Termination Rating of Drilled Cover Crops						
(Drilled 9/26/11) (1-Dead 3-Severe Damage 5- Moderate Damage 7-Fair 9-No Damage)						
Cover Crop	2 wk			4 wk		
	CR			CR		
Cereal Rye (CR)	3			1		
	CR	FT	O	CR	FT	O
CR +Forage Turnip (FT) + Oats (O)	3	1	5	1	1	3
	CR	HV		CR	HV	
CR + Hairy Vetch (HV)	3	1		1	1	
	CR	CC		CR	CC	
CR + Crimson Clover (CC)	3	1		1	1	
	AR	FT		AR	FT	
Annual Rye (AR) + FT	3	3		1	1	
	AR	LC		AR	LC	
AR + Ladino Clover (LC)	3	5		1	1	

Table 9

Average Termination Rating of Aerial Cover Crops						
(Aerially Broadcasted 9/20/11) (1-Dead 3-Severe Damage 5- Moderate Damage 7-Fair 9-No Damage)						
Cover Crop	2 wk			4 wk		
	CR			CR		
Cereal Rye (CR)	3			1		
	CR	FT	O	CR	FT	O
CR +Forage Turnip (FT) + Oats (O)	3	none	5	1	none	5
	CR	HV		CR	HV	
CR + Hairy Vetch (HV)	3	1		1	1	
	CR	CC		CR	CC	
CR + Crimson Clover (CC)	3	1		1	1	
	AR	FT		AR	FT	
Annual Rye (AR) + FT	3	none		1	none	
	AR	LC		AR	LC	
AR + Ladino Clover (LC)	3	none		1	none	

Table 10. 2012 Fall Evaluation						
Rating 1-Excellent -9 very poor 0-none						
Average Height						
% estimate of stand						
Fall	Cover Crop Mixtures(Aerial)	Seeding Rate /ac.	Rating. Ht., % stand	Rating. Ht., % stand	Rating. Ht., % stand	Rating. Ht., % stand
Treatments	following Leaf drop of soybe	by species in mix	Evaluation date 12- 12 -2012			
Plot size/ac.	.011 (50'X 10')X4 reps		REP 1	REP 2	REP 3	REP 4
1	Cereal ryegrass	22.5#	3 5" 40%	3 5" 40%	3 5" 40%	3 5" 40%
	Hairy Vetch	7.5#	3 5" 10%	3 5" 10%	3 5" 10%	3 5" 10%
		30#/ac				
2	Cereal ryegrass	22.5#	3 6" 35%	3 5" 35%	3 5" 60%	5 5" 40%
	Crimson clover	6.0#	3 4" 15%	3 3" 10%	3 4" 20%	5 4" 10%
		28.5#/ac				
3	Cereal ryegrass	15.0#	Alleopathic	5 5" 30%	5 5" 30%	3 5" 40%
	Oats	11.6#	effects on this plot	7 5" < 5%	7 5" < 5%	3 5" 10%
	Forage Turnip	1.3#	all cover crops 5%	5 6" < 5%	7 6" < 5%	9 4" <5%
		27.9#/ac				
4	Annual ryegrass	4.5#	3 6" 50%	3 5" 35%	7 5" 25%	3 7" 45%
	Ladino clover	1.5#	9 0.5" <5%	7 1" < 5%	0 0	0 0
		6.0#				
5	Cereal ryegrass	45.0#	3 7" 75%	3 6" 80%	3 6" 80%	3 6" 80%
6	Annual ryegrass	4.5#	3 6" 40%	3 7" 35%	7 5" 10%	5 5" 15%
	Forage Turnip	2.0#	3 7" 10%	3 7" 10%	7 5" < 5%	7 5" < 5%
		6.5#				

Table 11. 2012 Fall Evauation Data												
Rating 1-Excellent -9 very poor 0-none												
Average Height												
% estimate of stand												
Fall	Cover Crop Mixtures(Drilled)	Seeding Rate /ac.	Rating. Ht., % stand			Rating. Ht., % stand			Rating. Ht., % stand			Rating. Ht., % stand		
Treatments	following soybeans harvest	by species in mix	Evaluation date 12-12-2012											
Plot size/ac.	.011 (50'X 10')X4 reps		REP 1			REP 2			REP 3			REP 4		
1	Cereal ryegrass	22.5#	1	6"	75%	1	6"	75%	3	5"	70%	3	5"	65%
	Hairy Vetch	7.5#	3	5"	5%	5	4"	< 5%	5	4"	< 5%	5	4"	< 5%
		30#/ac												
2	Cereal ryegrass	22.5#	1	5"	70%	3	5"	50%	3	4"	50%	3	4"	45%
	Crimson clover	6.0#	3	3"	20%	3	3"	25%	3	2"	25%	3	3"	25%
		28.5#/ac												
3	Cereal ryegrass	15.0#	3	6"	50%	3	5"	70%	5	4"	40%	3	4"	60%
	Oats	11.6#	3	8"	20%	5	5"	5%	5	4"	10%	3	5"	10%
	Forage Turnip	1.3#	5	6"	10%	9	4"	<5%	7	4"	5%	9	4"	<5%
		27.9#/ac												
4	Annual ryegrass	4.5#	3	5"	45%	3	5"	60%	3	4"	55%	3	4"	50%
	Ladino clover	1.5#	7	1"	5%	0		0	3	1"	5%	7	1"	5%
		6.0#												
5	Cereal ryegrass	45.0#	1	5"	90%	3	5"	70%	3	4"	70%	3	5"	75%
6	Annual ryegrass	4.5#	3	5"	35%	3	4"	30%	3	4"	30%	3	4"	60%
	Forage Turnip	2.0#	5	6"	10%	7	4"	5%	5	4"	10%	9	4"	<5%
		6.5#												

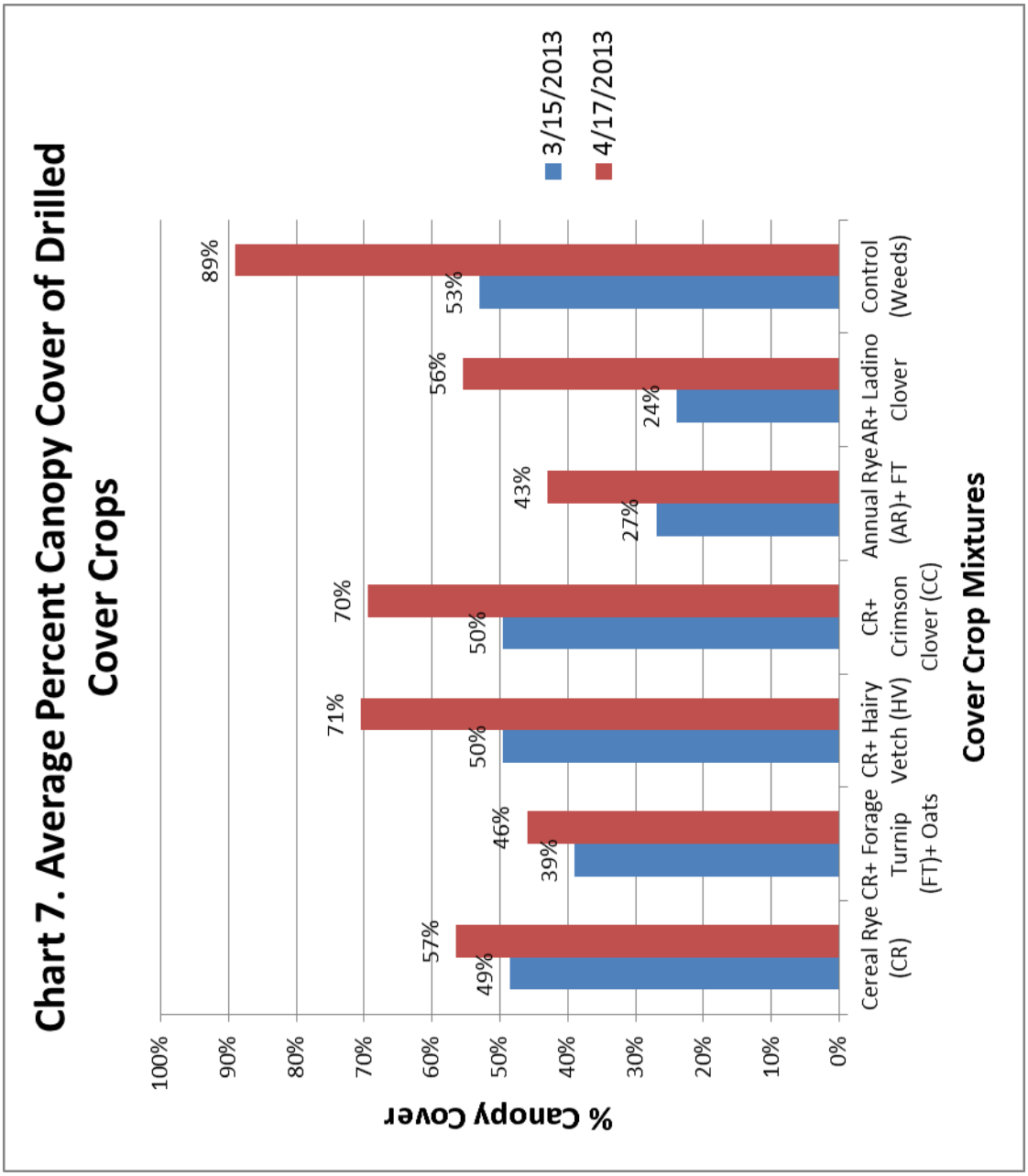


Chart 7. Average Percent Canopy Cover of Drilled Cover Crops
3/15/2013
4/17/2013
% Canopy Cover
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
89%
53%
56%
24%
43%
27%
70%
50%
71%
50%
46%
39%
57%
49%
Control (Weeds)
Ladino Clover
Annual Rye (AR)+ FT
CR+ Crimson Clover (CC)
CR+ Hairy Vetch (HV)
Cereal Rye Forage (CR) Turnip (FT)+ Oats
Cover Crop Mixtures

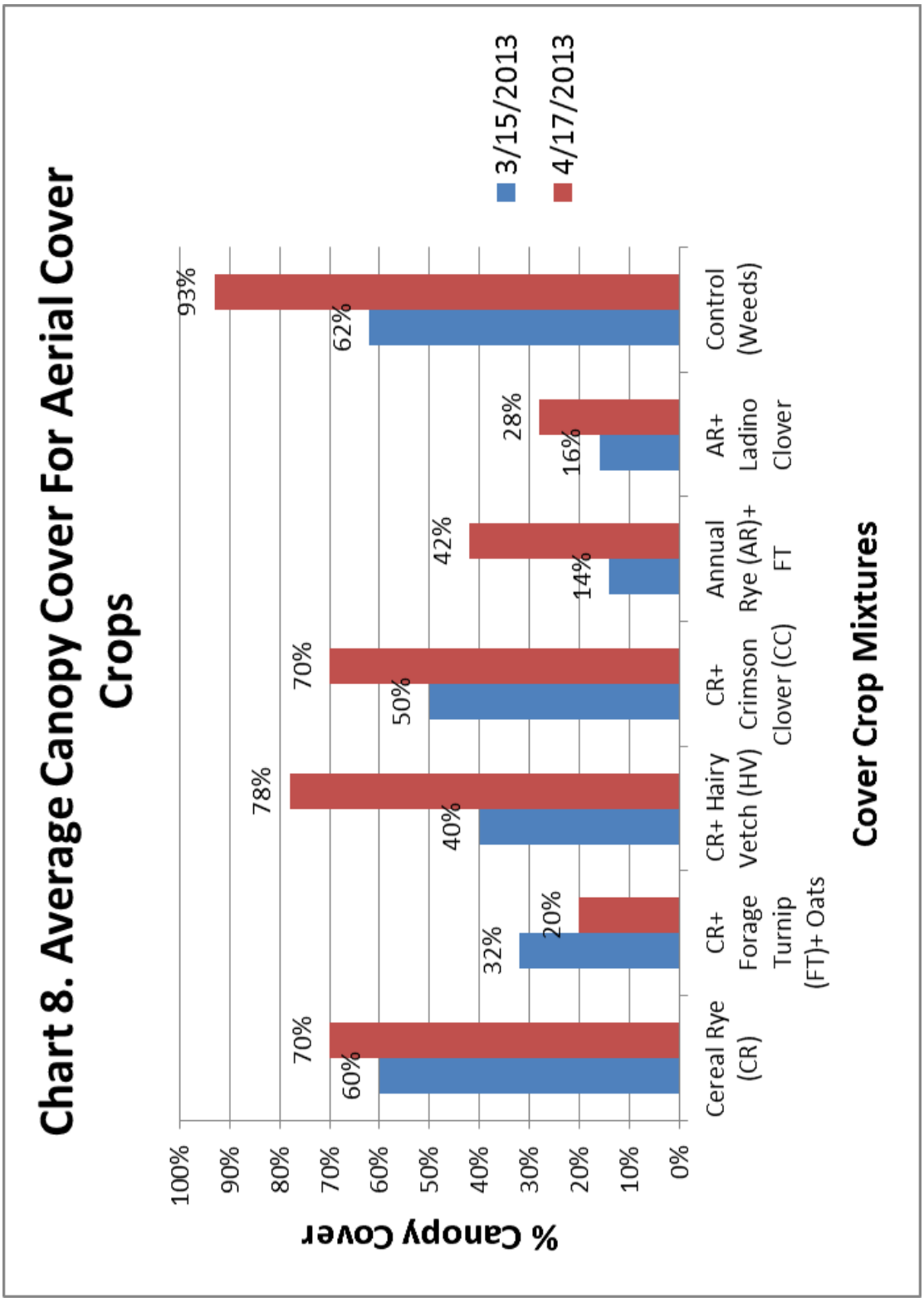


Chart 8. Average Canopy Cover For Aerial Cover Crops
3/15/2013
4/17/2013
% Canopy Cover
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
93%
62%
28%
16%
42%
14%
70%
50%
78%
40%
20%
32%
70%
60%
Control (Weeds)
AR+ Ladino Clover
Annual Rye (AR)+ FT
CR+ Crimson Clover (CC)
CR+ Hairy Vetch (HV)
CR+ Forage Turnip (FT)+ Oats
Cereal Rye (CR)
Cover Crop Mixtures

