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USDA NRCS East Texas Plant Materials Center
Nacogdoches, Texas

Adaptation of Perennial Native Cool Season Grasses in East Texas

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ABSTRACT

The USDA-Natural Resources Conservation Service recommends revegetating trails and landings after logging activities to reduce soil erosion and promote wildlife habitat. Five native perennial cool season grasses were evaluated from October 2016 to August 2018 for adaptation to East Texas. Virginia wildrye (*Elymus virginicus*), Canada wildrye (*Elymus canadensis*), broadleaf uniola (*Chasmanthium latifolium*), longleaf uniola (*Chasmanthium sessiliflorum*), and prairie junegrass (*Koeleria macrantha*) were assembled from commercial and USDA NRCS Plant Materials Center sources. Varieties and ecotypes of northern and southern origin were represented in the evaluation. The grasses were planted at the USDA-NRCS East Texas Plant Materials Center on 4 October 2016 in a randomized complete block design with three replications. Entries were evaluated for seedling emergence/ft^2, boot date, mature plant height, and seed maturity date. Longleaf uniola and prairie junegrass failed to emerge after drill planting. Emergence failure of the longleaf uniola entry is attributed to high seed dormancy of 94% along with incorrect planting depth. Given their small seed size, longleaf uniola and prairie junegrass appear better suited for broadcast or topdress seeding. Canada and Virginia wildrye entries emerged quickly in fall 2016. Northern wildrye entries had good seedling emergence but declined in vigor and did not reach maturity during the study. Only Lavaca Germplasm Canada wildrye from Texas and a Virginia wildrye ecotype from Georgia reached maturity in 2016-2017 and 2017-2018 growing seasons. Broadleaf uniola entries were not established until a year after initial planting and reached maturity in 2018. The South Carolina broadleaf uniola entry had the highest plant density and dry matter yield in the 2017-2018 growing season. Wildrye and broadleaf uniola entries with southern origins showed better adaptation than those of northern origins to East Texas growing conditions.

INTRODUCTION

Pine plantations comprise 21% of East Texas forest lands and forestry is an important regional industry (Rudis et al., 2003). Logging machines and trucks access forest property using roads and trails which remain after logging operations are finished. When revegetating roads and trails, earlier USDA Natural Resources Conservation Service (NRCS) reference materials recommended introduced warm season grasses such as bermudagrass [*Cynodon dactylon* (L.) Pers] (Stoner and McFall, 1991). However, introduced warm season grasses provide poor wildlife habitat due to their turflike growth (McPeake et al, 2008). Current NRCS conservation practice standards recommend native species to enhance wildlife habitat when revegetating forest trails and landings (USDA NRCS, 2012 and USDA NRCS 2017). The study objective was to evaluate commercially available perennial native cool season grasses suitable for wildlife

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habitat and for use on logging platforms, roads and as green firebreaks. Native cool season grasses Virginia wildrye, Canada wildrye, longleaf uniola, broadleaf uniola, and prairie junegrass were selected for study because they provide wildlife food and cover and are commercially available (Leithead et, al, 1971; Reilley, 2010; Miller and Miller, 1999).

MATERIALS AND METHODS

Seed lots of Canada wildrye, Virginia wildrye, broadleaf uniola, longleaf uniola, and prairie junegrass were assembled from commercial sources and USDA NRCS Plant Materials Centers in Elsberry, Missouri and Kingsville, Texas (Table 1).

