"Helping People Help the Land"

2011 ANNUAL TECHNICAL REPORT
Booneville Plant Materials Center

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
BOONEVILLE PLANT MATERIALS CENTER

'Bumpers' eastern gamagrass harvested from production fields

Bill Kuentsler shows NRCS field staff how to design buffer strips at PMC new employee training

Class participants look for ground-nesting bees at the PMC during the Xerces Society Pollinator Short Course

Eddie Pratt teaches new NRCS employees about farm equipment for seedbed preparation

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Introduction

The Booneville Plant Materials Center (PMC) was established and became part of the national plant materials system in 1987 and serves the plant material needs of the Southern Ozarks, Arkansas River Valley, and Boston and Ouachita Mountains. The Center's priorities include protection and enhancement of water quality, protection and enhancement of pastureland, critical area treatment, protection and enhancement of woodlands, and protection and enhancement of wildlife land. The Booneville PMC serves as a training facility for NRCS field office employees to assist them in designing, implementing, and managing vegetative conservation practices.

Location

The Booneville Plant Materials Center is located along the Petit Jean River in Logan County, Arkansas. The Center lies along north edge of the Ouachita National Forest. Mt. Magazine (2823 ft.) is to the northeast of the PMC and is well known as being the highest mountain between the Appalachian and Rocky Mountains. The PMC leases 282 acres from the State of Arkansas.

Service Area

The primary service area of the Booneville Plant Materials Center (PMC) includes portions of Arkansas, Oklahoma, and Missouri (approximately 54 million acres). This area includes the following Major Land Resource Area's:

Ozark Highland	116A	Ouachita Mountains	119
Ozark Border	116B	Western Coastal Plain	133B
Boston Mountains	117	Backland Prairie	135
Arkansas Valley and Ridges	118		

Much of the service area is characterized by rugged terrain with elevations from 300 to 2,800 feet. Average annual rainfall varies from 36 inches in the west to 53 inches in the eastern higher mountain areas. Forage production and woodlands are the major land uses, and small family farms characterize the agriculture.

Soils on the Center Include:

Leadville silt loam, 1 to 3 percent slopes. This is a deep, moderately well drained, nearly level soil on old stream terraces in broad valleys. Individual areas range from about 10 to 400 acres in size.

Taft silt loam, 0 to 2 percent slopes. This is a deep, somewhat poorly drained, level to nearly level soil on old stream terraces in broad valleys. Individual areas range from about 10 to 400 acres.

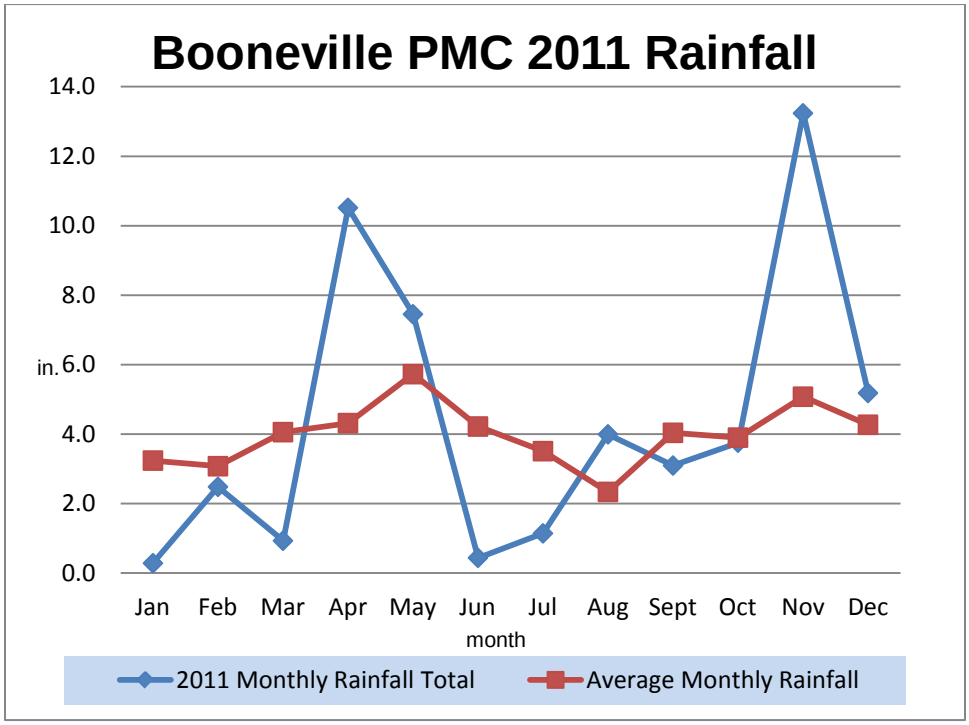
Linker fine sandy loam, 3 to 8 percent slopes. This is a moderately deep, well-drained, gently sloping soil on hilltops. Individual areas range from about 5 to 200 acres.

Enders-Mountainburg association, rolling. This association consists of well-drained soils in a regular and repeating pattern on rolling hillsides. Slopes are 8 to 20 percent. The mapped areas on this association range from about 50 to 700 acres.

2011 Rainfall and Temperature Data

2011 Weather Summary, Dale Bumpers Small Farms Research Center (Courtesy of Dr. David Burner, ARS)

Month	Monthly Rainfall Total	Average Rainfall	Average High	Average Low
	----------inches----------		---------^{0}F---------	
January	0.3	3.2	49	21
February	2.5	3.1	57	28
March	0.9	4.1	65	38
April	10.5	4.3	77	49
May	7.5	5.7	79	56
June	0.4	4.2	93	68
July	1.1	3.5	103	72
August	4.0	2.3	100	71
September	3.1	4.0	86	53
October	3.8	3.9	78	43
November	13.2	5.1	65	41
December	5.2	4.3	55	32
Total/Avg.	52.5	47.8	76	48



2011 Active Studies

The Booneville PMC solicits input from advisory committees to develop new studies to solve resource concerns with vegetative solutions. Advisory committees are made up of NRCS state office staff, grazing and grassland specialists, district conservationists, and other field office staff members. Studies are designed to provide practical, timely information to field office staff and their customers. This report summarizes the data collected from active, on-farm studies in 2011. Please see the 2011 Booneville PMC Annual Report of Activities for more information about Booneville PMC publications and trainings.

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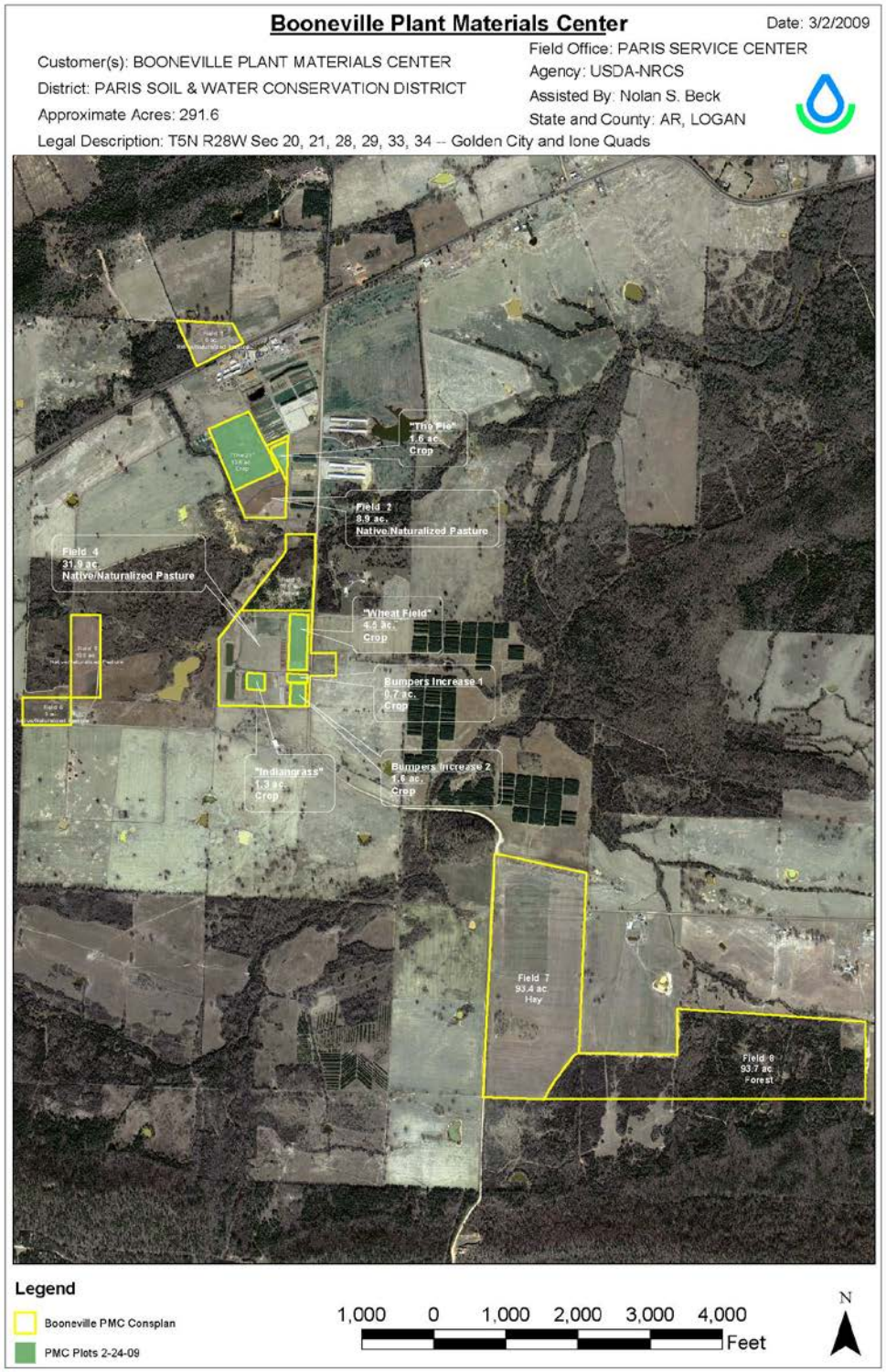
Map of Booneville Plant Materials Center