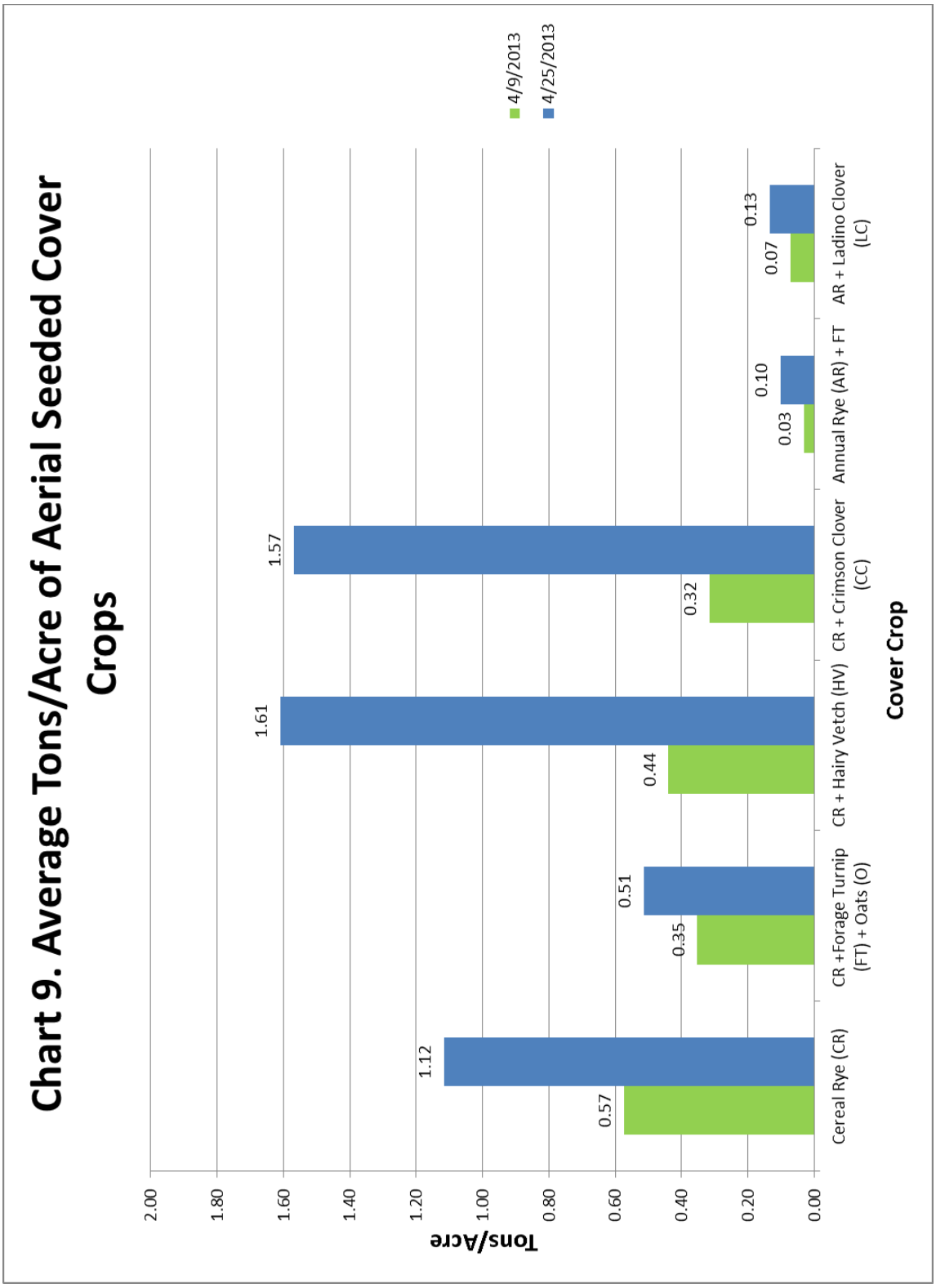


Chart 9. Average Tons/Acre of Aerial Seeded Cover Crops
4/9/2013
4/25/2013
Tons/Acre
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.57
1.12
0.35
0.51
0.44
1.61
0.32
1.57
0.03
0.10
0.07
0.13
Cereal Rye (CR)
CR +Forage Turnip (FT) + Oats (O)
CR + Hairy Vetch (HV)
CR + Crimson Clover (CC)
Annual Rye (AR) + FT
AR + Ladino Clover (LC)
Cover Crop

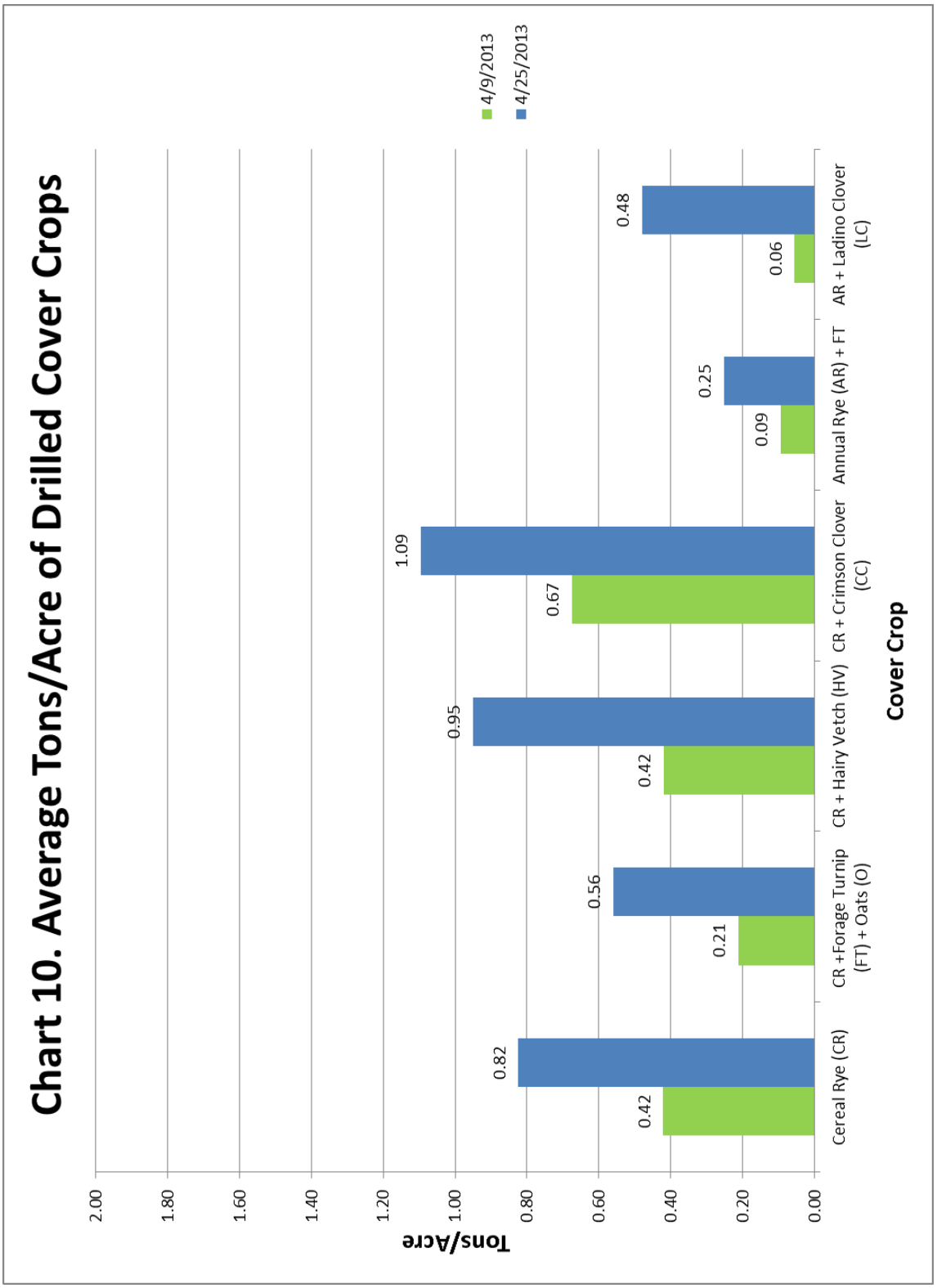


Chart 10. Average Tons/Acre of Drilled Cover Crops
4/9/2013
4/25/2013
Tons/Acre
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.82
0.42
0.56
0.21
0.95
0.42
1.09
0.67
0.25
0.09
0.48
0.06
Cereal Rye (CR)
CR +Forage Turnip (FT) + Oats (O)
CR + Hairy Vetch (HV)
CR + Crimson Clover (CC)
Annual Rye (AR) + FT
AR + Ladino Clover (LC)
Cover Crop

NEW STUDY AND DEMONSTRATION PLANS

Five new studies and two demonstrations were initiated from 2011-2013. The study and demonstration plans for each are found on the subsequent pages.

Plan No.	Study Name
MOPMC-T-1124	Using Biological Approach (Sheep/Goats) to Control Invasive Species with Emphasis on Bush Honeysuckle, *Lonicera maackii*, and Buckthorn, *Rhamnus cathartica*
MOPMC-T-1126	Collection of Plant Attributes from Plantings of Giant Miscanthus for RUSLE2
MOPMC-T-1227	Termination Timing of Selected Cover Crops Using a Roller Crimper
MOPMC-T-1228	National Study: Effect of Mixed Species Cover Crops on Soil Health
MOPMC-2013-CC	Cover Crop Demonstration for Soil Health Workshop
MOPMS-T-1125	Cool and Warm Season Cover Crop Evaluation
MOPMS-T-1228	Cool and Warms Season Cover Crop Demonstration and Evaluation

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMC-T-1124-NA,F	
Title	Using Biological Approach (Sheep/Goats) to Control Invasive Species with Emphasis on Bush Honeysuckle, *Lonicera maackii*, and Buckthorn, *Rhamnus cathartica*	
Project Number	Natural Areas 1.1, Forestland 1.1	
Study Type	Comparative Evaluation	
Study Status	Active	
Location	MOPMC, Elsberry, MO	
Study Leader	Ron Cordsiemon	
Duration	2011 through 2016	
Cooperators	Dr. Charlotte Clifford-Rathert, Lincoln University Harry Cope, Producer, Truxton, MO	
Land Use	Forestland	
Vegetative Practices	Primary	314 BRUSH MANAGEMENT
	Secondary	645 UPLAND WILDLIFE HABITATAT MANAGEMENT
Resource Concern(s)	Resource	Consideration/Problem
	Plant	Native Plants/ Invasive Species'
	Soil	Erosion/Lack of Vegetation Protecting the Soil
	Water	Water Quality/ Lack of Filter Vegetation
	Wildlife	Habitat/ Monoculture of Invasive Species'
NRCS Goals and Objectives	Goal #1- Get More Conservation on the Ground Goal #3- Create a Climate Where Private Lands Conservation Will Thrive	
NRCS Plant Materials Program Goals and Objectives	Goal #1: Identify and evaluate plants and develop technology for their successful establishment and maintenance to solve natural resource conservation problems. • Objective 1.1- Conserve and enhance soil resources with plant science technology. Goal #2: Provide plant materials and plant technology that	

	are economically feasible for meeting resource concerns. • Objective 2.2- Maintain and improve the productivity of agricultural lands and watersheds through plants and plant management technology. Goal #3: Provide Equal access for all Americans to the PMP. • Objective 3.1- Deliver products and services fairly and equitably. • Objective 3.3- Increase the use of plant materials to address issues of human health, safety, culture, and aesthetics.
Description	The purpose of this study is to address the invasive species' in the understory of woodland areas and areas not easily accessible with motorized equipment and/or herbicide applications. The use of a biological control agent, in this case using sheep and/or goats to control bush honeysuckle (*Lonicera maackii*) and common buckthorn (*Rhamnus cathartica*), may be a viable alternative to suppressing or eliminating the invasive species' competition, while promoting native plant vegetation. Evaluation of beneficial or more desirable plant species will be monitored, as well as the health of the sheep or goats.
Status of Knowledge	Bush honeysuckle (Lonicera maackii, Rupr.) is very well adapted to several different growing conditions. It is native to Asia and introduced to the United States in 1896. It readily grows in zones 3 to 8. In forests the plant can adversely affect populations of native members of the community. It can spread rapidly due to the seeds being dispersed by birds and mammals. It can form a dense understory thicket which can restrict native plant growth and tree seedling establishment.[1 USDA-Forest Service] Bush honeysuckle plants commonly are found growing under tall shrubs or trees that act as perch areas for birds. It is suspected that bush honeysuckles may produce alleopathic chemicals that enter the soil and inhibit the growth of other plants, preventing native plants from competing with the shrub. Shading by bush honeysuckle may also limit the growth of native species. Bush honeysuckles leaf out before many native species and hold their foliage until November.[2 Smith] In 1978, the Elsberry Plant Materials Center released Cling Red bush honeysuckle. Selection criteria for Cling Red bush honeysuckle, a selected class release, was based on plant vigor, ability to maintain seeds into the winter months and growth characteristics.

Common buckthorn is a shrub or small tree in the buckthorn family (Rhamnaceae) that can grow to 22 feet in height with a 10-inch wide trunk. Common buckthorn prefers lightly shaded conditions. An invader mainly of open oak woods, deadfall openings in woodlands, woods edges, roadsides, prairies and open fields. It is tolerant of many soil types, well drained sand, clay, poorly drained calcareous, neutral or alkaline, wet or dry. Common buckthorn is reported invasive in the following states: CO, CT, IA, IL, IN, MD, MA, MI, MN, MO, MS, ND, NH, NJ, NY, PA, RI, SD, TN, VA, VT, WI, and WY. Dense thickets form, crowding and shading out native shrubs and herbs, often completely eradicating them. Dense seedlings prevent native tree and shrub regeneration. In fire-adapted ecosystems such as savannas and prairies, the lack of vegetation under buckthorn prohibits fires.[3 USDA Forest Service] Common buckthorn produces fruit that is readily eaten by birds. The severe laxative effect of the fruits readily distributes seeds. The shrub easily resprouts from cut or damaged stems.[4 Smith]

Both bush honeysuckle and common buckthorn were introduced to the United States and they compete heavily against native vegetation. Many different control measures have been used to keep these two species' in check.
Mechanical control, or cutting or digging of the plant is an effective way to remove honeysuckle and buckthorn. The drawback to using a mechanical method is that it can become expensive and, in most cases, there will still need to be follow-up applications to completely control honeysuckle and buckthorn populations.
Chemical control is another way to suppress or eradicate unwanted vegetation. It can also become expensive and require follow-up applications to be successful.
Biological control or the use of animals to control brush has the potential to be a viable alternative to controlling or eradicating honeysuckle and buckthorn. Sheep/goats grazing is an ideal brush-control tool. Managing brush and woody plants with sheep/goats benefits the environment by eliminating the use of herbicides and benefits land managers by minimizing the need for costly mechanical clearing. Sheep are a natural, low-cost means of managing forests and rangelands, even as they produce important resources, such as wool, meat, and lanolin.

	Areas of honeysuckle and buckthorn infestation will be identified at the Elsberry Plant Materials Center. These identified areas will be enclosed using a 7-strand, high-tensile, electric fence. Random points within the paddocks will be identified (approximately 3-5 points per paddock) and the vegetation at those points will be documented. A photo will be taken in each direction (north, west, south and east) prior to the sheep/goats entering the treatment areas. Invasive species' (honeysuckle and buckthorn), as well as native species', will be accounted for and evaluated for percent coverage at each photo point. At the end of the treatment period and growing season, evaluations at each photo point will again be determined. Initial – In the fall of 2010, evaluation points will be made in each paddock and the existing vegetation surrounding each point will be documented. The vegetation will be given a subjective rating on the percentage of understory that each species represents, whether it is invasive or beneficial. Photos will be taken at each point, once in the fall 2010, again in the spring and at the end of the treatment period (Oct. – Nov.). The spring following each treatment, both the honeysuckle and buckthorn will be given a survival rating based of the number of plants that survive. April 2010, 45-50 Kahtadin hair sheep will enter the first paddock to start the treatment at the PMC. In subsequent treatments, the possibly of using only goats or goats and sheep together may need to be explored.
Experimental Design	Evaluations will be made at the end of this study to determine whether the biological treatment (sheep and/or goats) have made a detrimental impact on the honeysuckle and buckthorn population. Evaluations will also be made to determine the health of the native vegetation. Forester, wildlife biologist and agronomist will evaluate the paddocks to determine the overall health of the tree and shrub population, wildlife habitat and soil health. The project will also evaluate the health of the sheep and/or goats, as well as the economic potential.
Technology Transfer Products	Technical note, peer reviewed papers, poster and oral presentations

References	[1] USDA Forest Service, Forest Health Staff, Newtown Square, PA http://www.na.fs.fed.us/fhp/invasive_plants/weeds/amur-honeysuckle.pdf [2] Missouri Vegetation Manual, Tim Smith, Missouri Department of Conservation, 1997, p.22 [3] USDA Forest Service, Forest Health Staff, Newtown Square, PA http://www.na.fs.fed.us/fhp/invasive_plants/weeds/common-buckthorn.pdf [4] Missouri Vegetation Manual, Tim Smith, Missouri Department of Conservation, 1997, pp. 33-36
Keywords	Invasive species, honeysuckle, common buckthorn, sheep, goats, biological control

