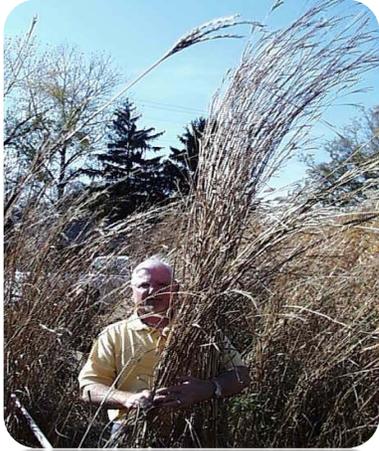


Big Bluestem and Indiangrass for Biomass Production by Variety Selection and Establishment Methods for Missouri, Illinois, and Iowa



Author

Jerry Kaiser, Plant Materials Specialist

Big bluestem (*Andropogon gerardii* Vitman) and indiangrass (*Sorghastrum nutans*) are tall, warm-season perennial grass with short rhizomes. The species occur naturally in every state in the continental United States, except Washington, Idaho, Oregon, Nevada, and California. They also occur in adjoining provinces of Canada (United States Department of Agriculture (USDA) Natural



Resources Conservation Service (NRCS) 2006b Plants Database). These species are palatable grasses for livestock. Crude protein and digestibility are high for both big bluestem and indiangrass during the summer growing season. Seed production yields have averaged 100 to 200 pounds per acre at the USDA NRCS Plant Materials Center (PMC) at Elsberry, Missouri. Big bluestem and indiangrass prefer well drained, deep soils but will tolerate dry, low pH, and low fertility soils. They are used for erosion control, livestock grazing, wildlife habitat, and native prairie restoration.

Study sites The study was to determine how these varieties of big bluestem and indiangrass performed in the three states of Missouri, Illinois and Iowa. The study was conducted in cooperation with several partners: USDA NRCS Elsberry PMC, in cooperation with the University of Missouri, Southwest Research Center, at Mount Vernon, Missouri; the University of Illinois, Orr Agricultural Research Center, at Perry, Illinois; and the University of Northern Iowa, Tallgrass Prairie Center, Cedar Falls, Iowa.

Dry matter yields and other plant characteristics were compiled at three sites. The data was collected in Missouri from 1993 to 1995, Illinois from 1992 to 1994, and Iowa from 1994 to 1996 (Elsberry PMC 1994-1998 Technical Report). The effects of seed origin (parentage) on plant performance were apparent. Eight seed selections or varieties of big bluestem and six seed varieties of indiangrass were evaluated. Southern seed sources generally had heavier biomass production. Plant density (stand index) was generally greater for southern origin seed sources. Northern varieties moved more than 200 miles southward from their origin generally performed relatively poorly, and yield was significantly less than the southern varieties. There were fewer days to seed maturity (phenology) for the northern selection/varieties compared to the southern selection/varieties.

University of Missouri, Southwest Research Center, Mount. Vernon, Missouri

Major Land Resource Area 116B - Springfield Plains, Ozark Border.

Data for the study site: The soil is a Hoberg-silt loam. The Hoberg series consists of very deep, moderately well drained soils that have a fragipan. These soils formed in a thin mantle of loess and the underlying residuum from cherty limestone. Permeability is moderate above the fragipan, slow in the fragipan and moderate below the fragipan. Slopes range from at the site was 2 to 5 percent. Average grass yields are generally excellent on the upland Hoberg silt loam soils.

Average annual precipitation is 43.7 inches per year. During the four years of the study precipitation varied at this location. In 1991 the establishment year rainfall was 20% (-8.95 inches) below the normal average of 43.73 inches. The highest biomass production was in 1993 and 1994 following rainfall in 1992 that was 28% (12.26 inches) above normal and 1993 that was 40% (17.28 inches) above normal.

The growing season at Mount Vernon, Missouri, is an average of 223 days.

University of Illinois, Orr Research Center, Perry, Illinois

Major Land Resource Area 115C - Central Mississippi Valley Wooded Slopes.

Data for the study site: The soil is a Muscatine silt loam. The Muscatine series consists of very deep, somewhat poorly drained soils formed in loess. These soils are on summits of interfluvial on dissected till plains and on treads and risers on stream terraces. Slopes range from 2 to 5 percent. Average grass yields are generally excellent on the Muscatine silt loam soils.

Average annual precipitation is 39.18 inches per year. During the four years of the study precipitation varied at this location. In 1990 the establishment year, rainfall was 23% (8.83 inches) above normal. The highest yield was in 1993 when rainfall was 38% (14.70 inches) above normal.

The growing season at Perry, Illinois, is an average of 187 days.

University of Northern Iowa, Tallgrass Prairie Center, Cedar Falls, Iowa

Major Land Resource Area 104 - Eastern Iowa Till Prairie.

Data for the study site: The soils on this site are a well drained Kenyon clay loam and Olin fine sandy loam. The Kenyon series consists of very deep, moderately well drained soils formed in 12 to 30 inches of silty or loamy sediments and the underlying till. These soils are on interfluvial and side slopes on dissected till plains on the Eastern Iowa and Minnesota Till Prairies. Slope ranges from 2 to 35 percent. The Olin series consists of very deep, well drained soils formed in 24 to 36 inches of loamy sediments and in the underlying glacial till. These soils are on interfluvial and side slopes on dissected till plains. Slope of the

plots range were 2-5%.

Average grass yields are generally excellent on the Kenyon clay loam soils and Olin loam soils.

Average annual precipitation is 33.7 inches per year. During the four years of the study precipitation was varied at this location. In 1992 the establishment year precipitation was below normal 8% (-2.73 inches). The highest biomass was in 1994 following above normal precipitation 57% (19.37 inches) in 1993 and 5% (1.60 inches) in 1994. In 1995 and 1996, 12% below normal precipitation resulted in lower yields.