Indiangrass Initial Evaluation Study

Introduction

Indiangrass accessions evaluated in 2011

Indiangrass (*Sorghastrum nutans*) is a native warm-season perennial grass, and a major component of the tall grass vegetation which once dominated the prairies of the central and eastern United States. Indiangrass grows three to five feet tall. Even as an immature plant, it can be distinguished from other native grasses by the "rifle-site" ligules at the point where the leaf attaches to the stem. The seed head is a single, narrow, plume-like panicle of a golden brown color. The seed is light and fluffy with small awns attached.

Indiangrass is adapted to the northeast, west to Texas, and North Dakota. It grows best in deep, well drained soils, however is highly tolerant of poorly to excessively well drained soils, acid to alkaline conditions and textures ranging from sand to clay. It is being recognized as a potential bio-fuel feedstock, a grass species for wildlife habitat, and water quality. Preliminary studies and plant surveys indicate that Indiangrass is will adapted to the service area of the Booneville Plant Materials Center (PMC).

Indiangrass that is drought tolerant and has increased dry-matter production may one day contribute to reducing our dependence on foreign oil and ease the energy crisis. Since Indiangrass is a renewable resource which is produced on American farms it has great relevance as a top current economic and environmental issue. Indiangrass is also used for wildlife habitat improvement; livestock forage, and a component of buffer systems to improve water quality.

Development of a substantially improved Indiangrass cultivar to use as a perennial crop for livestock consumption, wildlife enhancement, to use as a buffer crop to trap nutrients and possibly as a bio-fuel feedstock could benefit our agricultural economy by providing an important new source of income for farmers. Bio-fuel production from perennial cropping systems would help reduce loss of agricultural soils, reduce our dependence on imported oil supplies, and lower greenhouse gas emissions and other toxic material into the atmosphere.

Materials and Methods

The Booneville Plant Materials Center (PMC) has initiated a study to examine the possibility of developing a new Indiangrass cultivar. In the fall of 2006, numerous Indiangrass seed collections were made from western Arkansas, eastern Oklahoma, and southern Missouri. Each collection of seed was assigned an accession number. In February of 2006 the seed was planted in cones and maintained in the greenhouse for five to six weeks. The vegetative material was then transplanted to the field for initial evaluation. The transplants were established in five plant subplots, replicated three times. The middle three plants are used for evaluation. The ratings for the study consist of disease resistance, insect resistance, drought tolerance, basal distribution, plant height, leaf width, leafiness, and boot/bloom date. Ratings for the Indiangrass accessions were based on a numerical value from one to ten, ten being the highest. Visual ratings for the three replications were then averaged for a final numerical value, which is reported in the tables (2007-2008) at the end of this report.

The study was irrigated only in 2007 to insure establishment. The plots were burned mid March each year, followed by the application of two hundred and fifty pounds per acre of 17-17-17 fertilizer.

Results

2007-2008 Summary

All accessions in the study exhibited slight or no evidence of insect infestation in 2007 and 2008. The leaves of Indiangrass accessions were found to be infected with rust in 2007 but were 75% rust free during 2008. Accessions

with a rating of 7 to 8 would be considered more disease resistant than accessions with lower ratings. Drought tolerance is an important characteristic that will determine if the accession is selected for further evaluation. Rainfall amounts during the growing season 2008 were sufficient enough that no drought evaluations were performed. Basal diameter, plant height, leaf width and leafiness are all characteristics which are used to determine dry-matter production. Values of 5.7 and above are important in basal diameter selection. Visual ratings of 5.3 or higher are important for height and leaf width. Ten accessions had ratings of 5.7 or higher for leafiness in 2007, and nine accessions had a rating of nine or higher in 2008. The average bloom date in 2007 was September 4th and August 27th, in 2008. Some entries bloomed as late as September 20th in both years.

2009 Summary

The plots were burned in early March of 2009 and 250 lbs/acre of 17-17-17 complete fertilizer applied April 10th. Accessions (12) were selected, based on data collected in 2008 and 2009, for advanced evaluation. Forage samples were harvested in June 2009 and analyzed for forage quality (Table 3) by the University of Arkansas Forages Lab in Fayetteville, Arkansas. These selected plants will be transplanted to an advanced evaluation nursery in the spring of 2011. Selections will be evaluated based on seed production and seed quality, and forage dry matter yield.

2010 Summary

Indiangrass initial evaluation plots were burned March 12, 2010. Two hundred fifty pounds per acre of 17-17-17 complete fertilizer was applied on April 5. Accessions (9) selected in 2009 for advanced evaluation were harvested (grab sample) on June 11 and analyzed for forage quality by the University of Arkansas, Fayetteville forages lab (table 4). These selected plants will be transplanted to an advanced evaluation nursery in the spring of 2011. Selections will be evaluated based on seed production, seed quality, and forage dry matter yield/quality.

2011 Summary

Outstanding plants from the study were transplanted into a polycross nursery in May 2011. Progeny from this cross will be harvested in the fall of 2012 and planted in the spring of 2013, into a seed increase nursery. Foundation seed from this nursery will be commercially produced and available for sale to the public through a commercial seed company in the future.

Table 3. Forage Quality Estimates of Selected Indiangrass Accessions, June 2009 Harvest

Accession/Cultivar	Crude Protein	Acid Detergent fiber (ADF)	Neutral detergent fiber (NDF)	Total Digestible Nutrients(TDN)
	----------%----------			
905762	8.17	34.97	60.32	53.74
905763	7.36	35.09	61.87	53.15
905763	7.81	34.66	62.96	53.74
905768	7.14	35.71	64.16	52.58
905777	8.21	35.22	66.54	53.58
905802	6.41	37.97	66.36	50.51
905812	9.06	36.92	62.58	52.91
905812	7.99	35.90	62.80	52.96
905817	7.55	35.44	64.99	53.02
905835	8.09	36.27	62.11	52.76
905835	7.13	34.76	63.90	53.24
905837	5.93	33.90	60.22	53.11

Virginia Wildrye Initial Evaluation Study

Introduction

Virginia wildrye (*Elymus virginicus*) is a native, cool season, perennial bunchgrass which grows two to three feet in height. It reproduces by tillers and seed. Virginia wildrye self-fertilizes, but has been known to hybridize andintrogress (outcrossing depression). Virginia wildrye can be found throughout the United States except for Nevada, California, and Oregon. In Texas, it can be found occasionally throughout most regions with the exception of the most western fifth of the state. It can be found scattered on shaded banks, along fencerows and in open woodlands. Virginia wildrye prefers moist soils, high soil fertility, heavier soil textures, and it is shade tolerant.

Virginia wildrye is very palatable and nutritious, and is readily eaten by all classes of livestock in the spring and fall while it is green. It can be used in range restoration as a cool season grass, and in native range seed mixes. It can also be used as a cool season pasture grass in shaded, wooded, or riparian areas. Virginia wildrye is a good forage producer. It can produce as much as 3,300 lbs of dry weight forage per dryland acre.