Prepared by:	Ron Cordsiemon, Elsberry Plant Materials Center
Reviewed by:	Jerry U. Kaiser, Elsberry Plant Materials Specialist
Approvals:	Karen Brinkman, Missouri State Conservationist (acting)
	Karen Brinkman /s/ 3/21/2013
	Jay Mar, Iowa State Conservationist
	Jay Mar /s/ 4/3/2013
	Ivan Dozier, Illinois State Conservationist
	Ivan Dozier /s/ 4/10/2013

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMC-T-1126	
Title	Collection of Plant Attributes from Plantings of Giant Miscanthus for RUSLE2	
Project Number	Biomass/Biofuel 1.1, Cropland 1.1, Cropland 3.1	
Study Type	Technology Development	
Study Status	Active	
Location	MOPMC, Elsberry, MO	
Study Leader	Allen Casey	
Duration	2011 through 2013	
Land Use	Cropland	
Vegetative Practices	Primary	512 FORAGE AND BIOMASS PLANTING
	Secondary	511 FORANGE AND BIOMASS HARVEST MANAGEMENT
Resource Concern(s)	<u>Resource</u>	<u>Consideration/Problem</u>
	Soil Erosion	Sheet and Rill
	Plants	Productivity, health and vigor
	Plants	Noxious and invasive plants
NRCS Goals and Objectives	Goal #1- High Quality Productive Soils Goal #5- Adequate Energy Supply	
NRCS Plant Materials Program Goals and Objectives	Goal #1: Identify and evaluate plants and develop technology for their successful establishment and maintenance to solve natural resource conservation problems. • Objective 1.1- Conserve and enhance soil resources with plant science technology. • Objective 1.2- Improve water quality and quantity with plant science technology. Goal #2: Provide plant materials and plant technology that are economically feasible for meeting resource concerns. • Objective 2.2- Maintain and improve the productivity of agricultural lands and watersheds	

	through plants and plant management technology.
Description	This study will take measurements of giant miscanthus (Miscanthus giganteus) growth habits and parameters. The data collected will be included in the Revised Universal Soil Loss Equation 2 model (RUSLE2), which is used by NRCS field offices to determine the soil erosion of fields using plant management information. Data collected will include characters such as height, width of crown, surface residue, above ground biomass, and other data as required for inclusion into the model. Data that is collected will be delivered as required to the Agricultural Research Service (ARS) for inclusion into the model.
Status of Knowledge	There is a need to collect scientific data on plant attributes of giant miscanthus for inclusion into the RUSLE2 model. Currently RUSLE2 does not have any data about giant miscanthus. Giant miscanthus is starting to be planted extensively for use as a biofuel or biomass product to meet the energy needs of the United States and Europe. NRCS policy is for fields that are receiving subsidies to meet a minimum standard of soil loss. NRCS field staff use the RUSLE2 model to determine the soil loss that is occurring in a particular field by including data such as past and current tillage practices, rotations, and crops. Without the vegetation file of giant miscanthus included in RUSLE2, field office staff does not have a relatively quick and scientifically base method to determine if a field falls within the erosion compliance standards.
Experimental Design	Experimental design will be after the USDA Natural Resources Conservation Service Plant Materials Evaluation Protocols: Revised January 2012. The protocols for data collection will be modified and adjusted based on the needed information required by the RUSLE2 model. The existing giant miscanthus stand will be used to document an established stand. A new stand of giant miscanthus will be planted in 2011 and 2012 to get data during the establishment year and for the 2nd year of growth. These new plots will be planted using rhizomes from the established plots and planting them 3ft apart. Approved herbicides will be used to control weeds as necessary.

Technology Transfer Products	Vegetation file for the RUSLE2 model, peer-reviewed journal article, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides
Keywords	Biofuel, biomass, plant attributes, giant miscanthus, Miscanthus, RUSLE2, soil erosion, water quality

Prepared by:	Allen Casey, Elsberry Plant Materials Center
Reviewed by:	Ron Cordsiemon, Elsberry Plant Materials Center
Approvals:	Karen Brinkman, Missouri State Conservationist (acting)
	Karen Brinkman /s/ 3/21/2013
	Jay Mar, Iowa State Conservationist
	Jay Mar /s/ 4/3/2013
	Ivan Dozier, Illinois State Conservationist
	Ivan Dozier /s/ 4/10/2013

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMC-T-1127, CP	
Title	Termination Timing of Selected Cover Crops Using a Roller Crimper	
Project Number	Cropland 1.1– Controlling erosion on cropland with cropping and residue management systems	
Study Type	Comparative Evaluation	
Study Status	Active	
Location	MOPMC, Elsberry, MO	
Study Leader	Ron Cordsiemon	
Duration	2011 through 2016	
Land Use	Cropland	
Vegetative Practices	Primary	340 COVER CROP
	Secondary	NA
Resource Concern(s)	Resource	Consideration/Problem
	Soil	Erosion/Soil Health
	Water	Water Quality

NRCS Goals and Objectives

Goal #1- Get More Conservation on the Ground
Goal #3- Create a Climate Where Private Lands Conservation Will Thrive

NRCS Plant Materials Program Goals and Objectives

Goal #1: Identify and evaluate plants and develop technology for their successful establishment and maintenance to solve natural resource conservation problems.

- Objective 1.1- Conserve and enhance soil resources with plant science technology.

Goal #2: Provide plant materials and plant technology that are economically feasible for meeting resource concerns.

- Objective 2.2- Maintain and improve the productivity of agricultural lands and watersheds through plants and plant management technology.

Goal #3: Provide Equal access for all Americans to the PMP.

	• Objective 3.1- Deliver products and services fairly and equitably. • Objective 3.3- Increase the use of plant materials to address issues of human health, safety, culture, and aesthetics.
Description	Selected winter cover crops will be compared in replicated plots to evaluate their effective termination using a roller crimper. The selected cover crops will also be evaluated for their ability to maintain moisture in the soil, biomass production and weed suppression.
Status of Knowledge	Growers are always looking for effective and lower cost options to produce their crops. As cover crop use increases, their management becomes an important component of many farming systems. Timing and method of termination are the two most important factors of cover crop management6. Cover crops represent a cropping practice that has the potential to reduce herbicide reliance and minimize tillage while improving soil fertility1, reducing soil erosion2, sequestering soil carbon3, increasing soil water infiltration and storage4, and suppressing weeds5.
Experimental Design	RCB, with 4 replications. Plot size – 0.22 ac/ plot (type of cover) and 0.073 ac/subplot (timing of termination) Cover crop species treated as whole plot, termination dates subplot, sub-subplots will be taken to determine biomass and cash crop (soybean) yields will be taken within sub-subplots. Select cover crops (see chart below) typical to the Midwest region of Iowa, Illinois and Missouri will be planted by seed into plots that measure 96 feet by 100 feet (0.22ac). The plots will be divided into 3 subplots that will represent 3 different termination dates. Termination dates using a roller crimper will be defined as follows; an early termination, recommended termination, and late termination. VNS Cereal Rye, 'Gulf' Annual Ryegrass and a check plot will be treated with a non-selective herbicide using the same format

for termination dates. Plots will be planted October 2011 using a 10' Great Plains no-till drill.

Species	Recommended Planting Rate	Actual Planting Rate
VNS (Variety Not Stated) Cereal Rye	45 PLS/Acre	37.53 PLS/Acre
'Gulf' Annual Ryegrass	9 PLS/Acre	7.37 PLS/Acre
Pioneer 25R39 Wheat	60 PLS/Acre	60.0 PLS/Acre
VNS (Variety Not Stated) Hairy Vetch	11 PLS/Acre	11.0 PLS/Acre
'Aroostok' Cereal Rye	45 PLS/Acre	45.0 PLS/Acre

(reason for difference in recommended rates and actual planting rates was due to seed availability)

Evaluations

Soil moisture and temperature will be tracked using soil moisture probe and data logger.
Nitrogen readings will be taken prior to termination of the cover crop to determine nitrogen uptake of the cover crop.
Biomass cuttings will be taken using meter^2 samples to determine amount of biomass produced.
A line transect will be ran and counts of plant composition will be made in each subplot during the cover crop growing period.
Ceptometer measurements will be used as a comparison to canopy cover and biomass measurements.
Subplots will be evaluated 2 and 4 weeks after termination treatments for percent "kill".
Soybean collections will be made in meter^2 collections at the end of the growing season to determine soybean yields

Technology Transfer Products	Progress report, technical report, peer-reviewed journal article, technical Notes and poster and oral presentations.
References	1 Decker, A.M., A.J. Clark, J.J. Meisinger, F.R. Mulford, and M.S.M. Cinthosh. 1994. Legume cover crop contributions to no-tillage corn production. Agron. J. 86:126-135. 2 Langdale, G.W., R.L. Blevins, D.L. Karlen, D.K. McCool, M.A. Nearing, E.L. Skidmore, A.W. Thomas, D.D. Tyler, and J.R. Williams. 1991. Cover crop effects on soil erosion by wind and water. P. 15-22. In W.L. Hargrove (ed.) Cover crops for clean water. Soil and Water Conserv. Soc., Akeny, IA. 3 Sainju, U.M., B.P. Singh, and W.F. Whitehead. 2002. Long-term effects of tillage, cover crops, and nitrogen fertilization on organic carbon and nitrogen concentrations in sandy loam soils in Georgia, USA. Soil Tillage Res. 63: 167-179. 4 Munawar, A., R.L. Blevins, W.W. Frye, and M.R. Saul. 1990. Tillage and cover crop management for soil water conservation. Agron. J. 82:773-777. 5 Teasdale, J.R., and C.S.T. Daughtry. 1993. Weed suppression by live and dessicated hairy vetch. Weed Sci. 41:207-212. 6 Ashford, D.L., D.W. Reeves, M.G. Patterson, G.R. Wehtje, and M.S. Miller-Goodman. 2000. Roller vs. Herbicides: An alternative kill method for cover crops. 23rd Annual Southern Conservation Tillage Conference for Sustainable Agriculture Proceedings. pp. 64-69.
Keywords	Cover crops, roller-crimper, cereal rye, annual ryegrass, wheat, hairy vetch

Prepared by:	Ron Cordsiemon, Elsberry Plant Materials Center
Reviewed by:	Allen Casey, Elsberry Plant Materials Center
Approvals:	Karen Brinkman, Missouri State Conservationist (acting)
	Karen Brinkman /s/ 3/21/2013
	Jay Mar, Iowa State Conservationist
	Jay Mar /s/ 4/3/2013
	Ivan Dozier, Illinois State Conservationist
	Ivan Dozier /s/ 4/10/2013

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMC-T-1228	
Title	National Study: Effect of Mixed Species Cover Crops on Soil Health	
Project Number	Cropland 1.1	
Study Type	Technology Development	
Study Status	Active	
Location	MOPMC, Elsberry, MO	
Study Leader	Allen Casey	
Duration	2012 through 2015	
Cooperators		
Land Use	Cropland	
Vegetative Practices	Primary	340 COVER CROP
	Secondary	328 CONSERVATION CROP ROTATION
Resource Concern(s)	Resource	Consideration/Problem
	Soil Condition	Compaction
	Plants	Plants not adapted or suited
	Plants	Productivity, Health, and Vigor
NRCS Goals and Objectives	Goal #1- High Quality, Productive Soils	
NRCS Plant Materials Program Goals and Objectives	Goal #1: Identify and evaluate plants and develop technology for their successful establishment and maintenance to solve natural resource conservation problems. • Objective 1.1- Conserve and enhance soil resources with plant science technology. Goal #2: Provide plant materials and plant technology that are economically feasible for meeting resource concerns. • Objective 2.2- Maintain and improve the productivity of agricultural lands and watersheds through plants	

	and plant management technology. Goal #3: Provide Equal access for all Americans to the PMP. • Objective 3.1- Deliver products and services fairly and equitably. • Objective 3.3- Increase the use of plant materials to address issues of human health, safety, culture, and aesthetics.
Description	This study will take measurements of multiple cover crops species growth habits and parameters. The data collected will be included in the Revised Universal Soil Loss Equation 2 model (RUSLE2), which is used by NRCS field offices to determine the soil erosion of fields using plant management information. Data collected will include characters such as height, canopy cover, above ground biomass, and other data as required for inclusion into the model. Data that is collected will be delivered as required to the Agricultural Research Service (ARS) for inclusion into the model. Soil health parameters will also be measured. Parameters include soil compaction, soil moisture, soil temperature, bulk density, biological assessment, and soil indicators (SSL). Data will be compiled and provided to field office to use to recommend particular cover crop species and mixes in areas around the country. It will also be able to demonstrate the changes in soil health through the use of cover crops in rotation. Data will also be collected on height and yield of the cash crop, corn, which is going to be used in the rotation with the selected cover crops.
Status of Knowledge	There is a need to collect scientific data on plant attributes of cover crops and cover crop mixtures for inclusion into the RUSLE2 model. Currently RUSLE2 has limited data available on cover crops independently or as a mixture. Cover crops are starting to be planted extensively for conservation cover and as a green manure in the United States. NRCS policy is for fields that are receiving subsidies to meet a minimum standard of soil loss. NRCS field staff use the RUSLE2 model to determine the soil loss that is occurring in a particular field by including data such as past and current tillage practices, rotations, and crops. Without the data and parameters that would be provided by this study, field office staff do not have a relatively quick and scientifically base method to determine if a field falls within the erosion compliance standards or on what the planting of various cover crops have on soil health and cash crop productivity.

Experimental Design	Experimental design will be after the USDA Natural Resources Conservation Service Plant Materials Program Sampling Methods for Soil Health Study. The protocols for data collection will be modified and adjusted based on the needed information required by the RUSLE2 model and upon any issues that develop during the study. Two, four, and six species mixes will be planted, with treatments of 20, 40, and 60 seeds per square foot. Each plot will be 20ft x 30ft and be replicated 4 times in a randomized complete block design. Each plot will then be subdivided into plots that will get sampled once in the three year period.
Technology Transfer Products	Vegetation file for the RUSLE2 model, peer-reviewed journal article, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides
Keywords	Cover crop, biomass, plant attributes, cereal rye, tillage radish, canola, rapeseed, crimson clover, hairy vetch, oats, corn, RUSLE2, Soil health, soil biological assessment, bulk density, soil moisture, soil temperature.

Prepared by:	Allen Casey, Soil Conservationist, Elsberry Plant Materials Center
Reviewed by:	Ronald L. Cordsiemon, Elsberry Plant Materials Center Manager
	Ronald L. Cordsiemon /s/ 10/11/2012
Approvals:	Karen Brinkman, Missouri State Conservationist (acting)
	Karen Brinkman /s/ 3/21/2013
	Jay Mar, Iowa State Conservationist
	Jay Mar /s/ 4/3/2013
	Ivan Dozier, Illinois State Conservationist
	Ivan Dozier /s/ 4/10/2013

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMS-T-1125-CC	
Title	Cool and Warm Season Cover Crop Evaluation	
Project Number		
Study Type	Comparative Evaluation	
Study Status	Active	
Location	MOPMC, Elsberry, MO	
Study Leader	Jerry Kaiser	
Duration	2011	
Cooperators	Ron Cordsiemon, NRCS, Elsberry, MO Bill Kuenstler, NRCS, Fort Worth, TX Joel Douglas, NRCS, Fort Worth, TX Ron Miller, NRCS, Columbia, MO	
Land Use	Cropland	
Vegetative Practices	Primary	Cover Crops
Resource Concern(s)	Resource	Consideration/Problem
	Soil	Erosion
	Water	Water Quality
Missouri and Iowa PM Business Plans	Study falls under states business plans	
Description	Cool and warm season cover crops will be evaluated for their suitability and performance following wheat (warm season) and soybean production system (cool season). . Evaluation parameters for characterizing cover crop response are percent canopy cover, biomass, and cover crop termination success (refer to materials and methods section for specifics on planting, management, data collection dates, etc.	