The growing season at Cedar Falls, Iowa, is an average of 177 days.

Methods and Materials

The three sites were located within the PMC service area for the study. The northern site is at Cedar Falls (Northeast Iowa), the central site is at Perry (West Central Illinois) and the southern site is at Mount Vernon (Southwest Missouri). Released varieties of big bluestem and indiangrass were planted in a randomized complete block with three replications. Plot sizes at Perry were 15 feet by 50 feet. Seed was broadcast in a prepared seedbed. Plot sizes for Mount Vernon and Cedar Falls were 12 feet by 50 feet. A prepared seedbed was established and planted using a drill. The third year after seeding each site was subjected to a spring burn. Each plot was monitored for establishment the year of planting but was not evaluated until the third year. Evaluation criteria are annual biomass yield, plant height, percent stand, and plant phenology at plant maturity. Forage quality was collected by a grab sample for dry matter determination and chemical analysis; however, this technical note on biomass yield does not address the forage data from the study.



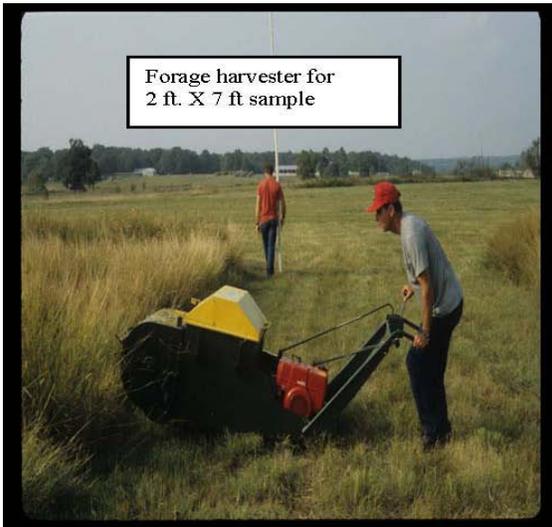
Cone seeder establishment of plots

Data for annual biomass yield production was collected only once per year, typically at the end of the growing season which varied by site location. This data did not take into account regrowth potential but rather a full season total dry matter yields. A harvested sample was taken and used to adjust the dry matter yields per acre for the big bluestem and indiangrass varieties being evaluated.

Data for annual biomass yield production was collected only once per year, typically at the end of the growing season which varied by site location. This data did not take into account regrowth potential but rather a full season total dry matter yields. A harvested sample was taken and used to adjust the dry matter yields per acre for the big bluestem and indiangrass varieties being evaluated.

Biomass Production

A two-foot by seven-foot sample was cut with a forage harvester to determine dry matter yield. A representative stand was harvested from each plot. Plot borders were excluded and an estimate of percent dry matter weed content in the sample was deducted from the total sample weight.

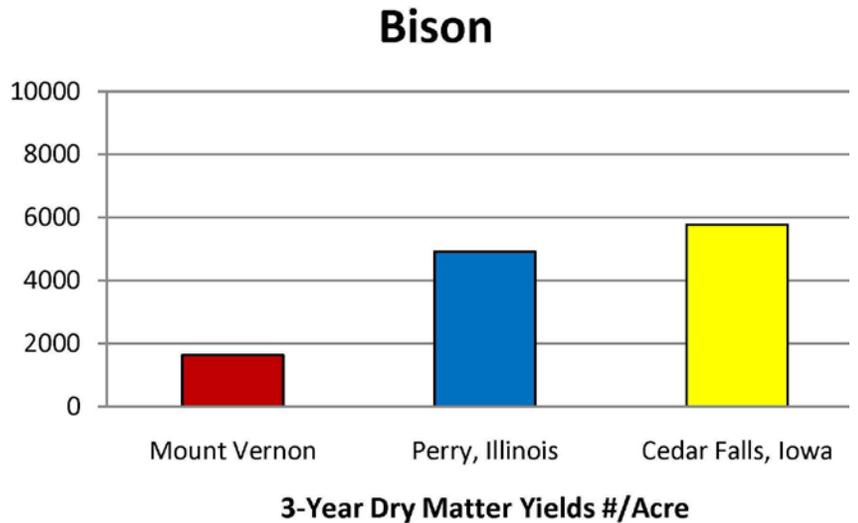


A summary table of each variety for each site location is listed below on page 9 and 10 for big bluestem and page 16 and 17 for indiangrass.

Variety/Collection Source 

Bison Big Bluestem

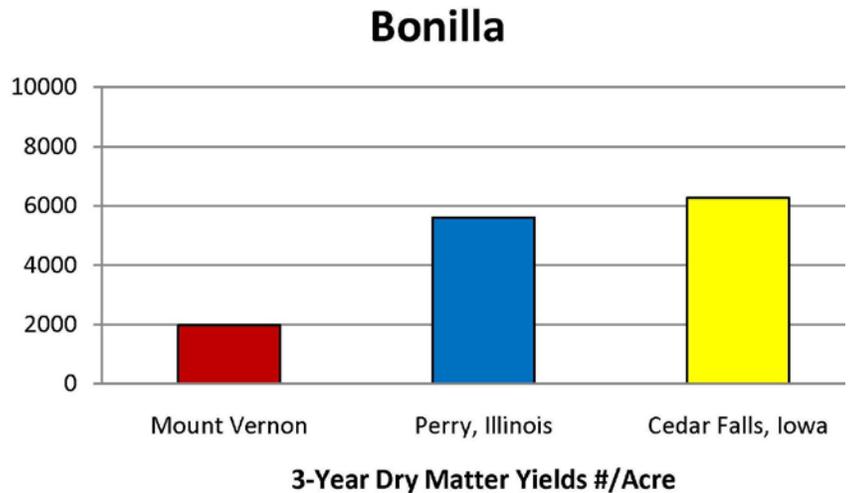
The original plants (NDG-4, PI 477994) were collected from a native stand near Price, Oliver County in central North Dakota. Plants were selected for uniformity of plant type, leafiness, vigor, seed yield, and winter hardiness. The variety Bison is 20 days earlier in anthesis than Bonilla and 30-48 days earlier than Kaw, Champ, and Pawnee. It tends to be shorter in mature height. Bison was released by the United States Department Agriculture (USDA)-Natural Resources conservation Service (NRCS), Bismarck Plant Materials Center (PMC), North Dakota, and USDA-Agriculture Research Service (ARS) and North Dakota and Minnesota Agricultural Experiment Stations.