Methods and Materials

The Booneville Plant Materials Center (PMC) has initiated a study to examine the possibility of developing a new Virginia wildrye cultivar. In the fall of 2009, eighty eight Virginia widlrye seed collections were made from western Arkansas. Each collection of seed was assigned an accession number. In January the seed was planted in cones and maintained in the greenhouse for five to six weeks. The vegetative material was then transplanted to the field for initial evaluation. The transplants were established in five plant subplots, replicated three times. Plots were irrigated during the spring and summer 2010. The middle three plants are used for evaluation. The ratings for the study will consist of disease resistance, insect resistance, drought tolerance, basal distribution, plant height, leaf width, leafiness, and boot/bloom date.

2010 Results

Survival data was collected during the 2010 growing season. Fifty six percent of the accessions survived the summer. Those accessions will be transplanted into a polycross nursery in the fall of 2011.

2011 Results

Outstanding accessions were selected from the initial evaluation field and transplanted into a polycross nursery. Progeny from this cross will be harvested in the fall of 2012 and planted in the spring of 2013 into a seed increase nursery. Foundation seed from this nursery will be commercially produced and available for sale to the public through a commercial seed company in the future.

Virginia wildrye accessions transplanted into polycross nursery, 2011

Yield and Persistence of Eleven Big Bluestem Sources in the Southern Ozarks

Introduction

Big bluestem (*Andropogon gerardii*) is a native, perennial warm season grass that occurs from the short grass prairie region to the Atlantic Ocean (Stubbendiek et al., 1993). It is tufted, forms sod, and has short, scaly rhizomes. Big bluestem is tall, reaching a height of six to eight feet. It is very leafy at the base, with some leaves carried up on the stem. Seed heads normally have a three spikelet bloom that resembles a turkey's foot.

There have been several prevarietal releases of big bluestem made in recent years by Booneville, Arkansas Plant Materials Center (PMC) and Elsberry, Missouri PMC. Comparative evaluations of these prevarietal releases and a selection from the Manhattan, Kansas Plant Materials Center are needed to further document their performance and adaptation in the southern Ozarks. In addition to these releases, standard big bluestem cultivars commonly used in the USDA, Natural Resources Conservation Service conservation plantings and programs will be included with other cultivars developed by the USDA-Agricultural Research Service in Lincoln, Nebraska for comparison purposes. The objective of the study is to evaluate production, forage quality and plant attributes of 11 big bluestem sources in the southern Ozark region.

Materials and Methods

Eleven sources of big bluestem were established at the Booneville PMC in 6' x 9' plots on a Leadvale silt loam in May 2008 (Table 1) Experimental design is a randomized complete block design with four replicates. Plots were irrigated in 2008 for establishment. No irrigation was applied in succeeding years. Soil phosphorus and potassium were adjusted according to soil test recommendations. Nitrogen fertilizer was applied at a rate of 60 lb/acre when the plants reached the third-leaf stage in 2009.Plots were burned annually in March. 34 lb/acre of nitrogen, phosphorus, and potassium was applied annually at green-up in April 2009-2011.

Yield was collected by harvesting twice a year in 2009-2011. The first harvest was collected when 50% of the first big bluestem source reached the late boot state (1st seed head emerging) of growth (this will be referred to as the summer harvest). The second harvest of re-growth was collected after the first killing frost in the fall (this will be referred to as the fall harvest). Yield was determined by sampling four plants from the center of each row at a cutting height of 8 inches. A grab sample was collected from each big bluestem source by harvest date. Samples were dried at 60° C for 24 hours and used to calculate dry matter yield. Total annual yield was determined by summing summer and fall harvests. Yields were not collected in the fall of 2011. After harvests, the remaining un-sampled plants were cut and removed from plot.

Average plant height was recorded from the center of each big bluestem source prior to the summer harvest.. Qualitative plant attributes for plant vigor, disease resistance, and insect resistance were determined by ocular estimation. Attributes were rated 1 = excellent; 3 = good; 5 = fair; 7 = poor.

Forage quality estimates of crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined from the summer harvest only. Percent total digestible nutrients (TDN) were estimated using the following equation: % TDN = 73.5 + (0.62 x %CP) – (0.71 x %ADF). Samples were dried in a forage oven, ground, and tested to determine percent crude protein (CP),

Yield, forage quality estimates and other plant attributes were subjected to analysis of variance procedures in the Statistix 8 software program (Tallahassee, FL). Means that differ significantly were separated using the least significant difference test (LSD; $P<0.05$) (Gomez and Gomez, 1984).

Results

Yield

Dry matter yields varied among the big bluestem sources, years, and harvest dates (Table 2). Yield was closely tied to rainfall amounts and influenced all big bluestem sources. A second harvest was not collected in 2011 due to lack of rainfall in June and July and subsequent lack of measurable re-growth. (Table 6).

The highest yield occurred in the first harvest taken in early summer of each year, when the grasses were at the boot stage. Yields collected from the second harvest showed that the amount of re-growth was about half the amount of the first harvest.

In 2009, Rountree and OZ-70 produced the highest yield, while Bonanza and Refuge produced the lowest yields. However, there were no significant differences in yield between all the sources. In 2010, Kaw, Hampton, and 446 produced the highest yield, with Epic and Refuge producing the lowest yields. In 2011, Goldmine produced significantly more forage than Kaw, 446, Rountree, Pawnee, Bonanza, Epic, and Refuge. However, yields were similar for Goldmine, 3274, OZ-70 and Hampton.

Over three years, Rountree, OZ-70, Hampton, 274, Kaw, 446 and Goldmine produced the highest total yields (Table 4). Each of these sources produced over 5,000 lb/acre (or 2.5 tons); however, differences among these sources were not significant. These dry matter yields were comparable to other warm-season forages used in the southern Ozarks such as common bermudagrass (*Cynodon dactylon*) (3 to 5 ton/acre), dallisgrass (*Paspalum dilatum*) (2 to 4 ton/acre) (Ball et al, 1996). Sources did not appear to be adversely affected by insect or disease pressure as minimal damage was evident over the course of the study (Table 5). Hampton Germplasm had excellent vigor while Pawnee, Goldmine, Refuge and Bonanza averaged fair to good vigor. Refuge had the lowest average plant height at the boot stage of 29 inches and 9083274 had the tallest height of 43 inches.

Quality

Forage quality data collected at the boot stage of growth was similar across all sources (Table 3). No significant differences were found between big bluestem sources in 2009. Data from 2010 and 2011 showed significant differences between big bluestem sources, but these differences were of minimal magnitude (Table 3). Average percent CP was 7, which is slightly below the ranges reported by Ball et al. 1996 for other common warm-season grasses. Common bermudagrass and dallisgrass all have 9-11 percent crude protein (Ball et al., 1996). Over the three-years, Hampton Germplasm had the highest CP of 8%, while Rountree had the lowest average CP of 6%.

Conclusion

Production,, forage quality, persistence, and disease and insect resistance were evaluated for eleven sources of big bkluestem in the southern Ozarks MLRA., Hampton Germplasm, OZ-70 Germplasm, 9083274, Rountree, Kaw, and 483446 produced above-average forage production with appreciable forage quality and resistance to disease and insect damage. Two-harvest frequencies showed that it is possible to first harvest the top performing big bluestem sources in the boot stage of growth to utilize as a hay or grazing crop, while stockpiling forage re-growth later in the year. Re-growth could be used for winter grazing or as a standing hay crop. However, forage quality would be greatly decreased compared to the first harvest earlier in the year

This information may be used to update conservation practice specifications for Forage and Biomass Planting (Practice 512) recommendations to include Hampton, OZ-70, 9083274, Rountree, Kaw and 483446 as acceptable big bluestem sources for the southern Ozarks. This data may also be used to update other conservation practice specifications for Conservation Cover (324) and Upland Wildlife Habitat (645).

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
Epic (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
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. Early summer, late fall, and season total production of eleven sources of big bluestem at Booneville, AR 2009-2011.

Source	DM Yield						
	2009			2010			2011
	22-Jun	8-Dec	Total	15-Jun	8-Dec	Total	23-Jun
	lb/acre						
Hampton	4480	2425	6905	5426	1371	6797	3884
OZ-70	5828	1959	7787	4558	1303	5861	4430
Refuge	2389	1378	3766	3082	550	3632	2945
9083274	4279	1872	6151	4751	1037	5788	4778
EPIC	4061	1887	5948	2267	1182	3449	3210
Rountree	6792	1430	8222	5555	997	6552	3879
Kaw	3898	2379	6277	5143	1751	6895	3891
483446	4403	3062	7464	4759	1687	6446	3778
Pawnee	3112	1644	4756	4493	825	5318	3692
Bonanza	2283	1393	3676	4469	791	5260	3366
Goldmine	2583	1325	3908	4637	1401	6038	5331
Mean	4010	1887	5896	4467	1172	5640	3926
LSD $_{(0.05)}$	NS†	NS	NS	NS	588	NS	1438

† not significant

Table 3. Forage quality estimates in boot stage of growth of big bluestem sources by harvest date and seasonal mean at Booneville, AR 2009-2011.