Status of Knowledge	The need for the cover crop study is to collect data for these 12 species of warm and cool season species in the planned mixes, by evaluating percent cover during the growing season, how much dry matter yield is produced, and timing of cover crop termination prior to establishment of the subsequent cash crop. The objective is to have cover after summer and fall cash crops so that the cover crop will perform multiple benefits for the resource base (e.g. soil protection). Cover crops can improve soil health by reducing compaction, improving organic matter, and decreasing runoff and erosion. Cover crops can improve water quality by sequestering nitrogen before it leaches into the ground water. A concern is on timing of cover crop termination prior to planting the cash crop. The study will demonstrate different termination dates for control of the cover crops. Annual ryegrass has an extensive root system that tolerates compacted soils and makes it an effective cover crop for excess nitrogen (Bjorkman et al., 2009). Radishes are excellent at breaking up shallow layers of compacted soils, earning them the nicknames “biodrills” or “tillage radishes.” A thinner extension of the tap root can penetrate deeper layers of compaction. The roots die over the winter and leave channels so that the soil dries and warms up faster in the spring (Bjorkman et al., 2009). Sorghum sudangrass provide abundant root biomass, which is useful for increasing soil organic matter (Bjorkman et al, 2009). Non-legume species such as rye, oats, wheat, forage turnips, oilseed radish, sudangrass, buckwheat recycle existing soil nitrogen and other nutrients and can reduce leaching losses. (Sundermeier et al., 1999) Certain broad-leaved plants are noted for their ability to accumulate minerals at high concentrations in their tissue (Sullivan et al, 2003). Studies have shown that legume cover crops can replace a portion of the fertilizer nitrogen requirements of the subsequent crop. The economic value of these nitrogen replacements can be calculated by using a local nitrogen price. These costs can then be compared to cover crop seed and planting costs. These simple nitrogen cost comparisons do not take into account the benefits of improved soil tilth and increased water infiltration resulting from cover crops (Sullivan et al,2003). Timing of burn down chemicals are important when terminating a spring growing cover crop. Ideally, cover crops

	should be allowed to grow as long as possible in the spring to add additional nutrients to the soil and suppress weeds. However, the longer the cover crop is growing the more moisture it removes and could potentially affect the growth and development of the subsequent crop, especially if drought conditions exists.. (Sundermeier et al, 1999)
Experimental Design	RCB, with 4 replications. Plot size –Based on a 7.5 inch row, 10 ft x 30 ft (Actual plot size planted will be 10'X50' per plot.) Cool and Warm season species treated as whole plot and evaluation dates subplot. Species (see list below) from appropriate sources will be planted by seed into plots containing 7.5 inch row, 10 ft x 30 ft (Actual plot size planted will be 10'X50' per plot.) Before soybean harvest in 2011-2013 during leaf yellowing and before leaf drop and aerial application of the cool season mixtures below (simulated by cyclone seeder) application over a set of 10'X 50'plots. No fertilizer or supplemental water will be applied during the study Experimental design is a randomized complete block with 4 replications. a. cereal rye b. cereal rye, oats, forage radish c. annual rye grass, forage radish d. cereal ryegrass, hairy vetch e. annual ryegrass, ladino clover f. cereal rye, crimson clover g. Soybean residue No cover crop Following soybean harvest in 2011-2013 the following cool season cover crops and mixes will be drilled into 10' x 50' plots at the Elsberry PMC. No fertilizer or supplemental water will be applied during the study. Experimental design is a randomized complete block with 4 replications. h. cereal rye i. cereal rye, oats, forage radish j. annual rye grass, forage radish k. cereal ryegrass, hairy vetch l. annual ryegrass, ladino clover m. cereal rye, crimson clover n. Soybean residue No cover crop Prior to the first killing frost, stand counts is determined for

each of the cover crops using the frequency grid and photographs to document early growth of the cover crop species.
Percent canopy cover measurement is determined using the line transect method.
Transects will be taken March 1, April 1, May 1 to construct a RUSLE 2 growth curve. Percent canopy cover is measured by placing the line transects in a "X" pattern across the plot.

Total dry matter yield is determined by taking 1 m2 sample from random locations in plots 10' x 10' (10' x 30' original plot size)
Cover Crop with Annual ryegrass
March 15, March 30th and April 15th

Cover Crop with Cereal ryegrass
April 15, May 1 and May 15. Subsamples
will be collected for dry matter determination
(55-60°C for 16-24 hrs or until dry).

Timing of Cover Crop Termination is determined by applying glyphostate at the recommended rate for burn down of cover crops. Cover Crop with Annual ryegrass use Glyphosate with citric acid March 15, March 30th, and April 15th.

Cover Crop with Cereal ryegrass use
Glyphosate with citric acid applied
April 15, May 1, and May 15.

Visual rating of burn down success will be
Determined 2 and 4 weeks after application.

Analysis of variance will be used to
determine differences in percent canopy cover and dry matter yield of cover crop
species and differences in cover
crop termination dates.

10' x 30 'plots divided into 3 equal subplots for dry matter yield and herbicide timing evaluations

Warm-season cover crops
Following wheat harvest in 2011-2012 the following warm season cover crops and mixes will be drilled into 10' x 30' plots at the Elsberry PMC. No fertilizer or supplemental

	water will be applied during the study. Experimental design is a randomized complete block with 4 replications. a. pearl millet, crimson clover, sorghum sudangrass, buckwheat, cow peas b. pearl millet, sorghum sudangrass, bobwhite soybean c. pearl millet, sorghum sudangrass, bobwhite soybean and sun hemp d. teff, forage radish e. commercial soybeans f. pearl millet, crimson clover, sorghum sudangrass, buck wheat, cow peas, bobwhite soybeans, forage radish, and sun hemp g. Wheat stubble residue no cover crop Total dry matter yield is determined by taking a 1 m2 sample from a random location in each plot approximately 1 week prior to the average first killing frost for Elsberry, Missouri. Analysis of variance will be used to determine differences in cover crop species on the basis of dry matter production. Percent residue canopy cover is determined using the line transect method following the same procedure as the cool season cover crop study. Measurements will be made May 1.
Technology Transfer Products	Progress report, technical report, peer-reviewed journal article, technical Notes and poster and oral presentations.
References	Bjorkman T, Cornell University, New York State Agricultural Experiment Station, Cover Crops in soil health, www.hort.cornell.edu/bjorkman/lab/covercrops/soil-health.php Sullivan P, National Center for Appropriate Technology, Overview of Cover Crops and Green Manures, http://attra.ncat.org/attra-pub/covercrop.html Sundermeiier A, Ohio State University, Department of Horticulture and Crop Science, Cover Crop Fundamentals, http://ohioline.osu.edu/agf-fact/0142.html
Keywords	Warm season, Cool season, Cover Crops

Prepared by:	Jerry U. Kaiser, Elsberry Plant Materials Specialist
Approvals:	JR Flores, Missouri State Conservationist
	J.R. Flores /s/ 6/29/2011
	Richard Sims, Iowa State Conservationist
	Richard Sims /s/ 6/22/2011
	William J. Gradle, Illinois State Conservationist
	William J. Gradle /s/ 6/29/2011

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	MOPMS-T-1228-CC
Title	Cool and Warm Season Cover Crop Demonstrations and Evaluations
Project Number	Cropland 1.1 Controlling erosion on cropland with cropping and residue management systems.
Study Type	Demonstrations and Evaluations
Field Trial Status	Active
Location	Areas to find location
Field Trial Leader	Jerry Kaiser
Duration	
Cooperators	Area to find cooperators
Land Use	Cropland
Vegetative Practices	Cover Crops

Resource Concern(s)	Resource	Consideration/Problem
	Soil	Soil Health
	Water	Water Quality

Missouri Soil Health Strategic Plan	Conservation Field Trial is documented within Missouri NRCS Soil Health Strategic Plan for Fiscal year 2012.
Description	Cool and warm season cover crops will be demonstrated and evaluated for their suitability and performance typical following crop production system. Evaluation parameters for characterizing cover crop response will be establishment times; percent canopy cover, biomass harvest, cover crop termination success and cash crop stand establishment. The cover crops will be mixtures to support or update the USDA NRCS 340 Cover Crop Standard for Missouri.

Status of Knowledge	The need is Conservation Field Trials to demonstrate cover crops for producers from Major Land Resource Areas (MLRA's) in Missouri. These demonstrations will be on farm learning for the acceptance of cover crop practice as part of a cropping system. Selection of cooperators will be based upon their prior knowledge of cover crops, conservation tillage and community leadership ability. Cool season species will be in the planned mixes, by demonstrating on a field scale and evaluating percent cover during the growing season, timing of cover crop termination prior to establishment of the subsequent cash crop, and stand establishment of cash crop. The objective is to have cover after fall cash crops so that the cover crop will perform multiple benefits for the resource base (e.g. soil protection). Cover crops can improve soil health by reducing compaction, improving organic matter, and decreasing runoff and erosion. Cover crops can improve water quality by sequestering nitrogen before it leaches into the ground water. Annual ryegrass has an extensive root system that tolerates compacted soils and makes it an effective cover crop for excess nitrogen (Bjorkman et al., 2009). Radishes are excellent at breaking up shallow layers of compacted soils, earning them the nicknames "biodrills" or "tillage radishes." A thinner extension of the tap root can penetrate deeper layers of compaction. The roots die over the winter and leave channels so that the soil dries and warms up faster in the spring (Bjorkman et al., 2009). Sorghum sudangrass provide abundant root biomass, which is useful for increasing soil organic matter (Bjorkman et al, 2009). Non-legume species such as rye, oats, wheat, forage turnips, oilseed radish, sudangrass, and buckwheat recycle existing soil nitrogen and other nutrients and can reduce leaching losses. (Sundermeier et al., 1999) Certain broad-leaved plants are noted for their ability to accumulate minerals at high concentrations in their tissue (Sullivan et al, 2003). Studies have shown that legume cover crops can replace a portion of the fertilizer nitrogen requirements of the subsequent crop. The economic value of these nitrogen replacements can be calculated by using a local nitrogen price. These costs can then be compared to cover crop seed and planting costs. These simple nitrogen cost comparisons

	do not take into account the benefits of improved soil tilth and increased water infiltration resulting from cover crops (Sullivan et al, 2003). Timing of burn down chemicals is important when terminating a spring growing cover crop. Ideally, cover crops should be allowed to grow as long as possible in the spring to add additional nutrients to the soil and suppress weeds. However, the longer the cover crop is growing the more moisture it removes and could potentially affect the growth and development of the subsequent crop, especially if drought conditions exists.(Sundermeier et al, 1999)
Materials and Methods	Each field trial will be 10 acres, subdivided into 4-2.5 acres plots. This will allow three different cover crop species/mixtures per farm, and one unplanted check plot. Quantities will be limited to 10 acres per farm and2 farms/targeted MLRA's of 107, 109,112,113,115,116,131and 134 in areas of cropland. Seed cost will be limited to $25.00/acre for up to10 acres at $250/farm in potentially 2 farms/ 8 MLRA's.=16 farms Total cost for the 3 years is ($4,000 x3 years) =$12,000 pending available funds. Seed mixtures will be shipped directly to the producer for drilling. Seed for the mixtures will be provided by the Elsberry Plant Materials Program. Species for consideration in the mixtures Cereal rye, or annual ryegrass, will be the base species for all cool season species mixture. Based on landowner needs the following species could be added to the mixture. N source- hairy vetch or red clover or crimson clover N scavenger- cereal rye, or annual ryegrass, oilseed radish N scavenger- summer-Sorghum-sudangrass or pearl millet Soil builder- cereal rye, or annual ryegrass, red clover or crimson clover Soil builder-summer- Sorghum-sudangrass and cow pea Subsoiler-oilseed radish, Weed suppressor- cereal rye

	Weed suppressor-summer-pearl millet, or sorghum sudangrass, or buckwheat. Data to be collected during the Cover Crop field trials Percent canopy cover Measurement is determined using the line transect method. Percent canopy cover is measured by placing the line transects in 3-5 locations across each 2.5 acre field. Transects for canopy cover will be taken March 1, April 1, May 1. Biomass Harvest Sample's using 3 sq. ft. 3-5 locations across each 2.5 acre field. Sampling for biomass harvest will be taken March 1, April 1, and May 1. Timing of Cover Crop Termination will vary from year to year. The optimum termination date will be determined by the rate of crop development. Cover crops will be terminated by applying glyphosate at the recommended rate. Visual rating of burn down success will be determined 2 and 4 weeks after application. Landowners/operators responsibilities Access to the site for data collection and field tours. Beginning soils test results for each 10 acre field. Providing equipment and labor (drill/tractor) to plant the cover crop mixtures. Farms with a Corn, soybean, and wheat rotation will receive higher priority. Landowners/ operators are responsible for herbicides and applications to control cover crops. These conservation field trials using cover crops are the landowners/operator responsibility for the cash crop yield.
Technology Transfer Products	Progress reports, technical report, peer-reviewed journal article, technical notes and poster and oral presentations.

References	Bjorkman T, Cornell University, New York State Agricultural Experiment Station, Cover Crops in soil health, www.hort.cornell.edu/bjorkman/lab/covercrops/soil-health.php Sullivan P, National Center for Appropriate Technology, Overview of Cover Crops and Green Manures, http://attra.ncat.org/attra-pub/covercrop.html Sundermeiier A, Ohio State University, Department of Horticulture and Crop Science, Cover Crop Fundamentals, http://ohioline.osu.edu/agf-fact/0142.html
Keywords	Cool season, Cover Crops

Prepared by:	Jerry U. Kaiser, Elsberry Plant Materials Specialist
Approvals:	JR Flores, Missouri State Conservationist **J.R. Flores /s/ 6/25/2012**

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

ID Code	MOPMC-2013-CC
Title	Cover Crop Demonstration Planting for Cover Crop Workshop
Demo Type	Technology Development
Status	Active
Location	MOPMC, Elsberry, MO
Demo Leader	Ron Cordsiemon
Duration	2013 through 2014
Cooperators	Jerry Kaiser, Plant Materials Specialist , Jodie Reisner, MO Agronomist; Doug Peterson, MO Soil Health Coordinator; Ron Miller, MO ACES;
Land Use	Cropland

Resource Concern(s)

Resource	Consideration/Problem
Soil Erosion	Sheet and Rill
Plants	Productivity, health, and vigor

NRCS Goals and Objectives

Goal #1- High Quality, Productive Soils

NRCS Plant Materials Program Goals and Objectives

Goal #1: Identify and evaluate plants and develop technology for their successful establishment and maintenance to solve natural resource conservation problems.
Objective 1.1- Conserve and enhance soil resources with plant science technology.
Objective 1.2- Improve water quality and quantity with plant science technology.

Goal #2: Provide plant materials and plant technology that are economically feasible for meeting resource concerns.
Objective 2.2- Maintain and improve the productivity of agricultural lands and watersheds through plants and plant management technology.