Variety/Collection Source

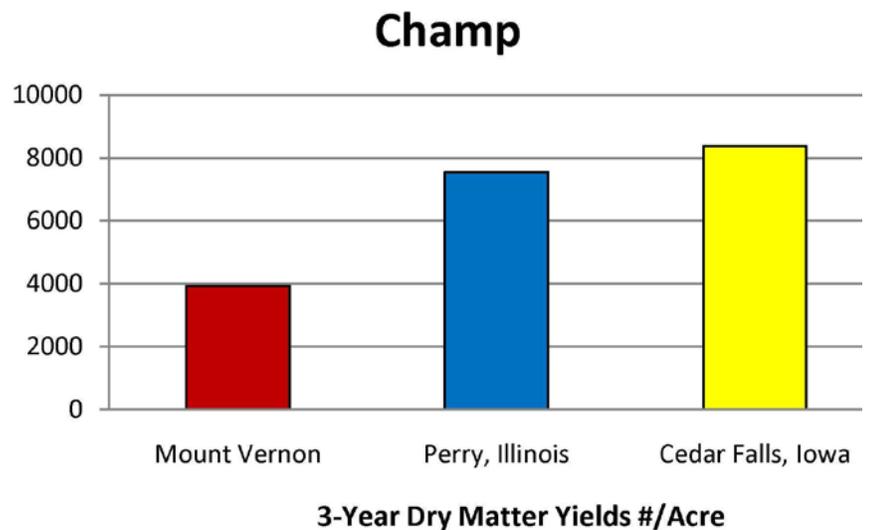
Bonilla Big Bluestem

The original seed (SD-27, PI 315658) was collected from native stands at two sites near Bonilla, Beadle County in east central South Dakota. Plants grown from original seed collections were selected for high seed and forage yields, and winter survival. It was released by the USDA-NRCS, Bismarck, North Dakota, USDA-ARS, and the Agricultural Experiment Stations of North Dakota, South Dakota, and Minnesota.



Champ Big Bluestem

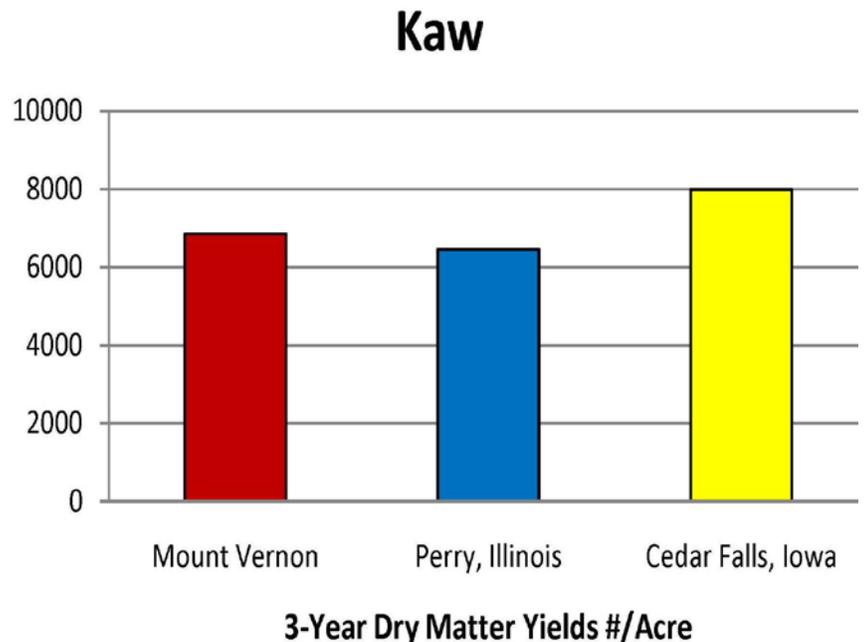
Champ was developed by hybridization of five typical clones of big bluestem from the fine textured prairie soils of Iowa and southeastern Nebraska with five clones of sand bluestem (*Andropogon hallii*) from the northern Nebraska sandhills. It is leafy, and seed set and seed qualities are superior to those of ordinary big bluestem. It was developed and released by the USDA-Agriculture Research Service and University of Nebraska at Lincoln, Nebraska.