Source	Forage quality estimates											
	Harvest dates											
	22-June 2009				15-Jun-10				23-Jun-11			
	CP[1/]	ADF[2/]	NDF[3/]	TDN[4/]	CP	ADF	NDF	TDN	CP	ADF	NDF	TDN
	%											
Hampton	9	36	65	53	9	36	65	53	6	36	64	53
OZ-70	7	36	65	52	7	36	65	52	6	35	63	52
Refuge	9	35	65	54	7	35	64	54	6	35	65	54
9083274	8	35	64	54	8	35	64	54	6	35	65	54
EPIC	8	36	64	53	8	35	64	54	6	33	61	54
Rountree	8	35	63	54	6	35	68	54	6	35	63	54
Kaw	8	36	63	53	8	36	65	53	6	36	62	53
483446	7	33	63	55	8	33	63	55	6	33	63	55
Pawnee	8	36	63	53	8	36	64	53	6	36	62	53
Bonanza	8	34	63	54	8	34	63	52	5	34	64	52
Goldmine	8	34	61	54	8	34	61	54	6	34	62	54
Mean	8	35	63	54	8	35	64.1	53	6	35	63	53
LSD (0.05)	NS†	NS	NS	NS	1.3	1.5	1.9	1.6	NS	2	2	1.7

† not significant; CP[1/] crude protein; ADF[2/] acid detergent fiber; NDF[3/] neutral detergent fiber; TDN[4/] total digestible nutrients

Table 4. Three-year average yield and quality of eleven big bluestem sources at Booneville, AR 2009-2011.

Source	Yield and Forage Quality				
	DM Yield	CP[1/]	ADF[2/]	NDF[3/]	TDN[4/]
	--lb/acre--	----------%----------			
Hampton	5862	8	36	65	53
OZ-70	6026	7	36	64	52
Refuge	3448	7	35	65	54
9083274	5572	7	35	64	54
EPIC	4203	7	35	63	53
Rountree	6218	6	35	65	54
Kaw	5687	7	36	63	53
483446	5896	7	33	63	55
Pawnee	4589	7	36	63	53
Bonanza	4101	7	34	63	53
Goldmine	5092	7	34	61	54
Mean	5154	7	35	64	53
LSD $_{(0.05)}$	NS†				

† not significant; CP[1/] crude protein; ADF[2/] acid detergent fiber; NDF[3/] neutral detergent fiber; TDN[4/] total digestible nutrients were estimated using the following equation:
%TDN = 73.5 + (0.62 x %CP) – (0.71 x %ADF)

Table 5. Three-year averages of qualitative evaluation criteria and plant height for eleven big bluestem sources at Booneville, AR 2009-2011.

Source	Vigor	Disease Resistance	Insect Resistance	Plant Height (in)
Hampton	1[1/]	1[1/]	1[1/]	40
OZ-70	3	1	1	38
Refuge	4	1	1	29
9083274	3	1	1	43
EPIC	4	1	1	32
Rountree	3	1	1	39
Kaw	3	1	1	36
483446	3	1	1	38
Pawnee	4	2	1	34
Bonanza	4	1	1	34
Goldmine	4	2	1	34
Mean	4	1	1	36

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Evaluation of fertilizer and irrigation to maximize biomass yield and quality of switchgrass in the Southern Ozarks

Introduction

Switchgrass (*Panicum virgatum* L.) is native to all of the United States except California and the Pacific Northwest (Stubbendiek et al., 1998). It is adapted to a wide range of soil textures and can withstand flooding for short periods (Stubbendieck et al. 1992). Switchgrass is a warm season, perennial grass with a rhizomatous growth habit. Culms can reach 9 feet tall, and inflorescence is an open, spreading panicle (Stubbendiek et. al 1992). One key identification characteristic is the presence of a triangular patch of hair at the point where the leaf attaches to the stem. Switchgrass has good forage value for all classes of livestock, and produces nutritious hay if cut prior to maturity (may want to include a reference here).

The US Department of Energy recognized switchgrass as a model perennial bioenergy feedstock crop in 1991 its ability to produce large amounts of biomass on relatively poor sites, where water and nutrient availability would prevent the successful production of conventional crops. Herbaceous energy crop production focuses on producing maximum biomass yield with low concentrations of water, N, and ash, but a high concentration of lignocelluloses. Harvesting switchgrass after it has gone dormant has shown to satisfy these conditions (Adler et al., 2005). however, a landowner may choose to utilize switchgrass during the growing season for hay or grazing. Large-scale integration of switchgrass into farming systems may be encouraged by providing options to farmers to choose whether they use a switchgrass crop for grazing/haying or sell as an energy crop. Currently, no local refineries for processing switchgrass biomass products exist in the southern Ozark region.

Objective of this study is to compare switchgrass cultivars (‘Alamo’ and ‘Cave-in-Rock’); using irrigated vs. non-irrigated and commercial fertilizer vs. animal waste fertility treatments to determine the optimum combination of these variables to maximize production and quality of annual biomass in the southern Ozark region.

Methods and Materials

‘Alamo’ and ‘Cave-in-Rock’ switchgrass cultivars were established at the Booneville PMC in 40 ft X 4 ft plots on a Leadvale silt loam on March 5, 2007. Plots were seeded at a rate of 5 lb/acre pure live seed (PLS) and planted with a Marliss grain drill. After drilling, the seedbed was rolled with a water-filled roller. Temporary sprinkler irrigation was applied for establishment. Soil samples were collected from each treatment/replication prior to planting. The University of Arkansas soils lab in Fayetteville, Arkansas analyzed samples and soil amendments were applied to bring nutrient levels up to medium production (according to the University of Arkansas soil testing laboratory values for phosphorus and potassium) values prior to planting. A permanent sprinkler irrigation system was installed in replicated irrigation treatments in the summer of 2007. Rain gauges were placed in the irrigated plots to calibrate the delivery system. Irrigation-treated plots received 1” of irrigation water per week during the summer months from 2008-2011. Plots were burned each year prior to spring greenup in early March. Fertilizer treatments were applied at green up in early April of 2008-2011. The poultry litter plots received 2 ton/acre of broiler litter, while the commercial fertility treatment was were applied to match nitrogen, potassium, and phosphorus levels in each batch of poultry litter. Litter was analyzed for nutrient every year.

Two harvest regimes were tested to determine maximum annual yield. A two-harvest regime consisted of harvesting the same plot first at the boot stage in June (summer harvest), and second after a killing frost in November (fall harvest). A single harvest was made in November after the first killing frost. Yield was determined by sampling a 3ft x 10ft area with a flail-type plot harvester with on-board scale. A grab sample was collected from each plot at each harvest date. Samples were dried at 60ºC for 24 hours and used to calculate dry matter yield and forage quality estimates of crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) were determined from the summer harvests only. An analysis of variance was used to compare total annual yield of the summer and fall harvests and a single fall harvest.

Yield

Dry matter yields differed among treatments and cultivars (Table 2). Alamo generally produced significantly more biomass than Cave-in-Rock in all treatments. Three-year averages show that the top-performing treatment was the

Alamo with irrigation and poultry litter fertilization; however, this yield was not significantly different from Alamo with irrigation and commercial fertilizer or Alamo that was non-irrigated with commercial fertilizer.

Yields were higher for both cultivars using the two-harvest regime. Treatments with Alamo under the two-harvest regime yielded an average of 4,527 lb/ac more than the single harvest (Table 2). Treatments with Cave-in-rock under the two-harvest regime yielded an average of 5,798 lb/ac more than the singe harvest regime. Though yields were higher with the two cut system for all treatments, early spring re-growth in was noticeably slower than treatments harvested only once a year. Growth in these areas catches up by the boot stage (when plants were harvested in the summer), but prolonged use of the double harvest regime may limit stand vigor over time. This may affect spring grazing rotations, as there is less biomass for livestock to consume. Two cut systems produced roughly 50% more biomass than single-harvest regimes; however, expenditure of time and equipment for an additional harvest may not be an economically feasible option for farmers.

Tillers of Cave-In-Rock grasses in the plots were observed to have a high degree of lodging, and harvest during the dormant season was difficult. Lower Cave-in-Rock biomass yields in the winter harvest may be attributed in part to lodging. Cave-in-Rock has been widely known as being a lowland type of switchgrass that is resistant to lodging; however, the addition of fertilizer may have caused lodging not seen typically in this cultivar. Based on this study, Alamo may be a better choice if farmers in this region are managing for dormant-season biomass harvests.