Table 1. Species, cultivar or ecotype, and origin of native cool season grasses in cool season grass adaptation study at the USDA NRCS East Texas Plant Materials Center. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

Species	Cultivar/Ecotype	Origin(s)	Species	Cultivar/Ecotype	Origin(s)
Broadleaf uniola	Ecotype	South Carolina	Canada wildrye	'Mandan'	Minnesota
Broadleaf uniola	VNS[1/]	Texas, Missouri, Pennsylvania	Canada wildrye	Lavaca Germplasm	Lavaca County, Texas
Prairie junegrass	'Blue Mountain'		Virginia wildrye	Cuivre River Germplasm	Missouri
Prairie junegrass	VNS	Oregon, South Dakota	Virginia wildrye	Ecotype	Georgia
Longleaf uniola	VNS	Not stated	Virginia wildrye	VNS	Minnesota

1/=variety not stated

The study was conducted from October 2016 to August 2018 at the East Texas Plant Materials Center (ETPMC), Nacogdoches, Texas. The study plot was planted on 4 October 2016 using a Hege model 1000 precision plot planter set on 8-inch rows (Kincaid Equipment, Haven, KS). Individual plots were 40 inches wide by 20 feet long and seeded at 30 pure live seed (PLS)/ft^2 rate. Experimental design was a randomized complete block with three replications. Plot soil type was a Bernaldo-Besner complex fine sandy loam. The study was watered after planting to aid seedling emergence.

Seedling emergence was evaluated 30 and 60 days after planting (DAP). A rod marked with an 18-inch segment was placed randomly beside interior plot rows and number of emerged seedlings within the segment counted and recorded. Three counts per plot were recorded and averaged to determine plants/ft^2/plot. Boot date was recorded when at least 50% of the plants in a plot reached boot stage. Seed maturity date was recorded, and mature plant height measured when greater than 50% of the inflorescence reached maturity in a plot. Mature plant height per plot was determined by taking four heights and averaging them. Mature plant height was measured in inches from ground level to top of a mature inflorescence. Plots were harvested at seed maturity to estimate dry matter yield. Only the broadleaf uniola entries, South Carolina Virginia wildrye ecotype, and Lavaca Germplasm Canada wildrye reached seed maturity and were harvested. Dry matter yields were estimated by laying a 3ft^2 frame in the middle of the plot and plants within the frame harvested to 4-inch foliage height. The samples were weighed after

clipping to determine wet weight, dried for 24 hours at 60°C, and reweighed to determine sample dry weight.

Data for 30 and 60 DAP field emergence, percent seed germination, plant density, mature height and dry matter yield were analyzed in Statistix 10 (Analytical Software, Tallahassee, FL) using mean and standard deviation to determine variation among entries within a species.

Seed germination tests were conducted on all seed lots in April 2017 to determine if seed dormancy had affected seedling emergence in the field. Seed lots were tested using four replications of 100 seed each. Germination testing of each species was conducted as noted in 2007 Rules for Testing Seeds (Association of Official Seed Certification Analysts, 2007). Germinated seedlings were counted, recorded and discarded on a weekly basis. Seed prechill treatments, germinator settings, and percent germination are presented in Tables 2 and 3.

RESULTS AND DISCUSSION

Canada wildrye entries had the highest mean nonprechilled seed germination followed by Virginia wildrye, prairie junegrass, broadleaf uniola, and longleaf uniola (Tables 2 and 3). Two Virginia wildrye entries from Minnesota had the highest seed germination of 97 and 90 percent.

Table 2. Seed prechill treatments, germinator settings, variety or ecotype, and percent germination of broadleaf uniola and Canada wildrye native perennial cool season grasses. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

							% Germination	
Species	Prechill[1/]	2% KNO3 added[1/]	Alternating temperatures degrees C[1/]	Light (hrs)[1/]	Final count (no. of days)[1/]	Variety or ecotype	Prechill	Nonprechill
Broadleaf uniola	7 days at 10°C	yes	20/30	8	28	VNS[2/] (MO)	61	37
						South Carolina ecotype	93	80
						VNS (TX)	6	5
						VNS (PA)	13	9
Mean							43	32
SD[3/]							37	31
Canada wildrye	14 days at 5°C	no	15/30	8	21	Mandan (MN)[4/]	44	88
						Mandan (MN)[4/]	34	75
						Mandan (MN)[4/]	31	65
						Lavaca germplasm	80	74
Mean							47	75
SD							21	11

1/=settings and temperatures noted in 2007 Rules for Testing Seeds (Association of Official Seed Certification Analysts), 2/=variety not stated, 3/=standard deviation, 4/=separate entries from same state of origin.