Variety/Collection Source

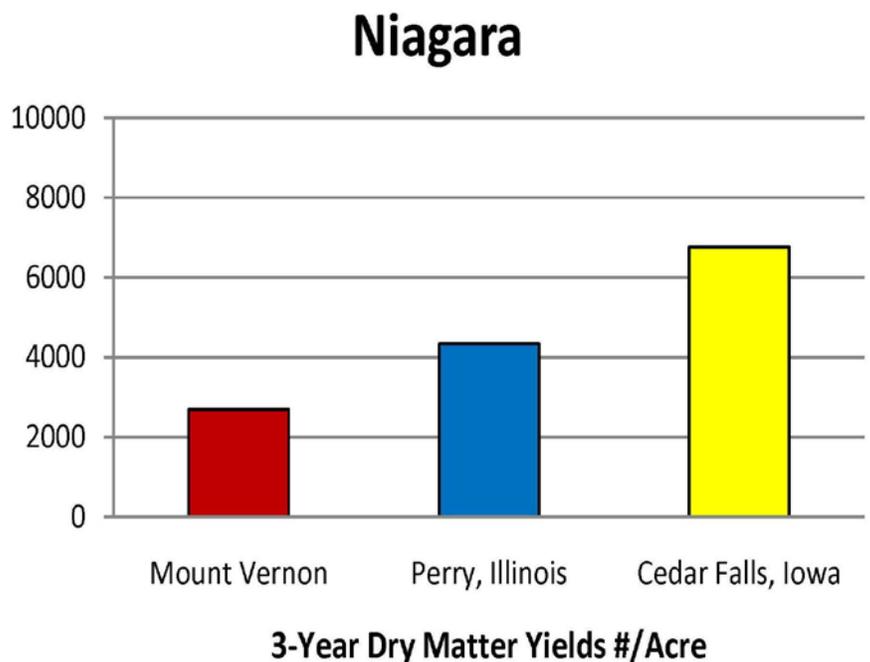
Kaw Big Bluestem

Kaw is a composite of lines selected after four generations from progeny of 200 accessions collected in the Flint Hills east central Kansas grassland south of Manhattan, Kansas. It is a late maturing, tall, uniformly leafy variety that is somewhat resistant to rust. It was released in 1950 by the Kansas Agricultural Experiment Station at Manhattan, Kansas.



Niagara Big Bluestem

The original accession was selected from an evaluation nursery that compared it to other big bluestem varieties at the Big Flats Plant Materials Center in Big Flats, New York. The flag leaf of Niagara is slightly wider than other varieties. Niagara regrowth is more rapid in late summer and early fall. Niagara was developed in 1985 by USDA-Natural Resources Conservation Service (NRCS) Big Flats Plant Materials Center (PMC), in cooperation with the USDA Agriculture Research Service (ARS), and the Pennsylvania Agricultural Experiment Station.



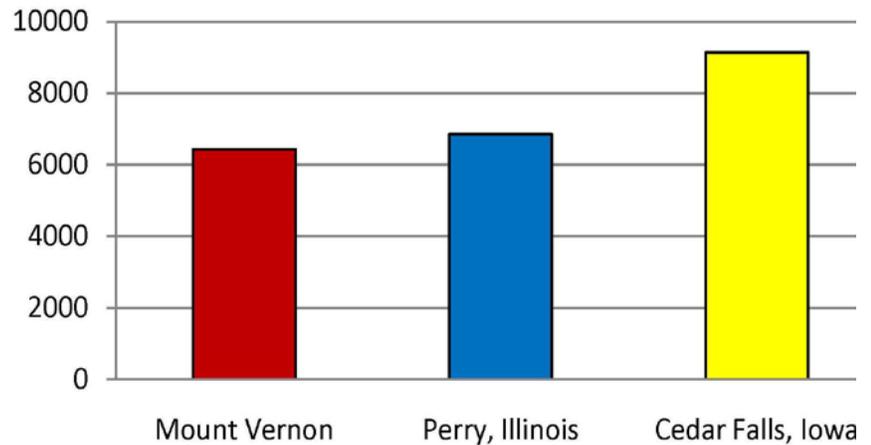
Variety/Collection Source



Pawnee Big Bluestem

The original plant material was collected from native prairie in Pawnee County in southeastern Nebraska. Several generations of selections were based on culm height and inflorescence color. The amount of pubescence varies considerably on the seed heads. Pawnee produces good forage yields. Pawnee was released by the USDA-ARS and the Nebraska Agriculture Experiment Station.

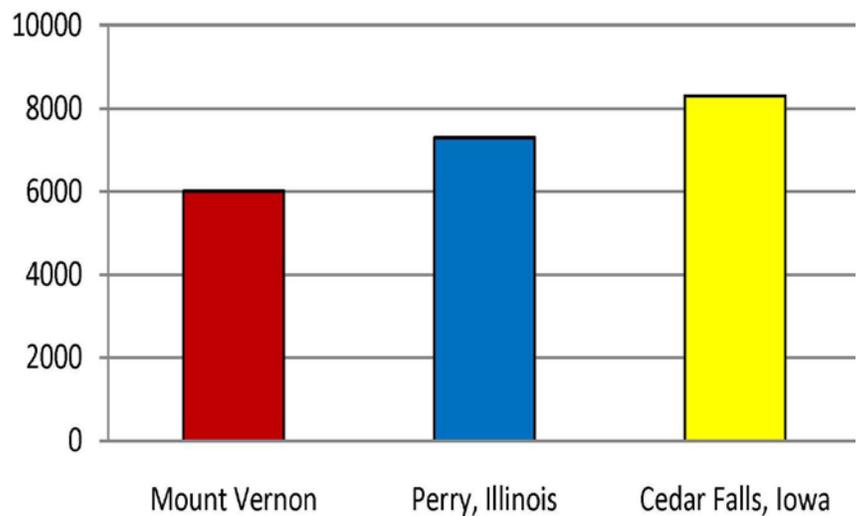
Pawnee



PI483446 Big Bluestem

PI 483446 (also tested under T0437) was evaluated against Kaw, Rountree, and Pawnee in a replicated trial at Manhattan and Mound Valley in Kansas, and at Haskell, Oklahoma. PI 483446 was not superior to any of the cultivars. No release of PI-483446 was made.