Quality

Forage quality estimates were similar throughout treatments and cultivars. The highest average CP value of 10% occurred in the Cave-In-Rock irrigated, commercially fertilized plots (Table 3). Forage quality estimates measured are similar to those measured by Sanderson et al .,(1998) in Texas.). Landowners may use this information to determine livestock supplementation needs throughout the growing season for grazing/hay.

Table 2. Three year average yields for Alamo and Cave-in-Rock switchgrass by fertility treatment and harvest system

	Yield							
	2008		2009		2010		2011	
Treatment	Two harvest mean total (June & Nov)	Single Harvest (Nov)	Two harvest mean total (June & Dec)	Single Harvest (Dec)	Two harvest mean total (June & Dec)	Single Harvest (Dec)	Two harvest mean total (June &Dec)	Single Harvest (Dec)
	----------lb/acre----------							
Alamo Comm. Fert.	15693	10400	25086	15815	14153	12976	14071	14263
Alamo Litter	18993	11853	23732	15423	12877	12664	13610	9249
Alamo Irrig. Comm. Fert.	11340	10633	24846	13411	13524	14632	13959	13462
Alamo Irrig. Litter	18027	14600	27460	12467	16642	14892	12966	7806
Cave-In-Rock Comm. Fert.	10753	7280	24211	7313	12082	7858	12956	12561
Cave-in-Rock Litter	13533	8227	20747	9643	10571	8971	9883	6643
Cave-In-Rock Irrig. Comm. Fert.	12347	8440	22076	9438	11436	8447	11646	11426
Cave-In-Rock Irrig. Litter	16807	8287	23516	8619	12012	10524	9645	7782
Mean	14687	9965	23959	11516	12912	11371	12342	10399
$LSD_{(0.05)}$	3323	2277	NS	3330	3539	3461	2260	3109

Table 3. Three year averages for forage quality estimates for Alamo and Cave-in-Rock switchgrass by fertility treatment and harvest system

Treatment	Forage quality estimates Average 2009-2011			
	CP	ADF	NDF	TDN
	----------%----------			
Alamo Comm. Fert.	9	36	65	55
Alamo Litter	7	36	66	54
Alamo Irrig. Comm. Fert.	8	36	66	55
Alamo Irrig. Litter	7	36	66	54
CIR Comm. Fert.	9	36	63	56
CIR Litter	8	36	63	55
CIR Irrig. Comm. Fert.	10	36	63	56
CIR Irrig. Litter	7	35	64	55
Alamo control	4	34	66	52
Alamo irrig. control	5	35	65	52
Mean	7	36	65	54

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Adler, P.R., M.A. Sanderson, A.A. Boateng, P.J. Weimer and Hans-Joachim G. Jung. 2005. Biomass yield and biofuel quality of switchgrass harvested in fall and spring. Agron. J. 98: 1518-1526.

Alamo Switchgrass Residue Measurements for the Revised Universal Soil Loss Equation (RUSLE 2)
Introduction

The Revised Universal Soil Loss Equation is model developed to guide conservation planning, inventory erosion rates and sediment delivery. It will be used in developing conservation plans to evaluate erosion potential on land used for the production of biomass for direct combustion or conversion into liquid fuel. The PMC began a study in 2010 in cooperation with Dr. Seth Dabney at the USDA-ARS National Sedimentation Laboratory in Oxford, MS, to collect biomass samples and residue (standing stubble and surface residue) from an established stand of 'Alamo' switchgrass.

Methods and Materials

A three acre field of 'Alamo' switchgrass planted in 2000 at the PMC on a Leadvale silt loam was used for biomass and residue collection. Biomass samples were collected monthly beginning in April and ending in November (after the first frost) to a height of 6 inches. A 1 m^2 frame is used to collect early spring growth and a forage harvester (3' x 10') for later months at three (3) random locations in the field. A subsample is collected from each harvest and dried at 60°C for 24 hours for dry matter determination. Yield, plant height and percent growth are reported monthly. Phenological growth stage will be reported 2011. Standing stubble is determined every other month beginning in May and ending in November by harvesting the remaining six inches of stubble to near ground level in the same portion of the field used to determine biomass production. Stubble is collected using 1/4 m^2 frame. Surface litter (leaves, stems, etc) is collected within the same area as the stubble height using a 1/4 m^2. Both residue components are dried at 60°C for 24 hours (see next page for protocol used for data collection).

2011 Results and Summary

Stubble and surface residue yields of Alamo switchgrass are presented in Table 1. Stubble yield varied slightly during the season but generally increased from May to November. This trend was also evident in the surface residue measurement, which stands to reason because as the grass matures leaves and other plant part fall from the plant and accumulate below the canopy. This data was sent to Dr. Seth Dabney for inclusion into the RUSLE2 database.

Table 1. Stubble and surface residue for 'Alamo' switchgrass, 2011.

Date	Stubble (lb/acre)	Surface residue (lb/acre)
	----------lb/acre----------	
Feb 23	1880	2771
May 9	1648	152
June 9	2411	1004
July 14	2995	1323
August 8	2514	1234
Sept 12	3464	1675
Oct 13	3317	1644
Nov 10	2998	1802
Mean	2653	1451

Stubble and Residual Surface Biomass Collection Procedure after Harvesting the Above Ground Biomass for Growth Curve

The residue left in the field (leaves, stems, standing stubble), following removal of the above ground biomass used to establish a growth curve of a particular grass species, is referred to as *stubble* and *surface residue* biomass. This residue is important in predicting water and wind erosion using the Revised Universal Soil Loss Equation and the Wind Erosion Prediction System.

Method of Data Collection

1. Collect above ground biomass from plots with a plot harvester or similar harvesting method. A 3ft x 10ft swath taken from the center of the plot is common with a sickle bar mowers or plot harvester. Determine plot weight and collect subsamples (grab sample) for percent dry matter determination.
2. Place a 0.25 m^2 (50 cm x 50 cm; 19.7" x 19.7") sampling frame in the harvested plot area and collect the remaining plant residue. The residue is separated into 2 components: (1) stubble and (2) surface residue. The *stubble* refers to crowns and standing stubble and the *surface residue* refers to unattached stems and leaves. When selecting an area within the harvested swath or strip to sample, avoid areas with too little or too much residue. The goal is to select a representative area within the harvested strip.
3. Harvest the stubble as close to the ground as possible (at ground level) and place sample in a paper bag*.

   **It is anticipated that clipping the plant this close may result in severe plant damage or possible death*. *Avoid sampling these plants in subsequent years.*
4. Collect surface residue in the same 0.25 m^2. Avoid soil contamination in the surface residue samples. Place sample in a paper bag.
5. Repeat the above procedure, selecting a minimum of 6 random locations in a large block planting or replicated plots. Keep samples separate.
6. Weigh the stubble and surface residue samples and dry in a forced air oven at 55-60°C for 16-24 hrs or until dry. (report wet and dry weight)
7. Express the amount of stubble and surface residue in lb/acre and kg/ha.
8. Report the date of the first killing frost and the spring regrowth date (50% green up)

Forage Distribution Pattern of 'Alamo' Switchgrass, 'Bumpers' Eastern Gamagrass and Hampton Germplasm Big Bluestem

Introduction

Warm season grasses provide multiple conservation uses including forage for livestock, biomass for energy conversion processes, soil conservation and wildlife habitat. Growth patterns or growth curves of different vegetation types is important for conservation planning and decision support tools used by NRCS field offices to assist landowners and land managers. For example, a grazing module has been added to RUSLE2 to improve soil erosion prediction in pastures for grazing livestock. However, monthly forage distribution patterns of grasses are required for the model/module to operate efficiently in predicting soil erosion.

Methods and Materials

A three acre field of 'Alamo' switchgrass, and 1 acre of 'Bumpers' eastern gamagrass and 1 acre of Hampton Germplasm big bluestem is used for this study. Biomass samples are collected monthly beginning in April and ending in November (after the first frost) to a height of 6 inches. A 1 m^2 frame is used to collect early spring growth and a forage harvester (3' x 10') for later months. Samples were taken at three (3) random locations in the field. A subsample is collected from each harvest and dried at 60°C for 24 hours for dry matter determination. Yield, plant height and percent growth are reported monthly. Phenological growth stage will be reported 2011.

2011 Results and Summary

'Alamo' Switchgrass

Monthly yield, percent growth, and height for 'Alamo' are presented in Table 4. Peak yield occurred in September (12,188 lb/acre) with the greatest percentage of growth occurring in June (46%). No additional increase in biomass or growth occurred after September.