Description	This demonstration will allow interested persons to look at multiple cover crop species at one time. This will allow greater familiarity with cover crop species growth habits, flowering time, and winter hardiness. This demonstration will be showcased extensively at the Cover Crop Workshop on November 7, 2013.
Status of Knowledge	There is a need to collect scientific data on plant attributes of cover crops for inclusion into the RUSLE2 model. Currently RUSLE2 has limited data about cover crop species. Cover crops are starting to be planted extensively for use as mechanism for soil health improvement. NRCS policy is for fields that are receiving subsidies to meet a minimum standard of soil loss. NRCS field staff use the RUSLE2 model to determine the soil loss that is occurring in a particular field by including data such as past and current tillage practices, rotations, and crops. Without accurate vegetation files of cover crops included in RUSLE2, field office staff do not have a relatively quick and scientifically base method to determine if a field falls within the erosion compliance standards.
Design	Planting of selected cover crops (see map attachment) will be in a clean tilled area starting on August 1, 2013 and continue every 14 days for a total of six planting times. Each species will be planted in a 10 foot wide by 20 foot long plot on each planting date. Each species will be planted beside itself on subsequent planting dates to showcase the differences in planting dates. See Attached Map. Photos will be taken of each species about every 2 weeks as the growth progresses. Height will also be measured periodically. Biomass and canopy cover will be taken of each species at least once during the fall 2013 and again in Spring 2014. Notes on phonological characteristics will be documented as appropriate.
Technology Transfer Products	Vegetation file for the RUSLE2 model, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides
Keywords	Biomass, Plant attributes, cover crop, RUSLE2, soil erosion, water quality, Brassica, Legumes, Grasses

Prepared by:	Allen Casey, Elsberry Plant Materials Center
Reviewed by:	Ron Cordsiemon, Elsberry Plant Materials Center Manager

Cool Season Cover Crop Planting Date Demonstration

Demonstration No. MOPMC-2013-CC

Demonstration Leader: Ron L. Cordsiemon, PMC Manager

Introduction: This project report is an analysis of one year of data and any conclusions in this report may change in the future as more data are collected and analyzed. This demonstration was designed to allow interested persons to look at multiple cover crop species that were planted at multiple dates all at the same time for comparison. This has allowed more familiarity with cover crop species growth habits, flowering time, and winter hardiness. Plant height was collected periodically throughout the fall and winter and will be collected again in the spring. Biomass data for each species and planting date was collected on Nov 15, 2013 and will be collected again in the spring on the species that survive the winter. The species that were planted and the above ground biomass on Nov 15, 2013 are shown in Table 1. All species were planted on the following dates in 2013; Aug 1, Aug 15, Aug 29, Sept 12, Sept 26, and Oct 10.

Objective: This demonstration will allow interested persons to look at multiple cover crop species at one time. This will allow greater familiarity with cover crop species growth habits, flowering time, and winter hardiness. This demonstration will be showcased extensively at the Cover Crop Workshop on November 7, 2013.

Procedure: Planting of selected cover crops (see map attachment) will be in a clean tilled area starting on August 1, 2013 and continue every 14 days for a total of six planting times. Each species will be planted in a 10 foot wide by 20 foot long plot on each planting date. Each species will be planted beside itself on subsequent planting dates to showcase the differences in planting dates. See Attached Map.

Photos will be taken of each species about every 2 weeks as the growth progresses. Height will also be measured periodically. Biomass and canopy cover will be taken of each species at least once during the fall 2013 and again in Spring 2014. Notes on phonological characteristics will be documented as appropriate.

Potential Products: Vegetation file for the RUSLE2 model, revised FOTG standards, technical notes, poster papers, technical reports, newsletter articles, oral presentations, plant guides

Progress or Status:

Highlight Summary of Preliminary Results

- For most of the species that were looked at the plant height starts to decline in late October due to the start of freezing temperatures.
- The earlier planting dates produced more above ground biomass than those planted later.
- The following species and planting dates did not provide any above ground biomass at the sampling date of Nov 15, 2013: White Ladino clover-Sept 26, Oct 10; tickseed coreopsis – all dates; hairy vetch- Sept 26, Oct 10; winter pea- Sept 26, Oct 10; red clover- Oct 10; berseem clover- all dates; Fava bean- Oct 10.

Table 1. Above ground biomass for each species and planting date. Sampled on Nov. 15, 2013.

Species	Planting Date	Above Ground Herbage biomass (lbs/acre)	Species	Planting Date	Above Ground Herbage biomass (lbs/acre)
Purple Top Turnip	1-Aug	4036.22	Plains Coreopsis	1-Aug	0.00
Purple Top Turnip	15-Aug	3729.31	Plains Coreopsis	15-Aug	0.00
Purple Top Turnip	29-Aug	3236.82	Plains Coreopsis	29-Aug	0.00
Purple Top Turnip	12-Sep	3247.53	Plains Coreopsis	12-Sep	0.00
Purple Top Turnip	26-Sep	524.60	Plains Coreopsis	26-Sep	0.00
Purple Top Turnip	10-Oct	35.69	Plains Coreopsis	10-Oct	0.00
Impact forage Collards	1-Aug	6873.35	Phalecia	1-Aug	3836.37
Impact forage Collards	15-Aug	5445.86	Phalecia	15-Aug	1680.86
Impact forage Collards	29-Aug	5413.74	Phalecia	29-Aug	3879.19
Impact forage Collards	12-Sep	2023.46	Phalecia	12-Sep	1820.04
Impact forage Collards	26-Sep	0.00	Phalecia	26-Sep	196.28
Impact forage Collards	10-Oct	0.00	Phalecia	10-Oct	42.82
Mustard	1-Aug	9025.28	Chickling Vetch	1-Aug	2926.35
Mustard	15-Aug	7915.41	Chickling Vetch	15-Aug	2644.42
Mustard	29-Aug	3954.14	Chickling Vetch	29-Aug	1688.00
Mustard	12-Sep	3144.04	Chickling Vetch	12-Sep	1220.50
Mustard	26-Sep	1177.68	Chickling Vetch	26-Sep	256.95
Mustard	10-Oct	39.26	Chickling Vetch	10-Oct	49.96
Kale	1-Aug	6220.27	Crimson Clover	1-Aug	1052.77
Kale	15-Aug	7397.95	Crimson Clover	15-Aug	1170.54
Kale	29-Aug	3797.11	Crimson Clover	29-Aug	2201.90
Kale	12-Sep	2073.42	Crimson Clover	12-Sep	592.41
Kale	26-Sep	249.81	Crimson Clover	26-Sep	78.51
Kale	10-Oct	14.27	Crimson Clover	10-Oct	42.82
Nitro Radish	1-Aug	5131.81	Lana Wolly Pod Vetch	1-Aug	4517.99
Nitro Radish	15-Aug	4792.78	Lana Wolly Pod Vetch	15-Aug	1841.46
Nitro Radish	29-Aug	3001.29	Lana Wolly Pod Vetch	29-Aug	2048.44
Nitro Radish	12-Sep	3554.44	Lana Wolly Pod Vetch	12-Sep	1184.81
Nitro Radish	26-Sep	813.67	Lana Wolly Pod Vetch	26-Sep	185.57
Nitro Radish	10-Oct	60.67	Lana Wolly Pod Vetch	10-Oct	46.39
Hunter Hybrid Turnip	1-Aug	4118.30	Cahaba Vetch	1-Aug	2134.09
Hunter Hybrid Turnip	15-Aug	5777.75	Cahaba Vetch	15-Aug	1959.22
Hunter Hybrid Turnip	29-Aug	4632.19	Cahaba Vetch	29-Aug	1905.69
Hunter Hybrid Turnip	12-Sep	2815.72	Cahaba Vetch	12-Sep	1759.38
Hunter Hybrid Turnip	26-Sep	1224.07	Cahaba Vetch	26-Sep	135.61
Hunter Hybrid Turnip	10-Oct	74.94	Cahaba Vetch	10-Oct	42.82
Canola	1-Aug	5253.15	Windham Winter Pea	1-Aug	4046.92
Canola	15-Aug	5963.32	Windham Winter Pea	15-Aug	2383.90
Canola	29-Aug	4296.73	Windham Winter Pea	29-Aug	2030.60
Canola	12-Sep	353.30	Windham Winter Pea	12-Sep	645.94
Canola	26-Sep	0.00	Windham Winter Pea	26-Sep	142.75
Canola	10-Oct	42.82	Windham Winter Pea	10-Oct	53.53

Species	Planting Date	Above Ground Herbage biomass (lbs/acre)	Species	Planting Date	Above Ground Herbage biomass (lbs/acre)
Graza Forage Radish	1-Aug	5278.13	Sainfoin	1-Aug	1013.52
Graza Forage Radish	15-Aug	5228.17	Sainfoin	15-Aug	695.90
Graza Forage Radish	29-Aug	3115.49	Sainfoin	29-Aug	920.73
Graza Forage Radish	12-Sep	2737.20	Sainfoin	12-Sep	278.36
Graza Forage Radish	26-Sep	756.57	Sainfoin	26-Sep	49.96
Graza Forage Radish	10-Oct	196.28	Sainfoin	10-Oct	7.14
Beet	1-Aug	1937.81	White Ladino Clover	1-Aug	1527.41
Beet	15-Aug	2719.36	White Ladino Clover	15-Aug	553.15
Beet	29-Aug	1498.86	White Ladino Clover	29-Aug	913.59
Beet	12-Sep	139.18	White Ladino Clover	12-Sep	153.45
Beet	26-Sep	42.82	White Ladino Clover	26-Sep	0.00
Beet	10-Oct	0.00	White Ladino Clover	10-Oct	0.00
Rudbeckia hirta	1-Aug	0.00	Tickseed Coreopsis	1-Aug	0.00
Rudbeckia hirta	15-Aug	0.00	Tickseed Coreopsis	15-Aug	0.00
Rudbeckia hirta	29-Aug	0.00	Tickseed Coreopsis	29-Aug	0.00
Rudbeckia hirta	12-Sep	0.00	Tickseed Coreopsis	12-Sep	0.00
Rudbeckia hirta	26-Sep	0.00	Tickseed Coreopsis	26-Sep	0.00
Rudbeckia hirta	10-Oct	0.00	Tickseed Coreopsis	10-Oct	0.00
Winter Triticale	1-Aug	2623.01	Flax	1-Aug	2598.02
Winter Triticale	15-Aug	3265.37	Flax	15-Aug	2544.49
Winter Triticale	29-Aug	2244.72	Flax	29-Aug	2876.38
Winter Triticale	12-Sep	553.15	Flax	12-Sep	1402.51
Winter Triticale	26-Sep	1302.58	Flax	26-Sep	767.27
Winter Triticale	10-Oct	0.00	Flax	10-Oct	82.08
Cereal Rye	1-Aug	2426.73	Hairy Vetch	1-Aug	5231.74
Cereal Rye	15-Aug	2637.28	Hairy Vetch	15-Aug	3436.67
Cereal Rye	29-Aug	2637.28	Hairy Vetch	29-Aug	1809.34
Cereal Rye	12-Sep	2119.82	Hairy Vetch	12-Sep	560.29
Cereal Rye	26-Sep	2216.17	Hairy Vetch	26-Sep	0.00
Cereal Rye	10-Oct	314.05	Hairy Vetch	10-Oct	0.00
Spring Forage Barley	1-Aug	2740.77	Winter Pea	1-Aug	2701.52
Spring Forage Barley	15-Aug	1413.21	Winter Pea	15-Aug	1820.04
Spring Forage Barley	29-Aug	2144.80	Winter Pea	29-Aug	1855.73
Spring Forage Barley	12-Sep	981.40	Winter Pea	12-Sep	785.12
Spring Forage Barley	26-Sep	927.87	Winter Pea	26-Sep	0.00
Spring Forage Barley	10-Oct	271.22	Winter Pea	10-Oct	0.00
Winter Barley	1-Aug	2455.28	Red Clover	1-Aug	2994.15
Winter Barley	15-Aug	2119.82	Red Clover	15-Aug	1074.18
Winter Barley	29-Aug	1994.91	Red Clover	29-Aug	581.70
Winter Barley	12-Sep	813.67	Red Clover	12-Sep	777.98
Winter Barley	26-Sep	1006.38	Red Clover	26-Sep	132.04
Winter Barley	10-Oct	799.39	Red Clover	10-Oct	0.00

Species	Planting Date	Above Ground Herbage biomass (lbs/acre)	Species	Planting Date	Above Ground Herbage biomass (lbs/acre)
Winter Wheat	1-Aug	3165.45	Berseem Clover	1-Aug	0.00
Winter Wheat	15-Aug	856.49	Berseem Clover	15-Aug	0.00
Winter Wheat	29-Aug	2976.31	Berseem Clover	29-Aug	0.00
Winter Wheat	12-Sep	635.23	Berseem Clover	12-Sep	0.00
Winter Wheat	26-Sep	331.89	Berseem Clover	26-Sep	0.00
Winter Wheat	10-Oct	221.26	Berseem Clover	10-Oct	0.00
Black Oats	1-Aug	6338.04	Spring Lentil	1-Aug	2052.01
Black Oats	15-Aug	1684.43	Spring Lentil	15-Aug	1434.62
Black Oats	29-Aug	2662.26	Spring Lentil	29-Aug	2109.11
Black Oats	12-Sep	2266.13	Spring Lentil	12-Sep	792.25
Black Oats	26-Sep	620.96	Spring Lentil	26-Sep	124.91
Black Oats	10-Oct	17.84	Spring Lentil	10-Oct	28.55
Annual Ryegrass	1-Aug	1484.59	Faba Bean	1-Aug	3786.41
Annual Ryegrass	15-Aug	1513.14	Faba Bean	15-Aug	2162.64
Annual Ryegrass	29-Aug	2066.29	Faba Bean	29-Aug	2490.96
Annual Ryegrass	12-Sep	1695.14	Faba Bean	12-Sep	1377.52
Annual Ryegrass	26-Sep	346.17	Faba Bean	26-Sep	428.25
Annual Ryegrass	10-Oct	0.00	Faba Bean	10-Oct	0.00
Spring Oats	1-Aug	2002.05	Common Vetch	1-Aug	1962.79
Spring Oats	15-Aug	1095.60	Common Vetch	15-Aug	1541.69
Spring Oats	29-Aug	1231.21	Common Vetch	29-Aug	1691.57
Spring Oats	12-Sep	1527.41	Common Vetch	12-Sep	970.69
Spring Oats	26-Sep	753.00	Common Vetch	26-Sep	160.59
Spring Oats	10-Oct	124.91	Common Vetch	10-Oct	10.71

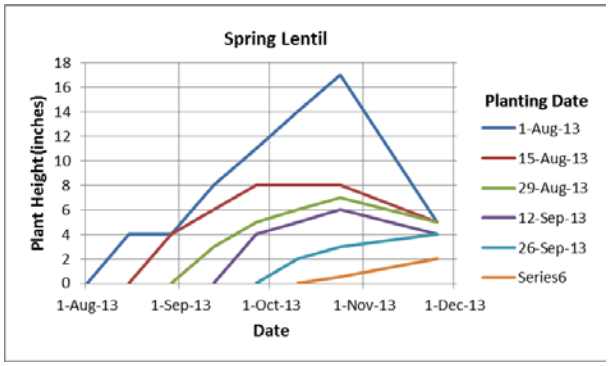


Chart showing mean height of spring lentil over time.

Spring lentil planted on Aug 15, 2013. Photo taken Nov 14, 2013.

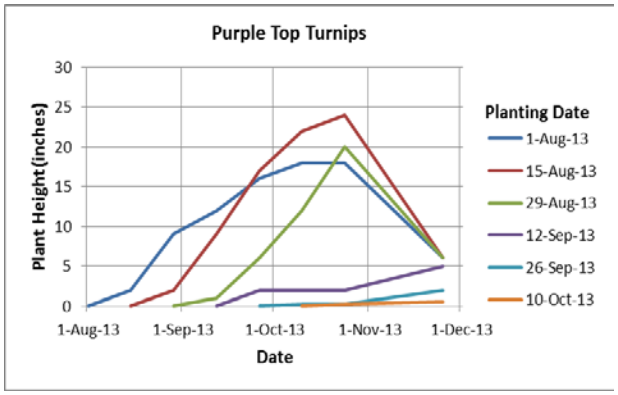


Chart showing mean height of purple top turnip over time.

Purple top turnip planted on Aug. 15, 2013. Photo taken Nov 14, 2013.

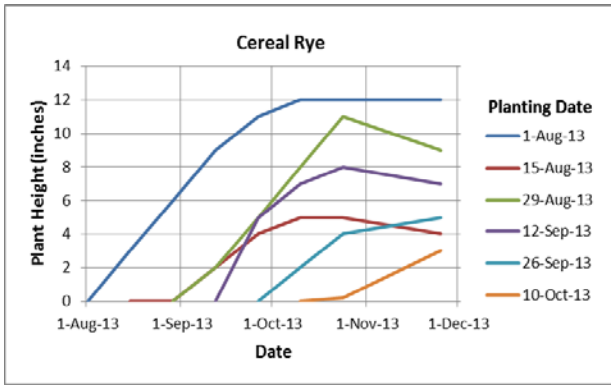


Chart showing mean height of cereal rye over time.