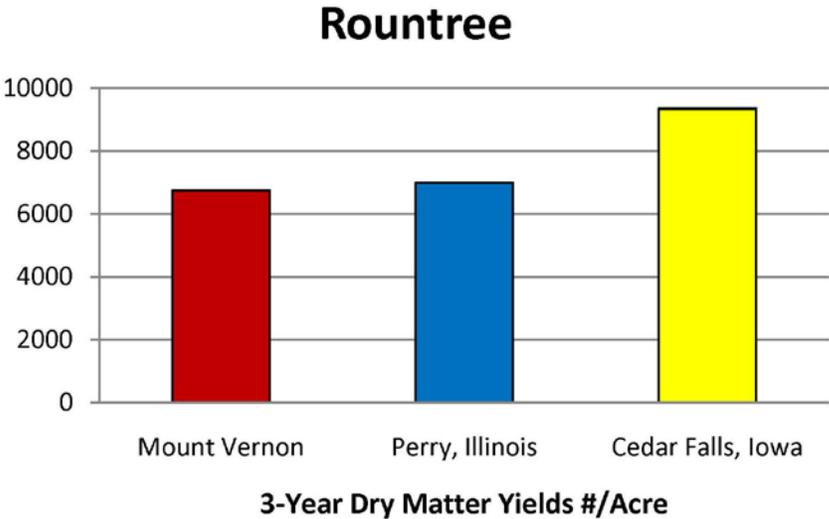
PI 483446



Variety/Collection Source 

Rountree Big Bluestem

Rountree originated from a native stand near the town of Morehead, Monona County in west central Iowa. It was selected for increased seedling vigor, increased leaf rust resistance, superior forage and seed production, and increased resistance to lodging. It was developed by the USDA-NRCS PMC at Elsberry, Missouri, in cooperation with the Missouri Agricultural Experiment Station.



Summary of Results			
Big Bluestem	Mount Vernon Missouri South Location	Perry Illinois Central Location	Cedar Falls Iowa North Location
Varieties Biomass Yields Range 5-6 tons/acre	None	None	None
Varieties Biomass Yields Range 4-5 tons/acre	None	None	Rountree Pawnee Champ PI483446
Varieties Biomass Yields Range 3-4 tons/acre	Kaw Rountree Pawnee PI483446	Champ PI483446 Rountree Pawnee Kaw	Kaw Niagara Bonilla

Summary of results for each site location

University of Missouri, Southwest Research Center, Mount Vernon, Missouri

Kaw and Rountree each produced an average yield of 6,800 pounds per acre. All varieties were in the 90% range in percent stand the third year after planting except for Niagara at 82% and Bison at 65%. Rountree at 5.6 ft. and Kaw at 5.4 ft. (based on an average forage height) were the tallest varieties. Kaw was also the latest for first seedhead emergence; average date was August 12th.

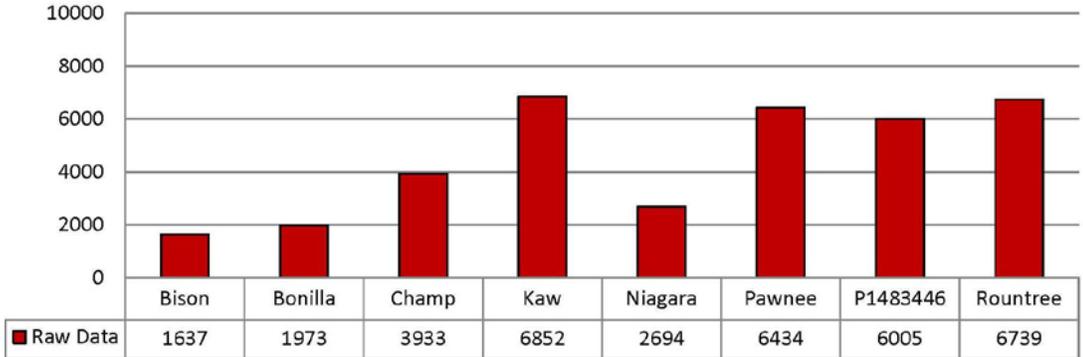
University of Illinois, Orr Research Center, Perry, Illinois

Champ produced an average yield of 7,500 pounds per acre. All varieties were in the 85% range in percent stand the third year after planting, except Bison at 78% and Niagara at 76%. PI483446 was tallest at 4.8 ft. followed by Rountree at 4.3 ft. and Champ at 4.1 ft. based on average forage height. PI483446 was also the latest for first seedhead emergence; average date was August 14th.

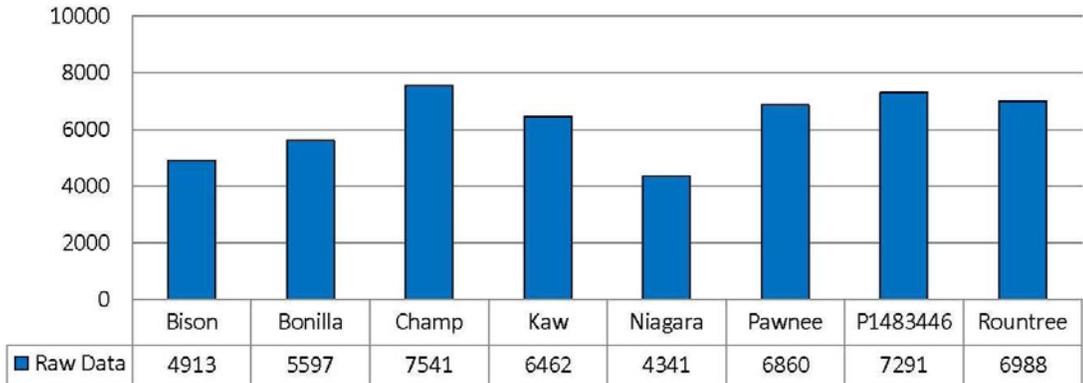
University of Northern Iowa, Tallgrass Prairie Center, Cedar Falls, Iowa

Rountree produced an average yield of 9,300 pounds per acre followed by Pawnee with a yield of 9,100 pounds per acre and Champ yield at 8,400 pounds per acre. All varieties were in the 90% range in percent stand by the third year after planting except for Bonilla at 82% and Champ at 80%. Rountree was tallest at 4.4 ft. PI483446 was also the latest for first seedhead emergence; average date was August 23rd.