Table 4. Monthly Yield, Percent Growth, and Height of 'Alamo' Switchgrass, 2011

Month	Yield (lb/acre)	% Monthly Growth	Plant Height (inches)
Apr	334	2	9
May	2072	13	37
Jun	8267	46	59
Jul	10031	13	69
Aug	8607	0	69
Sept	12188	26	79
Oct	10896	0	81
Nov	8421	0	80

'Bumpers' Eastern Gamagrass

Monthly yield, percent growth, and height for 'Bumpers' are presented in Table 4. Peak yield occurred in July (8,955 lb/acre) with the greatest percentage of growth occurring in June (67%). Unlike 'Alamo' switchgrass, 'Bumpers' added 14% of total yearly biomass during the fall in response to above-average rainfall.

Table 4. Monthly Yield, Percent Growth, and Height of ‘Bumpers’ Eastern Gamagrass, 2011

Month	Yield (lb/acre)	% Monthly Growth	Plant Height (inches)
Apr	503	5	12
May	1818	13	31
Jun	8791	67	69
Jul	8955	2	80
Aug	6694	0	49
Sept	6325	0	39
Oct	7810	14	41
Nov	6977	0	39

Hampton Germplasm Big Bluestem

Monthly yield, percent growth, and height for Hampton Germplasm are presented in Table 5. Peak yield occurred in June (8,842 lb/acre) with the greatest percentage of growth occurring in July (80%). Hampton Germplasm added 6% of total yearly biomass during the fall in response to above-average rainfall.

Table 5. Monthly Yield, Percent Growth, and Height of ‘Hampton Germplasm Big Bluestem, 2010

Month	Yield (lb/acre)	% Monthly Growth	Plant Height (inches)
Apr	339	3	12
May	1590	13	31
Jun	8842	74	69
Jul	7219	0	80
Aug	7535	3	49
Sept	5251	0	39
Oct	5839	6	41
Nov	3013	0	39

Vegetative Rehabilitation of Cut Highway Slopes in Eastern Oklahoma: Final Report

TECHNICAL REPORT DOCUMENTATION PAGE

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16. ABSTRACT

Areas of moderate to severe erosion are occurring on highway rights of way in eastern Oklahoma. The silt from this erosion is filling ditch bottoms causing drainage problems ranging from slight to severe. Current vegetative practices call for bermudagrass slab sod and seeded introduced species of grasses on newly constructed highway rights of way slopes. These practices work well for a limited time (2-3 years). The species begin to die from drought stress, allowing erosion to begin. This study identified species of native warm season grasses that will control erosion, and survive harsh conditions found on disturbed slopes along Oklahoma highways. Along with species tests, planting dates, planting rates, mulch materials, and mulch rates were explored. Three sites were selected by ODOT to perform these tests. The first site is one mile south of the maintenance facility in Poteau, Ok. The second site is 5 miles north of Heavener, on the east side of the highway, and the third is at Sugar Creek on SH-128. Site characterizations were performed at each test site prior to planting dates. Soil amendments were applied for medium production of each species tested. The objective of this study is to test and prepare planting specifications for ODOT to use when contracting vegetative cover establishment on newly constructed highway rights of way in eastern Oklahoma.

17. KEY WORDS Native warm season grasses, critical area planting, drought stress in native grasses	18. DISTRIBUTION STATEMENT No restrictions. This publication is available from the Planning & Research Div., Oklahoma DOT.		
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Introduction

The Oklahoma Department of Transportation (ODOT) is seeking solutions to soil erosion problems on highway rights of way in eastern Oklahoma. The United States Department of Agriculture: Natural Resources Conservation Service, Booneville Plant Materials Center (PMC) in Booneville, Arkansas, specializes in critical area establishment and rehabilitation of critical areas with native warm season grasses (nwsg).

The purpose of this study was to identify and test species of nwsg on highway rights of way in eastern Oklahoma. Three sites were selected by ODOT on which to perform these tests over a period of 5 years. Mulch rates and mulch application methods were also evaluated.

This document contains the details of the five year study, along with proven specifications for establishing nwsg on Oklahoma's rights of way.

ODOT will be able to include these specifications in future bid solicitations for vegetating new highway construction areas in eastern Oklahoma.

Objectives

1. Identify native warm season grass species suited for highway rights of way
2. Establish mulch materials
3. Establish mulch rates
4. Establish fertility levels to achieve 100% ground cover within a reasonable timeframe
5. Incorporate results of the study into planting specifications for ODOT

Tasks

1. Identify sites for the study
2. Procure needed materials to establish study plots
3. Prepare seedbed(s) for studies
4. Plant nwsg(s)
5. Mulch sites
6. Determine germination dates
7. Monitor ground cover percentages
8. Monitor effect of tillage vs. no-tillage plots on stand establishment percentages
9. Monitor effect of mulch rates on germination and stand establishment percentages
10. Monitor the effect of fertility on ground cover percentages

Background

In the past the ODOT has used bermudagrass slab sod extensively. It is a very expensive means to establish permanent cover on highway rights of way. It does a good job where adequate moisture is available during dry parts of the growing season in eastern Oklahoma. Moisture availability is a serious issue on many shallow soils in eastern Oklahoma. Disturbance of these shallow soils weakens their moisture holding capacity even further. Native warm season grasses (nwsg) are known for their deep fibrous root system and drought tolerance. Since these areas are along highway rights of way, they are characteristically steep and become highly susceptible to erosion when disturbed. 'Alamo' switchgrass, 'Cheyenne' indiangrass, 'Kaw' big bluestem, and 'Aldous' little bluestem were the native warm season grass species chosen for this study.

Three sites for the study were chosen by the ODOT. Two sites (Heavener and Poteau Sites) were chosen to test seedbed preparation methods. These two sites compared conventional tillage to no-till establishment methods, different levels of mulch rates, and use of supplemental fertility additions.

Site Layout

Prior to planting trials at the sites, baseline soil nutrient levels were determined. Soil samples were collected from each research site in March 2006 and analyzed by the Soils Lab at the University of Arkansas, Fayetteville (See Table 1.)

Heavener & Poteau Sites

Soil nutrient samples did not indicate any deficiencies at the Heavener site. The Heavener site was prepared and planted April 17 and 18, 2007. The Poteau site was prepared and planted on April 19 and 20, 2007. Site preparation was tillage (8' tractor mounted tiller was used) of half of each plot (300' X 60'). A mixture of 'Cheyenne' indiangrass, 'Kaw' big bluestem, 'Aldous' little bluestem, and 'Alamo' switchgrass was applied by means of a hydro-seeder. The seeding rate was: big bluestem @ 4 lb Pure Live Seed (PLS)/acre, switchgrass @ 4 lb PLS/ac, indiangrass @ 4 lb PLS/ac and little bluestem @ 4 lb PLS/ac.

The sites were mulched immediately after seeding with ½ ton and 1 ton of wood fiber mulch. Each mulch treatment was replicated three times at each site, on both tilled and non tilled plots.

Data was collected from the Heavener and Poteau sites on 10 day intervals (for 1 month, post planting) to record germination dates, plant vigor, and stand percentages.

The native grasses germinated (in tilled plots) within 15 days of planting. The stands averaged 85% on the tilled plots. Germination took 25 days in no-till plots. The grasses in the tilled plots have grown at twice the rate of plants in the no-till plots. This is a function of inter-species competition for light, moisture, and nutrients. The PMC staff evaluated these plots 12 times during October, November, and December, 2007. Stand success for native warm season grasses was measured by plant density percentages.

The fall evaluations produced data that indicated medium to high success for tilled treatments, and zero to poor success where seed was applied with the no-till treatment.

The pH of soils at both sites was within the range for establishment of nwsg; however, soil test results recommended phosphorus and potassium application (See Table 1). ODOT does not currently include fertilizer treatments in revegetation practices. Fertilizer treatments were applied in this study to provide options for improving success rates in future revegetation efforts. Improving soil nutrients will improve native warm season grass planting success rates in critical areas such as cut slopes. While fertilizing all plantings may be cost-prohibitive, fertilization of only particularly difficult areas to establish may prove worthwhile. The Heavener and Poteau plots received phosphorus and potassium fertilizer (200 lbs/ac of 0-60-60) in April of 2008. These plots were evaluated by PMC staff 10 times during March, April, May, and June of 2008.

The tilled plots were consistently producing 80-85% cover while the no-till treatments have only 0-5% cover. Competition from weed species has contributed to the failure of the no-till treatments. Weed species were present

in the tilled treatments, but over the next 2-3 growing seasons, the native grasses eliminated most competition without herbicide treatment.