Table 3. Seed prechill treatments, germinator settings, variety or ecotype, and percent germination of Virginia wildrye, prairie junegrass, and longleaf uniola. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

							% Germination	
Species	Prechill[1/]	2% KNO3 added[1/]	Alternating temperatures degrees C[1/]	Light (hrs)[1/]	Final count (no. of days)[1/]	Variety or ecotype	Prechill	Nonprechill
Virginia wildrye	14 days at 5°C	no	15/30	8	21	VNS[2/] (MN)[3/]	95	97
						VNS (MN)	93	90
						Georgia ecotype	42	47
						Cuivre River germplasm	0	0
Mean							58	59
SD[4/]							41	41
Prairie junegrass	no	no	20/30	8	14	Blue Mountain	[5/]	82
						VNS (OR)	[5/]	38
						VNS (SD)	[5/]	50
Mean								57
SD								21
Longleaf uniola	7 days at 10°C	yes	20/30	8	28	VNS (not stated)	7	5

1/= settings and temperatures noted in 2007 Rules for Testing Seeds (Association of Official Seed Certification Analysts), 2/=variety not stated, 3/= separate entries from same state of origin, 5/=prechill treatment not in 2007 AOSA Rules for Testing Seeds.

Table 4. Temperature and rainfall from October 2016 to July 2018 during cool season grass adaptation study. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

		Month												
Year		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg	Total
2016	High F°	1/	1/	1/	1/	1/	1/	1/	1/	1/	83[2/]	73	61	72	
	Low F°										57	49	43	50	
	Prec.(in)										1.2[2/]	0.1	0		2.3
2017	High F°	64	72	74	78	82	88	92	86	87	80	73	59	78	
	Low F°	44	49	50	53	57	70	72	72	64	54	49	36	56	
	Prec.(in)	0	0	0.3	4.6	8.6	5.7	7.2	7.1	1.9	4.5	2.6	2.8		45.3
2018	High F°	55	64	74	74	89	94	96	1/	1/	1/	1/	1/	78	
	Low F°	30	47	51	48	65	73	73						55	
	Prec.(in)	1.2	4.4	4.8	5.1	2.4	1.3	2.8							22.0

1/=month not included in study, 2/=temperatures and rainfall recorded from A.L. Mangham Jr. Regional Airport, Nacogdoches, Texas (wunderground.com) from October 2016 to July 2018.

Temperature and monthly precipitation during the study were recorded from A.L. Mangham Jr. Regional Airport approximately 5.7 miles northeast of the ETPMC (Table 4).

Average temperatures during the study were 72°F and 50°F and 78°F and 56°F in 2016-2017 and 2017-2018 respectively. Total precipitation during the study was 2.3 inches the last three months of 2016, 45.3 inches in 2017, and 22 inches the first seven months of 2018. Rainfall was three inches below normal in 2017. By July 2018, the ETPMC had received 45% of normal yearly rainfall.

Longleaf uniola and prairie junegrass

Prairie junegrass and longleaf uniola did not emerge in any replications and no data was collected during evaluation. Seed germination of prairie junegrass was adequate varying from 38% to 83% and longleaf uniola was less than 10% (Table 3). Emergence failure of prairie junegrass is attributed to incorrect planting depth. Longleaf uniola stand failure is attributed to very low seed germination as evidenced in the germination tests (Table 3). Seed of these species is small averaging 2.3 million for prairie junegrass (Ogle et al., 2006) and 85,000 for longleaf uniola (USDA NRCS, 2020). Based on study observation, prairie junegrass and longleaf uniola may have had better germination if top dressed or broadcast seeded.