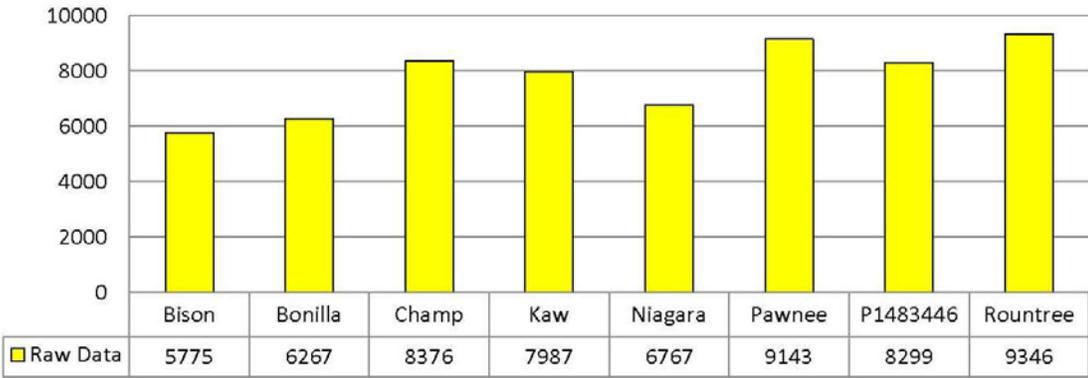
Mt. Vernon, Missouri
3-Year Dry Matter Yields #/Acre



Perry, Illinois
3-Year Dry Matter Yields #/Acre



Cedar Falls, Iowa
3-Year Dry Matter Yields #/Acre



Results and Discussion

Dry matter yields at all locations were dependent on seasonal precipitation patterns. Seed origin was also critical in overall performance. Previous studies at the Bismarck PMC have showed that, in general, warm-season grass species can be moved about 300 miles north or 200 miles south of their original collection location and still remain productive. Eastward and westward movement is affected by moisture and elevation (USDA, NRCS Northland News 2004/2005).

Rountree, Pawnee and Champ were the best varieties in yield at the north location near Cedar Falls, Iowa and central location at Perry, Illinois. On average, the yields were better at the north (Cedar Falls, Iowa) location than at the central location (Perry, Illinois) and the south location (Mount Vernon, Missouri).

Rountree, Pawnee, and Kaw performed the best at the south location. Varieties of northern origin, when moved too far south, mature early and become susceptible to foliar diseases due to higher precipitation and the humid climate. This is evident in the south location; the variety of Bison, from central North Dakota, produced an average first seed head emergence on June 27 with an average forage height of 3.1 feet compared to Kaw, from east central Kansas, which produced an average first seed head emergence on August 12 with an average forage height of 5.4 feet. This is again evident at the north location the variety Bison, from central North Dakota, had an average first seed head emergence on July 13 and an average forage height of 3.6 feet compared to Rountree, from western Iowa, with first seed head August 17 and an average height of 4.4 feet.

Southern origin varieties, when moved too far north, may experience a reduction in or no seed production or winter kill; however, this was not evident in the varieties tested at the Cedar Falls, Iowa, location.

At the north location (Cedar Falls, Iowa) all varieties were 80% stand after the second growing season.

At the central location (Perry, Illinois) all varieties were 85% stand after the second growing season, except for Bison 78% (North Dakota) and Niagara 76% (New York).

At the south location (Mount Vernon, Missouri) all varieties were 75% stand after the second growing season, except for Bison 27% (North Dakota) and Niagara 45% (New York).

PI483446 is an experimental composite that was in advanced evaluation at the Manhattan, Kansas, Plant materials Center but was determined to be too similar to Kaw to justify a release at this time.

Source of Varieties

Big Bluestem  (USDA NRCS).1994 Grass Varieties in United States Agriculture Handbook
170)

Bison

Original plants were collected from a native stand near Price, Oliver County, in North Dakota.

Bonilla

Bulk of seed collected from native stands at two sites near Bonilla, Beadle County, in South Dakota.

Champ

Domestic collections in Nebraska by L.C. Newell, D.E. Atkinson, and R.D. Staten. Iowa introductions supplied by NRCS.

Kaw

Composite of lines selected after four or more generations from progeny of 200 accessions collected in 1935 in the native Flint Hills grasslands south of Manhattan, Kansas.

Niagara

Seed collected in 1957 by Harry Porter from a native stand of big bluestem along Buffalo Creek, Elma Township, Erie County, New York

Pawnee

Collected in 1938 from Pawnee County, Nebraska – L.C. Newell and D.E. Atkinson.

PI 483446

A selection from a big bluestem assembly consisting of 123 accessions with seed origins from Kansas., Missouri, Arkansas, Oklahoma, and Texas. It is a polycross of four sources from the assembly. The four sources are from Hughes County, Oklahoma; Nowata County, Oklahoma, and Sumner County, Kansas. This selection has not been released.