Evaluations conducted between August 1, and September 30, 2008, indicated native grasses at both Heavener and Poteau (tilled plots) matured to the point of producing seed. This seed germinated in the spring of 2009 and increased the stand density significantly (5-10%). The native species grasses broke dormancy several weeks prior to weed seed germination, allowing the grasses to suppress weed infestation. On May 12, 2009 a complete fertilizer (13-13-13) was applied at rates of 100, 200, and 300 lb. /acre, replicated three times at each site to plots that were established on tilled seedbeds. Though ODOT currently does not apply fertilizer to plantings, treatments were included in this study in an effort to provide options to improve success rates.

Evaluations were made during June and July to determine what effect, if any, the added fertility had on grass density, soil protection, and weed populations (See Table 2).

Sugar Creek SH-128 Site

The PMC staff performed site characterization on SH-128 at Sugar Creek, during March 2006. Soil samples were collected at the site and analyzed by the University of Arkansas, Fayetteville. There was no recommendation for lime, based on species to be planted, but phosphorus and potassium were required. These elements were applied in the spring of 2008, at the rate of 150 lbs. per acre of 0-60-60 (P2O5 and K20).

PMC staff laid out the research area (approx. 600’ X 100’). Supplies (seed, fiber mulch, soils amendments, etc.) were purchased for the research plot in October. On November 5, 6, 7, and 8, the entire slope was hydro-seeded with 5 lb (PLS) /ac each of ‘Alamo’ switchgrass, ‘Kaw’ big bluestem, ‘Aldous’ little bluestem, and ‘Cheyenne’ indiangrass. The top 20’ of the site was mulched with wheat straw at a rate of 1.5 tons / ac, while the lower 80’ of the slope was hydro-mulched, at a rate of 1 ton/acre. This planting was deemed a failure in early April 2008, due to torrential rains in late winter that caused seed and mulch to be washed from the slope.

A contract modification for FY 2009 allowed the PMC to re-establish this planting. Fall 2008 evaluations of SH-128 indicate germination and survival of planted native grass species along the top of the slope on the west end of the plot. This area was also hydro-seeded, and mulched with wheat straw instead of wood fiber hydro-mulch. The wheat straw survived the rains of spring 2008. This is the reason for germination and survival of the grasses planted near the top of the slope. The PMC staff hydro-seeded the slope again in the spring of 2009 with drought-tolerant grass and legume species, and used grass hay mulch at a rate of 2 tons per acre over the entire area. The grass hay mulch was treated, after placement, with a ‘tacking’ substance to insure it remained in place until the seed germinated.

Seeding rates were increased to 8 pounds PLS per acre for the 2009 planting. Drought-tolerant grass and legume species planted included: sericea lespedeza, bahiagrass, crown vetch, switchgrass, indiangrass, and big bluestem. Spring temperatures were cooler than normal, and germination took longer than predicted. Germination was rated fair to good on all species with the exception of crown vetch, three weeks after seeding. Crown vetch has a high percentage of “hard seed.” This means a significant amount of the seed has a thick seed coat, which slows penetration of moisture needed for germination.

Evaluations 4 and 6 weeks after planting averaged nearly 5% per week improvement in ground cover (germination). Approximately 8 weeks after planting, the slope failed destroying 1/3 of the planting.

Results

The no-till component of the study, both at Poteau and Heavener, was a failure. Germination was below 10 percent at both sites, and under both mulch rates. The prepared seedbed plots of the test at both sites were a success, under one ton and one and a half tons of mulch per acre.

The predominant species in all plantings is ‘Alamo’ switchgrass. It had the best germination and best seedling vigor in all treatments across replications. Next, in terms of germination, were ‘Cheyenne’ indiangrass, ‘Kaw’ big bluestem, and ‘Aldous’ little bluestem.

Fertility rates affected stand density, but areas of low fertility, and ‘check’ plots, receiving no fertility, performed very well. The conclusion drawn from 3 years of data collection is that the native warm season grasses will provide 80-90% ground cover without fertilizer application. The significant benefit of applied fertilizer to native warm season grass stands along highway rights of way, based on our research, is the time in which 80-90% stand density is achieved.

Two rates (200 lb. / ac. And 300 lb. / ac) of 13-13-13 (N-P2O5-K20) complete fertilizer was applied to replicated plots of native warm season grasses (nwsg) in the spring of 2009 and 2010. All plots, prior to the first application, were approx. 65% stand density. Plots receiving fertilizer (both rates) achieved 80-90% density during the summer of 2009. Plots receiving no additional fertility achieved 80% density the spring of 2010.

The second planting at Sugar Creek was a success. Switchgrass and bahiagrass are performing well under the severe drought conditions. Succession is taking place on the slope presently, with volunteer pine and sycamore trees germinating along the entire slope.

Conclusions

Characterization of the planting site is probably the most important task in success of establishing nwsg on highway rights of way in eastern OK. Soil samples should be analyzed and recommendations made for application of soil amendments. Every site is different, so each should be characterized.

Soil Nutrient Recommendations

- Phosphorus soil levels should be near 150-200 pounds per acre, and potassium should be 300-350 pounds per acre with the soil pH of 5.0-6.5.
- Nitrogen shouldn’t be added during the establishment year.

Seedbed Preparation & Planting Recommendations

- A prepared seedbed is a requirement for successful establishment of nwsg. Normal seedbed preparation equipment (disk, grain drill, roller, etc.) r used on 3:1 or flatter slopes. Use tractor with dual rear wheels on all slope work. Use concrete ter filled roller to firm the seedbed before and after planting. This ensures a firm seedbed so seed will be placed at a uniform depth of ¼ inch. Planting deeper than ¼ inch will result in failure. Rolling after planting ensures good seed-to-soil contact for improved germination.
- The ideal dates for planting nwsg are from Feb. 1 thru May 15. That date may be extended when adequate moisture is present.
- Planting rates should be 4 pounds Pure Live Seed (PLS) each/acre for indiangrass, switchgrass, and big bluestem. Sericea lespedeza, bahiagrass, and crown vetch should be seeded at 8 pounds Pure Live Seed (PLS) each/acre (See Table 3). ‘Aldous’ little bluestem performed poorly in all tests and should be dropped out of the mix.

Mulching Recommendations

- Use 1.5 tons/acre of wood fiber or grass hay mulch for best establishment results. Use wood fiber mulch on 3:1 or flatter slopes, and grass hay mulch on slopes steeper than 3:1. Hydro-seeding is recommended for slopes steeper than 3:1.
- When use of a hydro-seeder is required, and slopes are too steep for use of a roller, seeding rates should be doubled (8 pounds PLS/acre instead of 4 to encourage adequate seed-to-soil contact.)

Maintenance Considerations

- Native warm season grasses are slow to establish (3-5 years under the best conditions). Once established, they will withstand nearly any conditions (with the exception of close mowing between mid July and the first killing frost).

- Under fair to good conditions, an 80% stand may be achieved in 3 years without post establishment nitrogen fertilization. To speed up ground cover percentage, apply 250 pounds/ acre of complete fertilizer (13-13-13) in April each year.
- Rights of way may be mowed to 4 inches until July 15, when height must be maintained at 8-10 inches. Mowers may remove all residue after killing frost each fall.

Tables

Table 1. Site Soil Analysis Results (Mehlich 3 at 1:10 ratio)
Soil samples collected from sites in March 2006. Lab analysis was performed by the University of Arkansas in Fayetteville, Arkansas
Highlighted pounds per acre values are below recommended levels

Measurements	Poteau		Heavener		Sugar Creek	
		lb/acre		lb/acre		lb/acre
pH	5.28	-	6.37	-	5.76	-
Ec (micro mhos/cm)	94	-	68	-	60	-
P, mg/kg	7.6	15.2	14.3	28.6	9.5	19
K, mg/kg	142	284	179	358	121	242
Ca, mg/kg	799	1598	1387	2774	862	1724
Mg, mg/kg	610	1220	465	930	336	672
S, mg/kg	23.6	47.2	6.6	13.2	8.6	17.2
Na, mg/kg	78	156	22	44	13	26
Fe, mg/kg	79	158	99	198	113	226
Mn, mg/kg	71	142	111	222	78	156
Zn, mg/kg	1.8	3.6	2.7	5.4	2.9	5.8
Cu, mg/kg	1.1	2.2	1.7	3.4	1.1	2.2
B, mg/kg	0.1	0.2	0.3	0.6	0.08	0.16