Cereal rye planted on Sept 12, 2013. Photo taken Nov 14, 2013.

Color Key:	"Brassica"	Grass	Legume	Native Forb	Forb	North ↓	West →
Purple Top Turnip	1-Aug	Rudbeckia hirta	1-Aug	Plains Coreopsis	1-Aug	Tickseed Coreopsis	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Impact forage Collards	1-Aug	Winter Triticale	1-Aug	Phalecia	1-Aug	Flax	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Mustard	1-Aug	Cereal Rye	1-Aug	Chickling Vetch	1-Aug	Hairy Vetch	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Kale	1-Aug	Spring Forage Barley	1-Aug	Crimson Clover	1-Aug	Winter Pea	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Nitro Radish	1-Aug	Winter Barley	1-Aug	Lana Wolly Pod Vetch	1-Aug	Red Clover	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Hunter Hybrid Turnip	1-Aug	Winter Wheat	1-Aug	Cahaba Vetch	1-Aug	Berseem Clover	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Canola	1-Aug	Black Oats	1-Aug	Windham Winter Pea	1-Aug	Spring Lentil	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Graza Forage Radish	1-Aug	Annual Ryegrass	1-Aug	Sainfoin	1-Aug	Faba Bean	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct
Beet	1-Aug	Spring Oats	1-Aug	White Ladino Clover	1-Aug	Common Vetch	1-Aug
	15-Aug		15-Aug		15-Aug		15-Aug
	29-Aug		29-Aug		29-Aug		29-Aug
	12-Sep		12-Sep		12-Sep		12-Sep
	26-Sep		26-Sep		26-Sep		26-Sep
	10-Oct		10-Oct		10-Oct		10-Oct

Cool and Warm Season Cover Crop Demonstrations and Evaluations

Study No. MOPMS-T-1228-CC

National Project(s): Cropland 1.1

Study Leader: Jerry Kaiser, Plant Materials Specialist

Introduction: The need is Conservation Field Trials to demonstrate cover crops for producers from Major Land Resource Areas (MLRA's) in Missouri. These demonstrations will be on farm learning for the acceptance of cover crop practice as part of a cropping system. Selection of cooperators will be based upon their prior knowledge of cover crops, conservation tillage and community leadership ability.

Cool season species will be in the planned mixes, by demonstrating on a field scale and evaluating percent cover during the growing season, timing of cover crop termination prior to establishment of the subsequent cash crop, and stand establishment of cash crop.

The objective is to have cover after fall cash crops so that the cover crop will perform multiple benefits for the resource base (e.g. soil protection). Cover crops can improve soil health by reducing compaction, improving organic matter, and decreasing runoff and erosion. Cover crops can improve water quality by sequestering nitrogen before it leaches into the ground water.

Annual ryegrass has an extensive root system that tolerates compacted soils and makes it an effective cover crop for excess nitrogen (Bjorkman et al., 2009). Radishes are excellent at breaking up shallow layers of compacted soils, earning them the nicknames "biodrills" or "tillage radishes." A thinner extension of the tap root can penetrate deeper layers of compaction. The roots die over the winter and leave channels so that the soil dries and warms up faster in the spring (Bjorkman et al., 2009). Sorghum sudangrass provide abundant root biomass, which is useful for increasing soil organic matter (Bjorkman et al, 2009).

Non-legume species such as rye, oats, wheat, forage turnips, oilseed radish, sudangrass, and buckwheat recycle existing soil nitrogen and other nutrients and can reduce leaching losses. (Sundermeier et al., 1999)

Certain broad-leaved plants are noted for their ability to accumulate minerals at high concentrations in their tissue (Sullivan et al, 2003).

Studies have shown that legume cover crops can replace a portion of the fertilizer nitrogen requirements of the subsequent crop. The economic value of these nitrogen replacements can be calculated by using a local nitrogen price. These costs can then be compared to cover crop seed and planting costs. These simple nitrogen cost comparisons do not take into account the benefits of improved soil tilth and increased water infiltration resulting from cover crops (Sullivan et al, 2003).

Timing of burn down chemicals is important when terminating a spring growing cover crop. Ideally, cover crops should be allowed to grow as long as possible in the spring to add additional nutrients to the soil and suppress weeds. However, the longer the cover crop is growing the more moisture it removes and could potentially affect the growth and development of the subsequent crop, especially if drought conditions exists.(Sundermeier et al, 1999)

Objective: The cover crops will be mixtures to support or update the USDA NRCS 340 Cover Crop Standard for Missouri.

Procedure: Each field trial will be 10 acres, subdivided into 4-2.5 acres plots. This will allow three different cover crop species/mixtures per farm, and one unplanted check plot.

Quantities will be limited to 10 acres per farm and2 farms/targeted MLRA's of 107, 109,112,113,115,116,131and 134 in areas of cropland.

Seed cost will be limited to $25.00/acre for up to10 acres at $250/farm in potentially 2 farms/ 8 MLRA's.=16 farms

Total cost for the 3 years is ($4,000 x3 years) =$12,000 pending available funds.

Seed mixtures will be shipped directly to the producer for drilling.

Seed for the mixtures will be provided by the Elsberry Plant Materials Program.

Species for consideration in the mixtures

Cereal rye, or annual ryegrass, will be the base species for all cool season species mixture.
Based on landowner needs the following species could be added to the mixture.
N source- hairy vetch **or** red clover **or** crimson clover
N scavenger- cereal rye, **or** annual ryegrass, oilseed radish
N scavenger- summer-Sorghum-sudangrass **or** pearl millet
Soil builder- cereal rye, **or** annual ryegrass, red clover **or** crimson clover
Soil builder-summer- Sorghum-sudangrass and cow pea
Subsoiler-oilseed radish,
Weed suppressor- cereal rye
Weed suppressor-summer-pearl millet, **or** sorghum sudangrass**,** or buckwheat.

Data to be collected during the Cover Crop field trials

Percent canopy cover

Measurement is determined using the line transect method. Percent canopy cover is measured by placing the line transects in 3-5 locations across each 2.5 acre field**.**

Transects for canopy cover will be taken March 1, April 1, May 1.

Biomass Harvest

Sample's using 3 sq. ft. 3-5 locations across each 2.5 acre field.

Sampling for biomass harvest will be taken March 1, April 1, and May 1.

Timing of Cover Crop Termination will vary from year to year. The optimum termination date will be determined by the rate of crop development. Cover crops will be terminated by applying glyphosate at the recommended rate. Visual rating of burn down success will be determined 2 and 4 weeks after application.

Landowners/operators responsibilities

Access to the site for data collection and field tours.

Beginning soils test results for each 10 acre field.

Providing equipment and labor (drill/tractor) to plant the cover crop mixtures.

Farms with a Corn, soybean, and wheat rotation will receive higher priority.

Landowners/ operators are responsible for herbicides and applications to control cover crops.

These conservation field trials using cover crops are the landowners/operator responsibility for the cash crop yield.

Potential Products: Progress reports, technical report, peer-reviewed journal article, Technical Notes and poster and oral presentations.

Progress or Status:

2012:
Conservation field trials for cool season cover crops mixtures were implemented with producers in 8 counties and within 6 Major Land Resource Areas (MLRA's). The counties and MLRA's are Saline, (107), Jackson, (112), Caldwell and Worth, (109), Ralls, (113), St. Charles and Perry, (115B), and Cape, (131A). Planting dates were from 9/11/2012 to 10/16/2012.

Each field trial is a total of 10 acres. The 10 acres is divided into (4) 2.5 acre fields. The following species and varieties were used.

The 1st 2.5 acres contains Annual ryegrass (Bounty) 3#PLS/ac; Crimson clover (AU Robbins) 4#PLS/ac; and oilseed radish (Enricher) 1.67#PLS/ac.

The 2nd 2.5 acres contains Cereal rye (Aroostook) 22.5#PLS/ac; Crimson clover (Dixie) 6#PLS/ac.

The 3rd 2.5 acres contains Cereal rye (Aroostook) 15#PLS/ac; Hairy Vetch (Purple Bounty) 5#PLS/ac; and oilseed radish (Tillage) 1.67#PLS/ac.

The 4th 2.5 acres is the control no cover crop just the previous crop residue.

A procedure for evaluations is developed and to be sent to field office contacts for follow-up data collection spring 2013.

2013:
The summary sheets follow for the data that was collected from each of the field trial sites.

The canopy cover data collected were 3 transects per field (each 2.5 acres field). The canopy cover was taken three times, one month apart during the spring active growing season and before termination of the cover crop for planting the cash crop. The amount of canopy cover was evaluated in the amount of percent cover based on interception of rainfall before striking the surface. Weeds were also evaluated on the percentage within the stands verse the control with no cover crop.

Dry matter data was collected by conducting 3 cuttings per field (each cutting was 1 sq.ft.). The cuttings were conducted at the same time of the transect data for canopy cover. The cuttings were dried for each field to obtain lbs./acre of cover crop species for each mixture used for that field. Weeds were also cut in the sampling and separated from the cover crop species to determine the lbs/ acre of weeds for each of the 2.5 acre fields including the control.

Visual ratings of herbicide application were determined 3 weeks after application for control measures for cover crop species.

Visual ratings of cash crop were determined 3 weeks after planting.

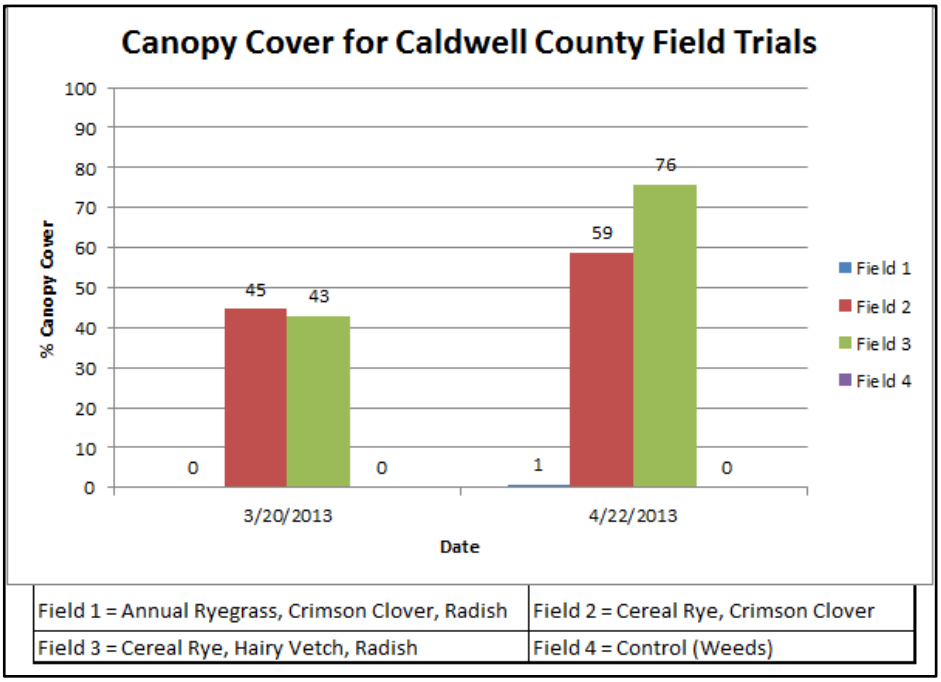
All county locations completed the plantings of the field trials in the fall of 2012 for the 2013 cash crop year. The field trial in Jackson County 2013 data could not be summarized because of worksheets and field data sites were mixed in the collection process.

The field trials in Cape County, Ralls County and Jackson County will not continue for the fall planting of cover crops in 2013.

Two new field trial sites in Cape County were identified for 2013 fall planting of the cover crop mixtures. Caldwell County has also selected another site location with the same landowner for the 2013 field trial cover crops.

The field trial sites in Perry, Saline, St Charles, and Worth counties will be in the same site location for 2013 fall planting of the cover crop mixtures.

2013 Summary sheet are listed below by the counties locations for the field trials.



Field 1 = Annual Ryegrass, Crimson Clover, Radish	Field 2 = Cereal Rye, Crimson Clover
Field 3 = Cereal Rye, Hairy Vetch, Radish	Field 4 = Control (Weeds)

Pounds Per Acre of Dry Matter - Caldwell County

	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	0.00	9.59	588.48	313.43	1125.78	143.92	0
April	3.2	95.95	3757.93	738.79	2446.65	1787.81	0
May							

Termination: 4/25/2013	Date of Cover Crop Termination Rating (Field Flooded)						
Evaluation: 5/24/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	1	Cereal Rye	1	Cereal Rye	1	Grass (Weeds)	1
Crimson Clover	1	Crimson Clover	1	Hairy Vetch	1	Broadleaf Weeds	1
Radish	1	Grass (Weeds)	1	Radish	1		
Grass (Weeds)	1	Broadleaf Weeds	1	Grass (Weeds)	1		
Broadleaf Weeds	1			Broadleaf Weeds	1		

Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

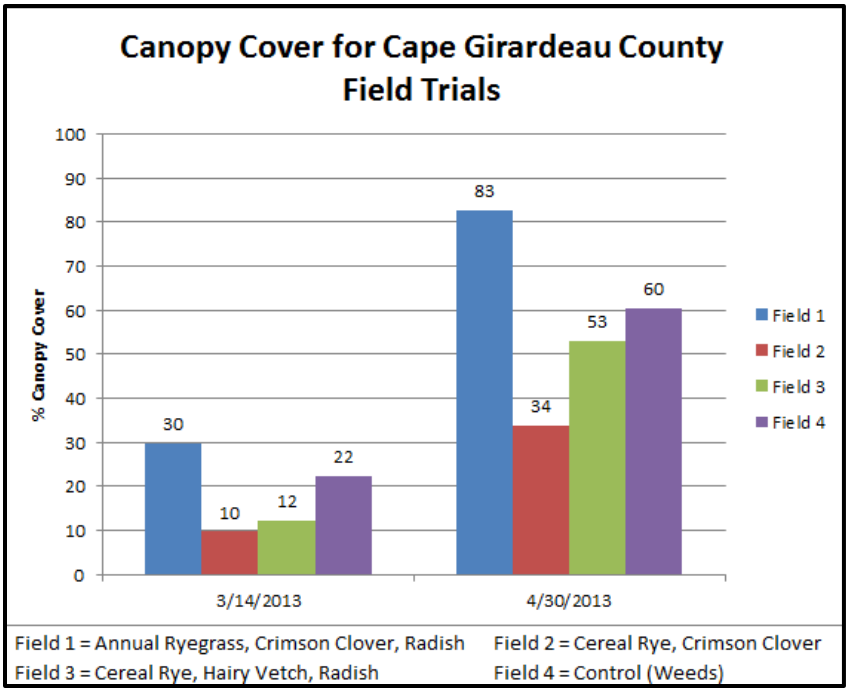
Date of Visual Rating of Cash Crop

24-May-13

	Field 1	Field 2	Field 3	Field 4
Rating	Flooded			

Ratings

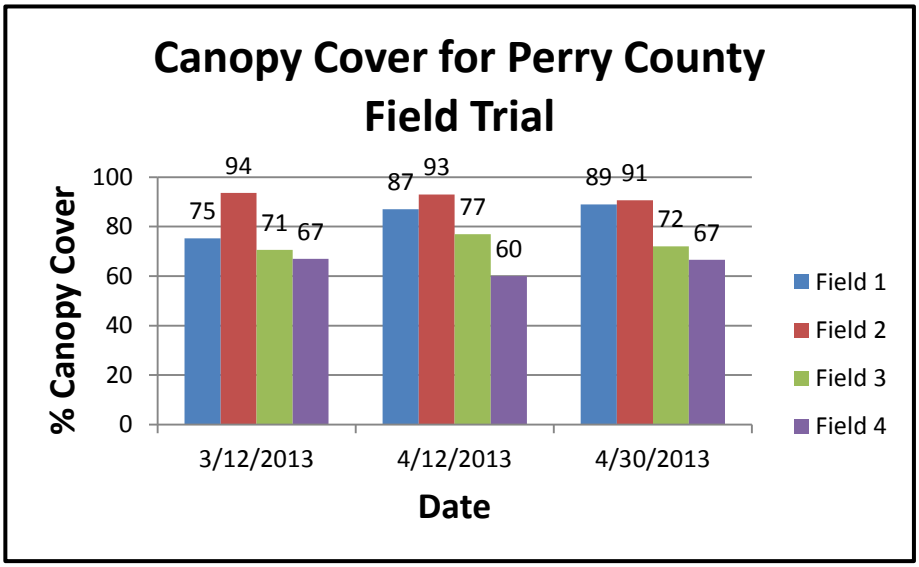
A = Excellent B = Good C = Average D = Poor E = Very Poor