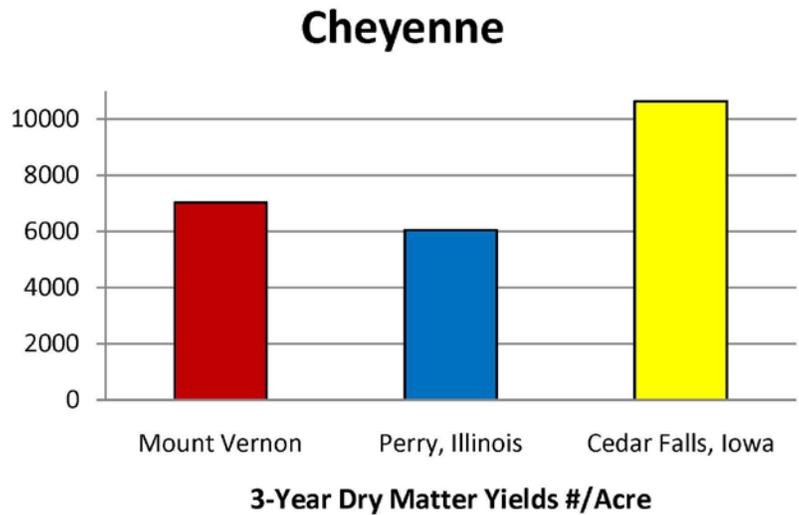
Rountree

Collected from a native stand near Morehead, Monona County, in Iowa, then evaluated, selected, and increased at the NRCS Elsberry Plant Materials Center, Elsberry, Missouri.

Variety/Collection Source

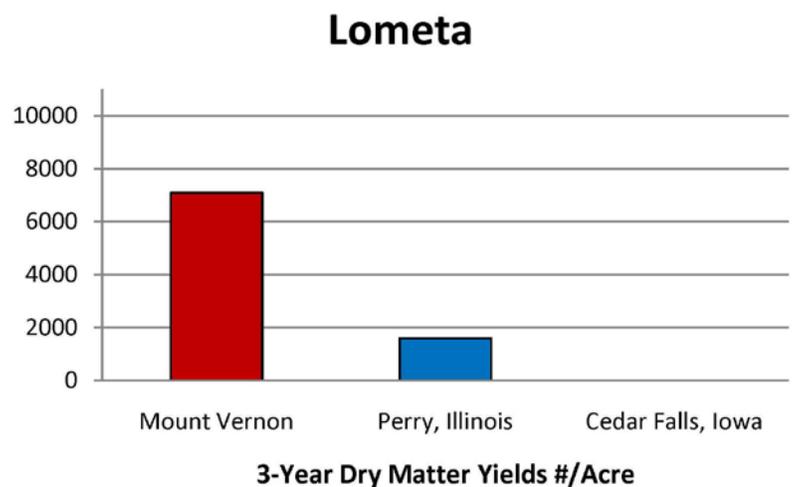
Cheyenne Indiangrass

Cheyenne originated from seed collected in 1942 in the rangeland of Western Oklahoma near Supply, Oklahoma. It was increased from this bulk collection at Cheyenne, Oklahoma. It is adapted for range and pasture for forage in Western Oklahoma and Texas. This variety was informally released by United States Department Agriculture (USDA) Soil Conservation Service (SCS) in 1945.



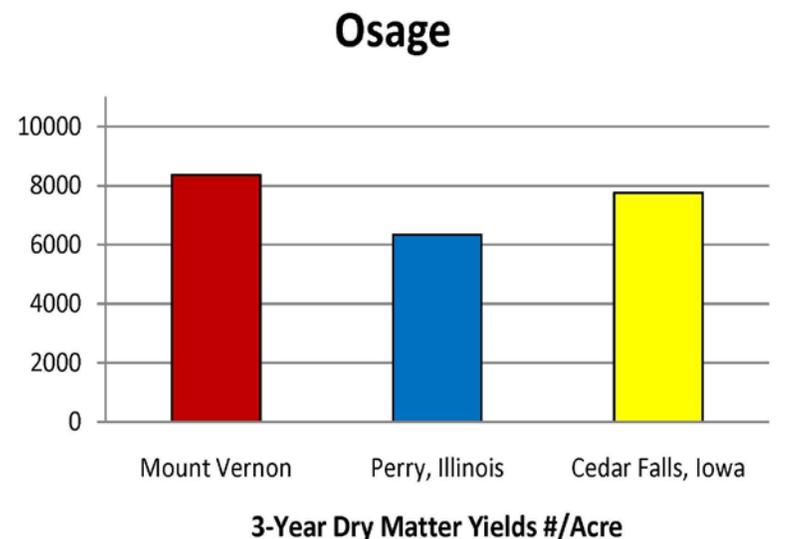
Lometa Indiangrass

Lometa originated from seed collected in 1964 near Lometa Texas. It was selected from 28 similar accessions for better forage production in central and south Texas. Released in 1981 by USDA-SCS Plant Materials Center in Knox City TX.



Osage Indiangrass

Osage originated from seed collected in eastern and central Kansas and Oklahoma. Recurrent selection for leafiness, vigor, free from rust, and earliness of maturity in Kansas was used as the method of development. It was released in 1966, cooperatively by Kansas Agricultural Experiment Station; Plant Sciences Division, Soil Conservation Service; and Plant Science Research Division, Agricultural Research Service.