Broadleaf uniola

Broadleaf uniola seedling emergence was sporadic in fall 2016 as three of the four entries had seed dormancy ranging from 73% to 89% as noted on seed lot information tags. Entries were not well established until fall 2017 a year after planting. In October 2017, the South Carolina ecotype had highest average density of 1.5 plants/ft^2 followed by the Missouri entry at 1.2 plants/ft^2, Texas entry at 0.3 plants/ft^2, and Pennsylvania entry at 0.2 plants/ft^2 (data not shown). Greater plant density of the South Carolina and Missouri entries is attributed to their higher percent seed germination compared to the Pennsylvania or Texas entries (Table 2). All entries progressed to seed maturity in early August 2018 and were clipped to determine dry matter yield (Table 5). The South Carolina ecotype had the highest dry matter yield of 6019 lb/acre (Table 5) and was due to better stands compared to the other entries. The biomass yield of 3 tons was surprisingly high given the fact this species is usually found is shaded areas throughout the southeastern US (Shaw, 2012 and Leithead et al, 1971).

Table 5. Broadleaf uniola ecotype or origin, seed maturity date, mature plant height, and dry matter yield. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

Ecotype or seed origin	Seed maturity date	Mean mature plant height[2/] (in)	Mean dry matter clipping yield at maturity (lb/ac)
South Carolina ecotype	8/15/2018	36	6019
VNS[1/] (MO)	8/7/2018	34	1905
VNS (TX)	8/7/2018	28	2586
VNS (PA)	8/7/2018	30	2858
Mean		32	3639
SD [2/]		6	2212

1/ VNS=variety not stated, 2/ SD=standard deviation.

Canada wildrye

All commercial seed sources sent 'Mandan' Canada wildrye grown in Minnesota. Lavaca germplasm Canada wildrye originated from seed collected in Lavaca County, Texas and was developed by the USDA NRCS Plant Materials Center in Kingsville, Texas (Reilley, 2010)

'Mandan' entries had higher seedling density compared to Lavaca germplasm in fall 2016 (Table 6). 'Mandan' grew well through early spring 2017 but as expected, it slowed its growth as temperatures increased. 'Mandan' entries remained in vegetative stage during the study and decreased in vigor as the study progressed. 'Mandan' was developed from seed collections in North Dakota and is adapted to the Northern Great Plains (USDA NRCS Bismarck PMC, 2012). In contrast, Lavaca germplasm reached maturity both growing seasons (Table 7) (Fig.1). Grasses are more vigorous when grown close to their center of origin but less vigorous when moved farther away (Leithead et al., 1971). The 'Mandan' entries did not perform well because they were over 500 miles south of their area of origin, whereas Lavaca germplasm was closer to its area of origin about 200 miles southeast of the ETPMC.

Figure 1. Lavaca Germplasm Canada wildrye plot at seed maturity.

Table 6. Canada wildrye (*Elymus canadensis*) seed source, cultivar or ecotype, and mean number of seedlings/ft^2 30 and 60 days after planting. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

		Mean seedlings/ft^2	
Seed source	Cultivar or Ecotype	30 DAP	60 DAP
Commercial	'Mandan' (MN)	8	11
Commercial	'Mandan' (MN)	7	7
Commercial	'Mandan' (MN)	9	8
USDA NRCS Kika de la Garza PMC	Lavaca Germplasm (TX)	4	4
Mean		7	8
SD [1/]		4	5

1/= standard deviation.

Table 7. Lavaca Germplasm Canada wildrye (*Elymus canadensis*) boot date, mature plant height, and seed maturity date for 2016-2017 and 2017-2018 growing seasons. USDA-Natural Resources Conservation Service East Texas Plant Materials Center, Nacogdoches, Texas.

Growing season	Boot date	Mean mature plant height [1/] (in)	Seed maturity date	Mean dry matter yield (lb/ac.)
2016-2017	05/02/2017	30	6/20/2017	1858 [2/]
2017-2018	4/08/2018	43	6/4/2017	

1/= measured from ground level to top of inflorescence, 2/=not harvested

Virginia wildrye

Virginia wildrye entries originated from Georgia, Minnesota, and Missouri. All Virginia wildrye entries, except Cuivre River Germplasm, emerged by 60 DAP in fall 2016. A Minnesota entry had highest seedling emergence at 30 and 60 DAP (Table 8). Cuivre River Germplasm had no emergence at 60 DAP. Emergence failure is probably due to older seed lot age of twelve years and loss of seed viability. Virginia wildrye seed has a longevity of three years without much viability loss and should not be stored more than two years before planting (Wolff, 1951).