Pounds Per Acre of Dry Matter - Cape Girardeau County							
	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	150.32	47.97	358.2	12.79	335.81	99.15	70.36
April	4093.74	28.78	4010.59	703.61	2590.57	646.04	869.92
May							

Termination: 4/13/2013	Date of Cover Crop Termination Rating						
Evaluation: 5/16 & 6/20/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	3	Cereal Rye	1	Cereal Rye	3	Grass (Weeds)	5
Crimson Clover	1	Crimson Clover	1	Hairy Vetch	1	Broadleaf Weeds	5
Radish	1	Grass (Weeds)	N/A	Radish	1		
Grass (Weeds)	3	Broadleaf Weeds	N/A	Grass (Weeds)	3		
Broadleaf Weeds	3			Broadleaf Weeds	3		
Termination Ratings							
1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage							

Date of Visual Rating of Cash Crop					
20-Jun-13					
	Field 1	**Field 2**	**Field 3**	**Field 4**	
Rating	N/A				
Ratings					
A = Excellent B = Good C = Average D = Poor E = Very Poor					



Field 1 = Annual Ryegrass, Crimson Clover, Radish Field 2 = Cereal Rye, Crimson Clover
Field 3 = Cereal Rye, Hairy Vetch, Radish Field 4 = Control (Weeds)

Pounds Per Acre of Dry Matter - Perry County							
	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	1160.96	63.96	1695.07	0.00	802.76	22.39	1020.24
April	2219.58	47.97	4064.96	0.00	4016.99	60.77	869.92
May	2437.06	0.00	8005.19	0.00	6332.51	0.00	620.46

Termination: 5/1/2013	Date of Cover Crop Termination Rating						
Evaluation: 5/30/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	3	Cereal Rye	3	Cereal Rye	3	Grass (Weeds)	1
Crimson Clover	3	Crimson Clover	3	Hairy Vetch	3	Broadleaf Weeds	5
Radish	1	Grass (Weeds)	1	Radish	1		
Grass (Weeds)	1	Broadleaf Weeds	1	Grass (Weeds)	1		
Broadleaf Weeds	1			Broadleaf Weeds	1		

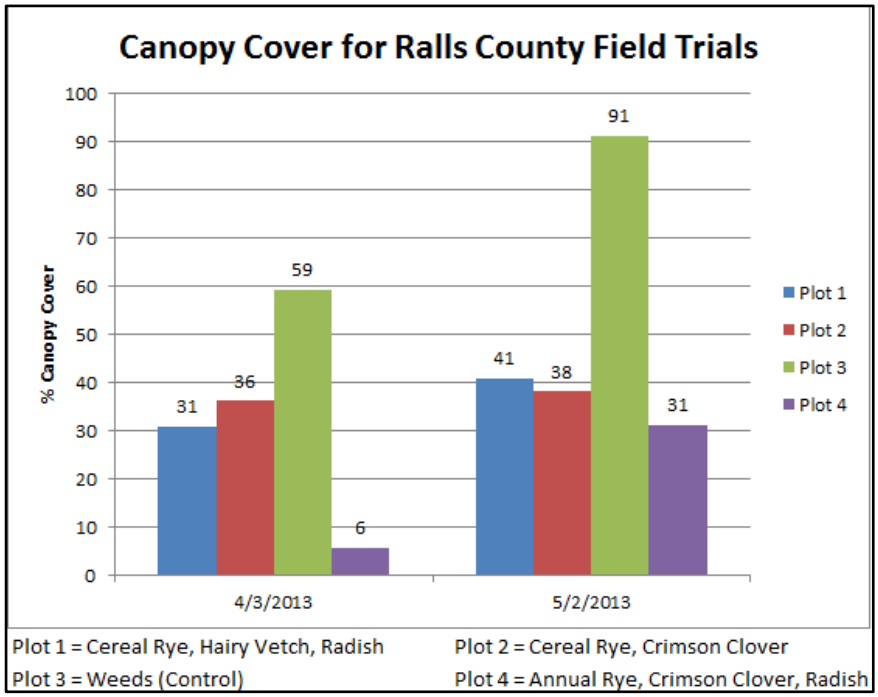
Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

Date of Visual Rating of Cash Crop					
30-May-13					
	Field 1	**Field 2**	**Field 3**	**Field 4**	
Rating	B	C	B	B	

Ratings

A = Excellent B = Good C = Average D = Poor E = Very Poor



Pounds Per Acre of Dry Matter - Ralls County

	Plot 1		Plot 2		Plot 3	Plot 4	
	Cereal Rye, Hairy Vetch, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Control (Weeds)	Annual Ryegrass, Crimson Clover, Radish	Weeds
March	361.40	521.31	428.56	703.61	601.27	35.18	156.71
April	1611.91	345.41	1990.9	1117.78	2317.12	307.03	618.86
May							

Termination: 5/25 - 5/27/2013	Date of Cover Crop Termination Rating						
Evaluation: 6/21/2013	**Rating**		**Rating**		**Rating**		**Rating**
Plot 1		**Plot 2**		**Plot 3**		**Plot 4**	
Cereal Rye	1	Cereal Rye	1	Grass (Weeds)	1	Annual Ryegrass	1
Hairy Vetch	1	Crimson Clover	1	Broadleaf Weeds	1	Crimson Clover	1
Radish	1	Grass (Weeds)	1		1	Radish	
Grass (Weeds)	1	Broadleaf Weeds	1		1	Grass (Weeds)	
Broadleaf Weeds	1				1	Broadleaf Weeds	

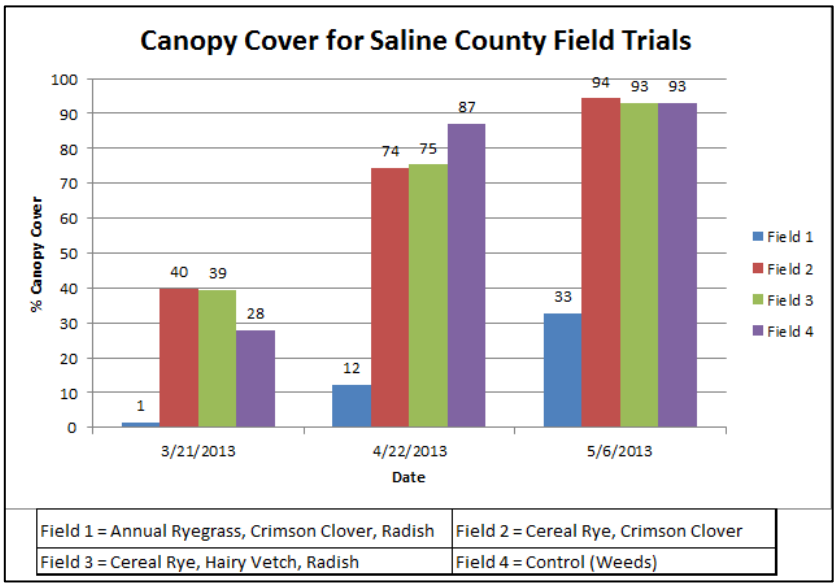
Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

Date of Visual Rating of Cash Crop					
1-Jul-13					
	Plot 1	**Plot 2**	**Plot 3**	**Plot 4**	
Rating	B	B	B	B	

Ratings

A = Excellent B = Good C = Average D = Poor E = Very Poor



Field 1 = Annual Ryegrass, Crimson Clover, Radish	Field 2 = Cereal Rye, Crimson Clover
Field 3 = Cereal Rye, Hairy Vetch, Radish	Field 4 = Control (Weeds)

Pounds Per Acre of Dry Matter - Saline County

	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	19.19	335.81	393.38	28.78	412.57	230.27	821.95
April	35.18	972.26	1375.24	172.70	1541.55	307.03	1065.01
May	463.74	1365.65	5213.13	409.37	4234.47	316.63	2750.48

Termination: 5/8/2013	Date of Cover Crop Termination Rating						
Evaluation: 6/18/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	4	Cereal Rye	1	Cereal Rye	1	Grass (Weeds)	1
Crimson Clover	1	Crimson Clover	1	Hairy Vetch	1	Broadleaf Weeds	1
Radish	1	Grass (Weeds)	1	Radish	1		
Grass (Weeds)	3	Broadleaf Weeds	1	Grass (Weeds)	1		
Broadleaf Weeds	3			Broadleaf Weeds	1		

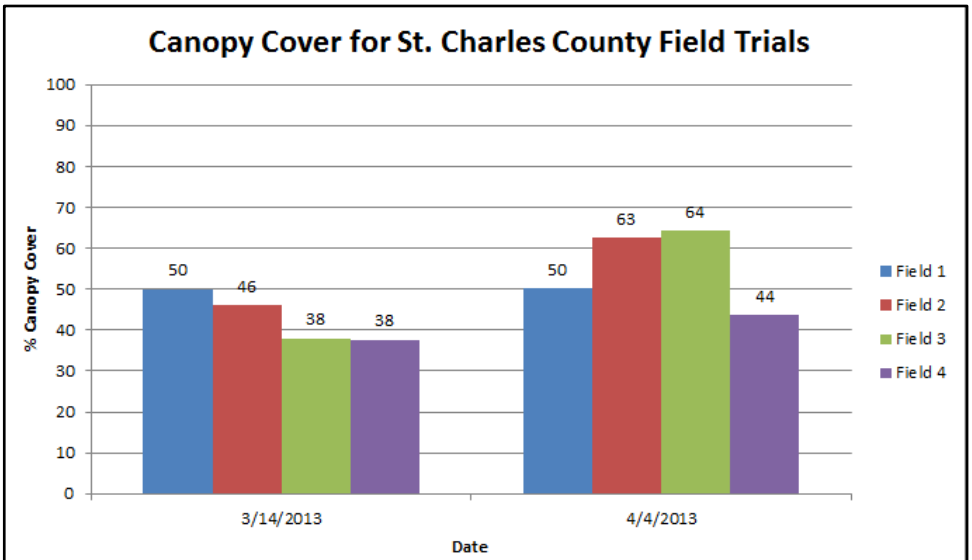
Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

Date of Visual Rating of Cash Crop					
18-Jun-13					
	Field 1	**Field 2**	**Field 3**	**Field 4**	
Rating	B	A	A	A	

Ratings

A = Excellent B = Good C = Average D = Poor E = Very Poor



Field 1 = Annual Ryegrass, Crimson Clover, Radish	Field 2 = Cereal Rye, Crimson Clover
Field 3 = Cereal Rye, Hairy Vetch, Radish	Field 4 = Control (Weeds)

Pounds Per Acre of Dry Matter - St. Charles County

	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	821.95	339.01	668.43	259.06	441.36	201.49	431.76
April	476.54	546.9	588.48	153.52	1036.23	108.74	972.26
May							

Termination: 4/5 & 5/14/2013	Date of Cover Crop Termination Rating						
Evaluation: 6/15/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	1	Cereal Rye	1	Cereal Rye	1	Grass (Weeds)	1
Crimson Clover	1	Crimson Clover	1	Hairy Vetch	1	Broadleaf Weeds	1
Radish	1	Grass (Weeds)	1	Radish	1		
Grass (Weeds)	1	Broadleaf Weeds	1	Grass (Weeds)	1		
Broadleaf Weeds	1			Broadleaf Weeds	1		

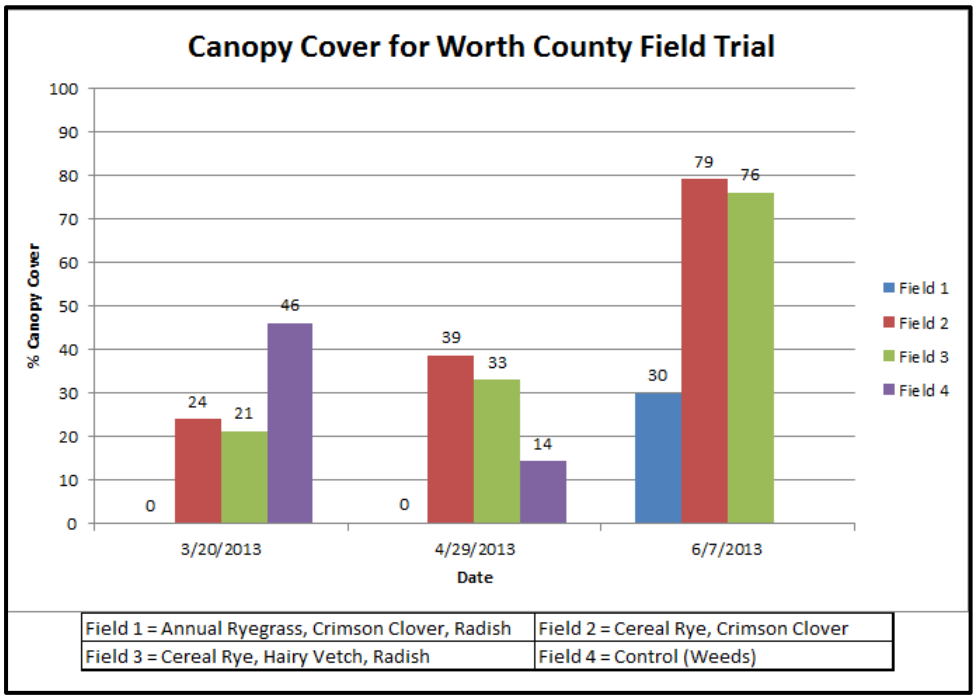
Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

Date of Visual Rating of Cash Crop					
19-Jun-13					
	Field 1	**Field 2**	**Field 3**	**Field 4**	
Rating	B	B	B	B	

Ratings

A = Excellent B = Good C = Average D = Poor E = Very Poor



Field 1 = Annual Ryegrass, Crimson Clover, Radish	Field 2 = Cereal Rye, Crimson Clover
Field 3 = Cereal Rye, Hairy Vetch, Radish	Field 4 = Control (Weeds)

Pounds Per Acre of Dry Matter - Worth County

	Field 1		Field 2		Field 3		Field 4
	Annual Ryegrass, Crimson Clover, Radish	Weeds	Cereal Rye, Crimson Clover	Weeds	Cereal Rye, Hairy Vetch, Radish	Weeds	Control (Weeds)
March	0.00	111.94	25.59	0.00	28.78	0.00	0
April	31.98	319.82	383.79	134.33	441.36	86.35	502.12
May	706.81	1100.19	5817.59	601.27	4451.95	143.92	3054.32

Termination: 5/28/2013	Date of Cover Crop Termination Rating						
Evaluation: 7/1/2013	**Rating**		**Rating**		**Rating**		**Rating**
Field 1		**Field 2**		**Field 3**		**Field 4**	
Annual Ryegrass	N/A	Cereal Rye	1	Cereal Rye	1	Grass (Weeds)	1
Crimson Clover	N/A	Crimson Clover	1	Hairy Vetch	1	Broadleaf Weeds	1
Radish	1	Grass (Weeds)	1	Radish	1		
Grass (Weeds)	1	Broadleaf Weeds	1	Grass (Weeds)	1		
Broadleaf Weeds	1			Broadleaf Weeds	1		