Table 2. Effects of Fertilizer Application on Plant Density

Poteau (measured June-July 2009 & June-July 2010)						
Treatment (lbs of 13-13-13)	**2009 Plant Density (% Cover)**			**2010 Plant Density (% cover)**		
	Rep 1	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
0 lb	78	82	72	84	81	84
100 lb	88	81	83	92	85	86
200 lb	87	90	86	90	90	88
300 lb	92	90	94	95	98	99
Heavener (measured Jun-July 2009 & June-July 2010)						
Treatment (lbs of 13-13-13)	**2009 Plant Density (% Cover)**			**2010 Plant Density (% cover)**		
	Rep 1	**Rep 2**	**Rep 3**	**Rep 1**	**Rep 2**	**Rep 3**
0 lb	80	76	82	82	80	76
100 lb	80	78	84	85	84	87
200 lb	83	86	79	93	95	90
300 lb	90	97	88	94	100	98

Table 3. ODOT Plant Materials Study Species

Common Name	Scientific Name	Cultivar	(PLS)/ac
Indiangrass	*Sorghastrum nutans* (L.) Nash	Cheyenne	4
Switchgrass	*Panicum virgatum* (L.)	Alamo	4
Big Bluestem	*Andropogon gerardii* Vitman	Kaw	4
Little Bluestem	*Schizachyrium scoparium* (Michx.) Nash	Aldous	4
Sericea Lespedeza	*Lespedeza cuneata* (Dum. Cours.) G. Don	common	8
Bahiagrass	*Paspalum notatum* Flueggé	Pensacola	8
Crown Vetch	*Securigera varia* (L.) Lassen	common	8

Photos

Heavener Site Preparation, 2007

Heavener Site Vegetation, 2010

Mulching at Sugar Creek Site, April 2007

Sugar Creek Site Vegetation, September 2010

A complete report of this study is available on our website under publications:
www.plant-materials.nrcs.usda.gov/arpmc

Agroforestry Practice: Alley Cropping with Shortleaf Pine and Switchgrass

Introduction

Height and diameter of shortleaf pine trees are measured

Agroforestry combines agriculture and forestry technologies to create diverse, profitable and sustainable land-use system. One Agroforestry practice that may appeal to landowners is alley cropping. Alley cropping is defined as the planting of trees or shrubs in two or more sets of single or multiple rows with agronomic, horticultural or forage crops cultivated in the alleys between the rows of woody plants. Growing switchgrass (*Panicum virgatum* L.) between rows of shortleaf pine (*Pinus echinata* Mill.) for biofuel may have potential as an Agroforestry practice for landowners in western Arkansas. However, there is limited information on the growth and production of shortleaf pine from competition of switchgrass interplanted between the rows in subsequent years following tree establishment. Objective of this study is to determine the effect of switchgrass on growth and survival of shortleaf pine.

Methods and Materials

The study is conducted at the PMC on a Leadvale silt loam. Shortleaf pine was established in a block (14' x14'), double row (8' x 8') and single row (8' x 24') tree arrangement in January 2006. Length and width of block, double row and single row planting was 154' x 378', 152' x 376' and 120' x 376', respectively, with a 40' alley between arrangements. The stocking rate for block, double row and single row tree arrangement was 222, 227 and 226 trees/acre, respectively. Tree arrangements were planted as a randomized complete block with three replications. 'Alamo' switchgrass was interplanted between tree rows at a rate of 5 lb PLS/acre on 13 April 2006. Above average precipitation during the late fall and early spring in 2007-2009 prevented extensive data collection. The first significant data collection began in 2010. A mix of native warm season grasses was planted in alleyways as a control for the alleyways with switchgrass. Species included are switchgrass, little bluestem, big bluestem, and indiangrass. A separate switchgrass planting was also established as a control of switchgrass production within the tree alleyways

2010 Results and Summary

Four years after planting short-leaf pine and switchgrass on this site in 2006, there has been no negative effect of the switchgrass on the growth and development of the pine trees (Table 1). These findings suggest the landowner could plant trees in the winter and switchgrass the following spring and not be concerned that the switchgrass will hinder the growth and development of shortleaf pine on this type of site. This would enable landowners to transition more quickly into a silvopasture or biofuel production system without a 1 to 2 year delay for tree establishment before planting the switchgrass in the alleys.

Table 1. Height and diameter of shortleaf pine grown with and without Alamo switchgrass between the alleys, 2010

Treatment	Tree Measurements	
	Height (ft)	Diameter (in)
Switchgrass	8.1 a[1]	2.5 a
Control (no switchgrass)	8.0 a	2.5 a

1= means in columns followed by the same letters are not significantly different at P<0.05.

2011 Results and Summary

There was no significant difference in the diameter or height of trees grown with or without switchgrass in alleys in 2011 (Table 2). However, trees grew slightly taller in treatments without switchgrass from 2010-2011. Trees grew an average of 2.4 inches more in treatments without swichgrass (data not shown). This was significant at the P<0.05 level, but the magnitude is very small. This indicates a minimal impact on tree growth over the five-year study period.

For the first time in the study, switchgrass was harvested to determine whether or not tree growth has affected switchgrass biomass production. Switchgrass yield was determined by harvesting 10 x 10ft sections with a mechanical harvester equipped with on-board scale. Dry matter was determined by collecting a grab sample, and drying at 60˚F for 24 hours. Switchgrass production in shortleaf pine alleys was compared with control plots of switchgrass not grown in alleys. Yield was also determined for the native warm season grass mix control plots that were grown in pine alleys. Switchgrass grown outside tree alleys produced an average of 29% more biomass (lb/acre) than switchgrass grown within alleys (Table 2). Shading from trees and competition for moisture may explain these differences. Switchgrass in the alleys produced 20% more biomass (lb/acre) than the native warm season grass mix in the alleys. Results from 2012 show that the added benefit from growing Alamo rather than native warm season grass mix in the alleyways produced very little negative effects on tree growth.

Table 2. Height and diameter of shortleaf pine grown with and without Alamo switchgrass between the alleys, 2011

Treatment	Tree Measurements	
	Height (ft)	Diameter (in)
Switchgrass	9.4 a[1]	3.3 a
Control (no switchgrass)	9.4 a	3.4 a

1= means in columns followed by the same letters are not significantly different at P<0.05.

Table 3. Differences in biomass production by treatment, 2011

Treatment	yield
	----lb/acre----
switchgrass in alley	6006
switchgrass no alley	8424
nswg mix control in alley	4811

Table 4. Shortleaf pine summary data 2010-2011.

	Tree Height				Tree Diameter (12" above ground)			
	Average (ft)		Range (ft)		Average (in)		Range (in)	
Treatment	2010	2011	2010	2011	2010	2011	2010	2011
Switchgrass	8.1	9.3	5.3 – 11.3	6.1 – 12.9	2.4	3.3	1.1 – 3.3	1.8 – 4.2
Control	7.9	9.3	5.2 – 10.3	6.3 – 12.1	2.5	3.4	1.4 – 3.4	2.0 – 4.3

New Study

Evaluation of Commercial Pollinator Mixes for Conservation Reserve Program (CRP) CP52 Pollinator Habitat conservation practice in western Arkansas

Introduction

Insect pollination is vital to the economic and ecological sustainability of many food crops grown in the United States; however, populations of bees and other beneficial insects have sharply declined. In recent years, USDA has encouraged private landowners to implement conservation measures to maintain or establish pollinator habitat. At the state level, support for pollinators and their habitats includes developing biology technology notes with state-appropriate plant lists, conservation program enhancement job sheets, and other guidance documents for field office conservationists.

The most widely-used cost-sharing assistance program has been the Farm Service Agency's Conservation Reserve Program (CRP), which offers a conservation practice called CP42 Pollinator Habitat. Program requirements call for a mix of nine pollinator species, with three species blooming during April-June 15, June 15-July, and August-October. In addition, CP42 plantings must be maintained for 10 years, with a mid-contract management requirement (implementing a cultural disturbance such as burning to stimulate pollinator species). The Arkansas Forestry Commission or commercial seed companies often provide technical assistance since technical information regarding species selection, and longevity of species. Flowering species response to cultural management techniques is lacking for most of the ARPMC service area.

Materials and Methods

Three commercially available pollinator mixes will be planted in a 10' x 10' randomized complete block design with three replicates in March 2012. A seedbed will be prepared in February 2012 by disking and harrowing the designated plot area. Weeds in the plots will be chemically killed with glyphosate prior to planting. Seed mixes will be broadcast and rolled to ensure proper planting depth.

Blooming data for each plot will be taken at two-week intervals during each of the three blooming periods (April-June 15, June 15-July, August-October) for the next three years. In year three, one replication in each plot of each mix will be burned; rep 2 will be lightly disked; rep 3 will serve as a control. Blooming data will be collected for years 4-10.