Moving grass ecotypes more than 200 miles south of their origin can lead to problems with winter hardiness, longevity, and disease (Cooper, 1957). During the study, Minnesota entries and Cuivre River Germplasm remained in vegetative stage or reached flag leaf stage. Spring flowering of cool season grasses is affected by exposure to cold temperatures or vernalization (Ehlke and Undersander, 1990). Minnesota and Cuivre River Germplasm entries probably did not receive sufficient cold weather for vernalization and subsequent spring flowering as they were more than 300 miles south of their origin. However, the Georgia ecotype reached maturity both growing seasons in the study (Table 9). Ecotypes when moved east or west are more affected by precipitation amounts and elevation (Duebbert et al., 1981) than temperature. At Nacogdoches, the Georgia ecotype was grown west of its origin but under similar climatic conditions. Average rainfall in east Texas is 48 inches which is in the range of 45 to 75 inches for Georgia (National Climatic Data Center, 2020).

Table 8. Virginia wildrye (*Elymus virginicus*) cultivar or ecotype and mean number of seedlings/ft^2 30 and 60 days after planting. USDA NRCS East Texas Plant Materials Center, Nacogdoches, Texas.

Seed source	Cultivar or Ecotype	30 DAP	60 DAP
Commercial	VNS (MN)	4	5
Commercial	VNS (MN)	10	10
Commercial	Georgia ecotype	3	2
USDA NRCS Elsberry PMC	Cuivre River Germplasm (MO)	0	0
Mean		4	4
SD [1/]		5	5

1/=standard deviation.

Table 9. Georgia ecotype Virginia wildrye (*Elymus virginicus*) boot date, mature plant height and seed maturity date for 2016-2017 and 2017-2018 growing seasons. USDA-Natural Resources Conservation Service East Texas Plant Materials Center, Nacogdoches, Texas.

Growing Season	Boot date	Mean mature plant height [1/] (in)	Seed maturity	Mean dry matter yield (lb/ac.)
2016-2017	05/17/17	35	7/12/17	2154
2017-2018	5/01/18	43	6/28/18	[2/]

1/=measured from ground level to top of inflorescence, 2/=not harvested.

CONCLUSION

In this study, prairie junegrass and longleaf uniola failed to emerge. Both species are small seeded and the longleaf uniola had high seed dormancy of 94%. Broadcast seeding or topdressing may be preferable planting methods for these grasses compared to drill planting. Further study of these species is justified; longleaf uniola and prairie junegrass occur in east

Texas (Shaw, 2012). Seeded broadleaf uniola was slow to emerge and not fully established until a year after planting. The South Carolina entry had the highest mean plant density and dry matter yield compared to broadleaf uniola entries from Missouri, Texas, and Pennsylvania. Virginia wildrye Georgia ecotype was more vigorous and progressed to seed maturity as opposed to Cuivre River Germplasm from Missouri and Minnesota ecotypes which did not reach maturity in the study. 'Mandan' Canada wildrye was the cultivar sent by commercial growers when this study was conducted. 'Mandan' Canada wildrye, a northern cultivar, did not perform as well as Lavaca Germplasm, a southern ecotype, which was more vigorous, reached seed maturity, and better adapted to East Texas growing conditions. Lavaca Germplasm Canada wildrye performance verified its recommended use in USDA NRCS Zone 4 in Texas (USDA NRCS, 2018). It is recommended that USDA NRCS personnel and land managers in East Texas specify Lavaca Germplasm when planting Canada wildrye and a local adapted ecotype or southeastern US ecotype when planting Virginia wildrye or broadleaf uniola from commercial sources.

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