Termination Ratings

1 = Dead 3 = Severe Damage 5 = Moderate Damage 7 = Light Damage 9 = No Damage

Date of Visual Rating of Cash Crop					
1-Jul-13					
	Field 1	**Field 2**	**Field 3**	**Field 4**	
Rating	B	B	B	B	

Ratings

A = Excellent B = Good C = Average D = Poor E = Very Poor

Studies and Projects at the Elsberry Plant Materials Center 1958-Current

Study/Project	Title	ATR	Page
2-58	Quaker Comphrey Evaluation	1962	28
3-58	Comparison of Winter Annual Cover Crops	1962	30
6-62	Fertilizer Rate Study on Midland Bermudagrass, *Cynodon dactylon*	1963	47
10-59	Interseeding Cover Crops in Corn	1963	52
14-61	Evaluation of *Lotus corniculatus* L. Strains	1966	24
15-61	Evaluation of Bermudagrass Strains	1965	17
17-61	Black Locust, *Robinia pseudoacacia* L. Trials	1967	35
18-61	The Rate, Date and Method of Seeding *Lespedeza daurica schimadae*	1962	23
19-61	Living Fence Trials	1968	26
20-61	Plants for Bank stabilization	1962	10
21-62	Evaluation of Legumes for wildlife	1962	11
23-63	Evaluation of *Phalaris arundinacea* L. 'Ioreed' Reed Canarygrass Strains	1964	13
24-72	Method of Seeding Creeping Foxtail	1962	24
25-63	Advanced Evaluation of Plant Materials for Grass Waterways	1968	27
26-63	Evaluation of Japanese Pagodatree, *Sophoro japonica*, for Posts	1962	16
27-63	Direct Seeding vs. Transplanting Sawtooth Oak, *Quercus acutissima,* Carruthers	1964	60
28-63	Effect of Cultural Methods on Crownvetch, *Coronilla varia* L., Seed Production	1964	64
31-63	*Lespedeza capitata* Michx. – Roundhead Lespedeza Ecotype Evaluation	1964	64
34-63	Cultural Methods for Seeding Grasses in woodland Pastures	1963	58
35-63	Effect of Cultural Methods on Seed Production of *Phalaris arundinacea* L., 'Ioreed' Reed Canarygrass	1964	13
37-63	Forage Yields and Season of Production for Several Grasses and Legumes Clipped Bi-Weekly at Three Inches and Six Inches	1964	78
38-64	Advanced Evaluation of Perennial Grasses for Summer Pasture	1968	28
42-65	Establishment of Crownvetch and Trefoil in Dead Litter Mulch	1967	41
44-65	Grasses and Legumes for Goose Browse on the Clarence Cannon Wildlife Refuge	1973	
		Part 1	8
		Part 2	44
46-66	Method of Seeding Trials with 'Garrison' Creeping Foxtail	1966	26
49-69	Seed Yield of Three *Panicum virgatum*, Switchgrass Selections: Mich 381; 'Blackwell', M1-5714, and M1-5845, 'Cave-In-Rock'	1971	

		Part 1	5
		Part 2	46
50-69	Seed Yield and Seed Retention of Four *Phalaris arundinacea*, Reed Canarygrass Selections – 'Ioreed', 'Rise', 'Frontier', and 'Auburn'	1976	12
51-C-71	Herbicide tolerance of New Seeding of tall Fescue, Big Bluestem, Indiangrass, and Switchgrass	1979	55
29I052W	Growth Rate Study of European Alder on Deep Alluvial Soil	1980	4
53-72	Growth Rate Study of Poplar (Cottonwood) On A Deep Alluvial Soil	1972	
		Part 1	7
		Part 2	53
54-72	Rhizome Development of Two tall Fescue, *Festuca arundinacea*, Selections: M1-6161 and M1-6162	1971	
		Part 1	7
		Part 2	54
29A055	Evaluations of *Sorghastrum nutans*, Indiangrass (M1-7073), Poly-Cross Indiangrass for Leafiness, Disease-Free Characteristics and Seed Production	1981	81
56-71	Comparative Evaluation of New Lotus Accessions with Names and Used Varieties to Determine Potential as a Long Lived Legume in Three State Areas Served	1974	
		Part 1	4
		Part 2	4
29I057-72	Growth Rate Study of Poplars (Cottonwood) on a Deep Alluvial Soil	1981	4
29A058-72	Evaluation For Naming and Releasing of Elsberry Developed Big Bluestem and Indiangrass	1981	83
59-72	Sorghum Evaluation as Wildlife Game Feed	1973	
		Part 1	11
		Part 2	55
29I060-69	Replacement of the American Elm Tree	1979	80
61-72	Advanced evaluation of Meadow Foxtail, *Alopecurus pratensis*, PI-305495, as Waterway Grass as Compared to 'Garrison' Creeping Foxtail, *Alopecurus arundinaceus*, the Standard for Comparison	1973	
		Part 1	12
		Part 2	56
29I062J	Trees and Shrubs for Use as Wildlife Food and Cover Plants	1979	11
29I063	Plants for Use in Critical Area Stabilization	1979	21
29I064W	Plants for Wood Products	1979	23
65-78	Plants for Use in Landscape and Beautification	1976	10

29I066W-72	Developing Winter Hardy Nut Bearing Trees and Shrubs for Planting in Parks, Wildlife Areas and Natural Areas	1979	27
29I067K	Trees for windbreaks	1979	29
29A068-72	Response of Yellow Poplar to thinning	1979	67
29A069-72	Black Cherry Demonstration	1979	70
29A070-73	*Desmodium* for Wildlife Food and Cover	1979	31
29A071-73	Evaluation for Naming and Releasing of Elsberry Developed Autumn Olive, M1-6369	1978	73
29A072-73	Evaluation of M1-4701, *Lonicera maackii*, Amur Honeysuckle for Naming and Releasing	1978	74
29A073G	Establishment of warm-Season Grasses with Herbicides for Weed Control. Herbicides are Not Tested or Have Label Clearance for Warm-Season Grasses	1979	72
29A139G	Field Evaluation of Establishment of Herbaceous Plant Materials on Sand Covered Flooded Areas in Missouri	1994-1998	149
29A074M	Cover Crops in Soybeans	1984	258
Misc.	NJ-927, *Eleagnus umbellata*, Autumn Olive for wildlife Food and Cover	1981	101
29A075F	Plants for Shoreline and Wetland Stabilization	1990	64
29I076G-78	Establishment of Warm Season Grasses	1981	7
Misc.	Evaluation of Cold Hardy *Paspalum notatum* Selections	78	76
Study			
29I077P	Evaluation of Plants for Vegetating Salt Damaged Areas	1981	11
29I078D	Field Evaluation Planting to Evaluate Species of Plants for Use on Alkali Bearing Soils in Southern Illinois	1981	19
29I079D	Field Evaluation Planting to Evaluate Species of Plants for Use on Revegetating Acid Coal Mine Spoil in Illinois (Saline County SWCD and Peabody Coal Company)	1984	25
29I080D	Field Evaluation Planting to Evaluate Species of Plants for Use in Revegetating Acid Coal Mine Spoil in Iowa (VanBuren County SWCD)	1980	56
29I081D	Field Evaluation Planting to Evaluate Species of Plants for Use in Revegetating Acid Coal Mine Spoil in Iowa (Marion County SWCD)	1980	77
29I082D	Field Evaluation Planting to Evaluate Species of Plants for Use in Revegetating Acid Coal Mine Spoil in Illinois (Fulton County SWCD and Freeman United Coal Mine)	1984	117
29I083M	Legume Cover Crop for No-Till Corn Production	1984	160
29I084G	Legumes to Enhance Fescue Pastures	1986	6
29A085S	Debearding Fluffy Native Grass Seed (Big Bluestem and Indiangrass)	1981	92

29A086L	Use of an Absorbent Polymer in Coating Native Grass Seed	1982	106
29I087D	Plants with Increased tolerance to Aluminum and Manganese	1984	192
29A088W	Cooperative Screening Study of Native and Introduced Sources of Eastern Cottonwood	2000	129
29I089V	Multiple Use Legume Assembly and Evaluation	1988	4
29I090G	No-Till Establishment of Warm-Season Grasses in Cool Season Grass Sod	1984	219
29I091G	Weed Control Treatments for Warm Season Grass Establishment	1988	7
29I092G	Perennial Grasses as Cover Crops for Use in No-Till Systems	1988	12
29I093R	Miscellaneous Herbaceous Plant Evaluation	**2013**	21
29A094M	Cover Crops in Corn, Soybeans, and Milo	1987	5
29I096F	Streambank Stabilization	1988	14
29I097G	Assembly and Evaluation of Big Bluestem, *Andropogon gerardii*, Vitman.	**2013**	25
29I098M	'Tinga' Tangier Pea for Soil Protection	1987	7
29I099J	Assembly and Evaluation of Roughleaf Dogwood, *Cornus drummondii*	1994-1998	13
29I100J	Assembly and Evaluation of Blackhaw, *Viburnum prunifolium* L.	1999	17
29I101J	Assembly and Evaluation of Arrowwood, Viburnum dentatum	2006	21
29A102M	Evaluation of Perennial Grass as Cover Crops for No-Till Soybeans	1990	85
29A105M	Evaluation of Winter Annual Grass for Cover Crops in No-Till Soybeans	1993	34
29I107G	Assembly and Evaluation of Eastern Gamagrass, *Tripsacum dactyloides* L.	2006	24
29I108G	Assembly and Evaluation of Low Growing Rhizomatous Switchgrass, *Panicum virgatum* L., for Use in Waterways, Filter Strips and Other Conservation Uses	**2013**	34
29I109W	Direct Seeding Methods of *Quercus* sp., Oaks	1993	17
29I110J	Assembly and Evaluation of Chokecherry, *Prunus virginiana* L.	2007	27
29A111G	Field Evaluation of Selected Perennial Grasses for Pasture Wildlife Habitat and Erosion control (Varietal Study)	1994-1998	91
29I112J	Assembly and Evaluation of Nannyberry, *Viburnum lentago* L.	1993	21
29I113J	Assembly and Evaluation of Serviceberry, *Amelanchie*r *arborea* (Michx.F.) Fern.	1993	22
29I114K	Field Evaluation of Woody Plant Materials in Cooperation with Mineral area College	1993	22
29A116W	Field Evaluation of Woody Plant Materials in Cooperation with Mineral Area College	2010	31

29A117H	Intercenter Strain Trial of *Tripsacum dactyloides* L., Eastern gamagrass	1993	46
29A118G	Field Evaluation of Selected Perennial Grasses for Pasture, Wildlife Habitat and Erosion Control (Varietal Study)	1994-1998	91
29A121W	Conifer Evaluation for Windbreak Plantings	2000	137
29A122G	Evaluation of Perennial Warm-Season Grasses as Windbarriers in Southeast Missouri	1994-1998	125
29A123M	Winter Cover Crop Study for No-Till Soybeans	1993	54
29A124G	Fertility and Harvest Management of Eastern Gamagrass for Forage Production	2010	35
29I126W	Woody Columnar Collection	1993	30
29A127G	Field Evaluation of Selected Perennial Grasses for Pasture, Wildlife Habitat and Erosion Control	1994-1998	91
29A128J	*Cornus florida* L., Flowering Dogwood, Interagency Study Between Department of Interior, National Parks Service, National Capital Region and the Department of Agriculture	2006	52
29A131O	Treatment of Animal wastewaters by Constructed Wetlands	1993	66
29I132O	Miscellaneous Wetland Plant evaluation	2003	49
29I133J	Assembly and Evaluation of Gray Dogwood, *Cornus racemosa*	NA	NA
29I134J	Assembly and Evaluation of Eastern Redcedar, *Juniper virginiana* L.	2002	55
29I135J	Assembly and Evaluation of Hazelnut, *Corylus Americana*, Marsh	2007	43
29I136J	Assembly and Evaluation of Wild Plum, *Prunus Americana*, Marsh.	2006	54
29A137O	Wetland Riparian Propagation, Establishment and Demonstration	**2013**	51
29I138G	Residue Decomposition Trial	1994-1998	68
29A139G	Field Evaluation of Establishment of Herbaceous Plants	1994-1998	149
29A140W	Yellow Poplar Evaluation	1994-1998	159
29I141G	Assembly and Evaluation of Little Bluestem, *Schizachyrium scoparium*, Michx.	**2013**	64
29I142G	Production of Native Missouri Ecotypes of Grasses, Legumes and Forbs for Roadside, Critical Areas, and All Other Vegetative Plantings Where Native Plants are Now Being Planted	**2013**	84
29I143G	Seed Coating/Seed Rates	2002	129
29A144G	Biofuel Study of Different Strains/Varieties of Switchgrass	1999	147
29A145	Wear Tolerance Demonstration of Vegetation in High Traffic Areas	2000	154
MOPMC-P-0001, WO, WL,	Assembly, Evaluation and Selection of Bur Oak, *Quercus macrocarpa*, Michx.	**2013**	89

WE			
MOPMC-P-0002, WE, WL	Assembly, Evaluation and Selection of False Indigo Bush, *Amorpha fruticosa,* L.	2006	127
MOPMC-P-003 PA,WL	Evaluation and Release of Eastern Gamagrass, *Tripsacum dactyloides*, L.	2006	136
MOPMC-T-0104	Native Plant Identification	2005	150
MOPMC-T-0105, PA	Compatibility Study Using Warm Season and Cool Season Native Grasses with Legumes and Forbs	2010	106
MOPMC-T-106, BU	Collection and Evaluation of Native Cool Season Grasses and Sedges for Filter Strips	**2013**	113
MOPMC-P-0107, PA, WL	Evaluation and Release of Big Bluestem, *Andropogon gerardii* L.	2002	176
MOPMC-T-0208, PA	Testing Warm Season Grasses for Forage Quality	2006	162
MOPMC-T-0209, PA, WL	Evaluation and Release of *Paspalum* Species 2003	2003	156
MOPMC-T-310-PA,WL	Incorporating Native Warm Season Grasses into Cool Season Pasture with Grazing Management	2007	132
MOPMC-T-0311, RI, BU	Control of Reed Canarygrass in Riparian Buffer Plantings	2006	175
MOPMC-T-0412, WE, WL, RI	Testing Selected Trees for Tolerance to the Herbicide Outrider	2006	185
MOPMC-P-0613-PA, WL	Evaluation and Release of a Shade Tolerant Big Bluestem, *Andropogon gerardii*, L. for Silvopasture	**2013**	126
MOPMC-P-0614-PA, WL, BF	Evaluation and Release of Switchgrass, *Panicum virgatum* L.	2007	138
MOPMS-T-0615-	Direct Seeding of Woody Shrubs for Establishing Shrub Cover for Wildlife Habitat of the Following Species. False Indigo Bush, *Amorpha fruticosa,*(a native legume), American Plum, *Prunus americana,* Roughleaf Dogwood, *Cornus drummondii,* Fragrant Sumac, *Rhus aromatica,* Chokecherry *Prunus virginiana*, Arrow-wood *Viburnum dentatum,* American Hazelnut, *Corylus Americana, (*all are native woody shrubs.)	2009	117
MOPMC-T-0716-BF	In-Field Weathering Effects on Biomass Yield and Biofuel Quality of Warm Season Grasses	**2013**	149
MOPMC-P-0717-PA, WL	Evaluation and Release of a Shade Tolerant Little Bluestem for Silvopasture	**2013**	163
MOPMC-T-0718-WE, WL	Evaluation of Flood Tolerance of Planted Oak Seedlings Derived from Different Seed Origins	**2013**	165
MOPMS-T-0719-CR/RI07-016	Critical Area Roadside Vegetation Establishment	2009	144
MOPMC-P-0820-UR	Evaluation and Release of Native Plants for Urban Landscaping	**2013**	167

Elsberry Plant Materials Program Staff – 2013

(L to R) Allen Casey, Assistant Manager/Soil Conservationist; Ben Bruckerhoff, Summer WAE; Jerry Kaiser, Plant Materials Specialist; Nick Adams, Biological Science Technician; Ron Cordsiemon, Plant Materials Center Manager