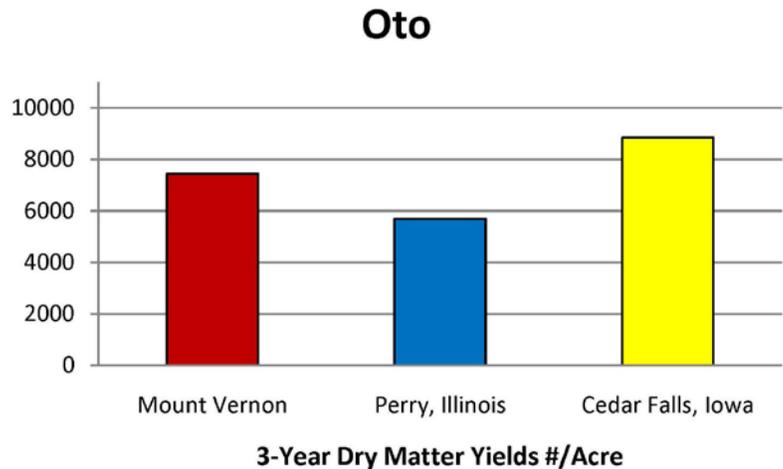


Variety/Collection Source



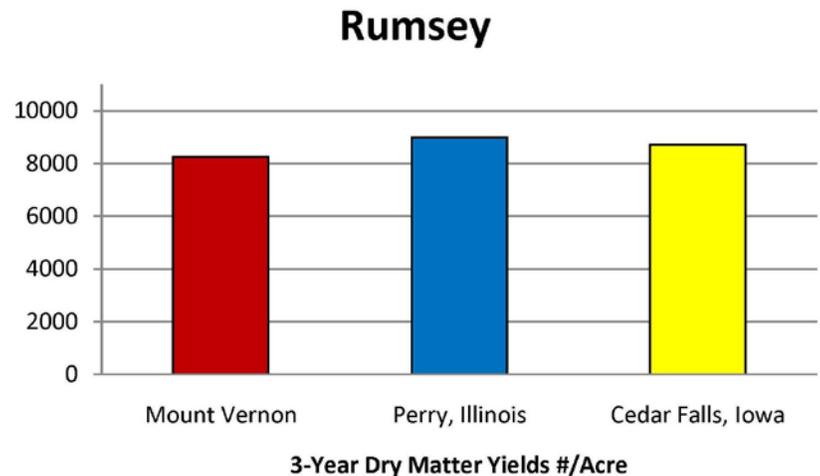
Oto Indiangrass

Oto originated from collections from natural grasslands of Nebraska and Kansas in 1953-1954. Fifteen collections (accessions) exhibited bright green leaves, brown panicles and late maturity. One group of 100 clones was isolated and progeny bred true for brown glumed seed. It was developed at the Nebraska Agricultural Experiment Station, Lincoln, and cooperatively released with USDA-Agriculture Research Service (ARS) in 1970.



Rumsey Indiangrass

Rumsey originated from a collection from a native stand in southern Illinois (Jefferson County). Rumsey is described as having increased seedling growth rate, superior forage production, and increased resistance to lodging. It flowers late in the growing season. Rumsey was tested, selected and released in 1983 by the USDA (SCS) now NRCS Elsberry Plant Materials Center at Elsberry Missouri in cooperation with the Missouri Agricultural Experiment Station.



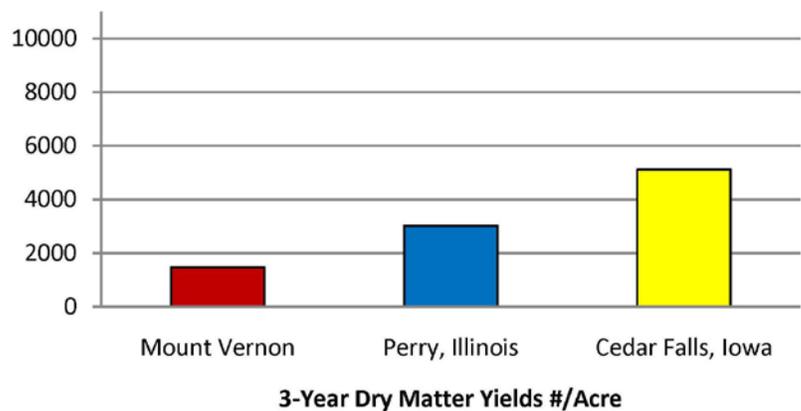
Variety/Collection Source



Tomahawk Indiangrass

Tomahawk originated from a composite of three seed collections made in 1961 from native stands near Ludden, North Dakota (Dickey County); Britton, South Dakota (Marshall County); and Hecla, South Dakota (Brown County). These were selected from a comparison trial at the USDA Bismarck Plant Materials Center for high seed yield and winter survival. At northern latitudes, forage production is similar to the variety Holt. Seed matures approximately 30 days earlier than Holt, 70 days earlier than Oto, and 80 days earlier than Osage and Rumsey. It was released cooperatively in 1988 by the USDA-NRCS Plant Materials Center, Bismarck, North Dakota; USDA-ARS Northern Great Plains Research Laboratory, Mandan, North Dakota; and the North Dakota, South Dakota, and Minnesota Agricultural Experiment Stations.

Tomahawk



Summary of Results			
Indiangrass	Mount Vernon Missouri South Location	Perry Illinois Central Location	Cedar Falls Iowa North Location
Varieties Biomass Yields Range 5-6 tons/acre	None	None	Cheyenne
Varieties Biomass Yields Range 4-5 tons/acre	Osage Rumsey	Rumsey	Oto Rumsey
Varieties Biomass Yields Range 3-4 tons/acre	Oto Lometa Cheyenne	Osage Cheyenne	Osage

Summary of varieties results for each site location.

University of Missouri, Southwest Research Center, Mount Vernon, Missouri

Osage and Rumsey each produced an average yield of 8,300 pounds per acre. Three varieties were in the 90% stand the second year after planting; Osage, Rumsey, and Cheyenne. Rumsey was the tallest at 5.0 ft. based on the average forage height. Lometa was latest for seed head emergence; average date was September 28th.

University of Illinois, Orr Research Center, Perry, Illinois

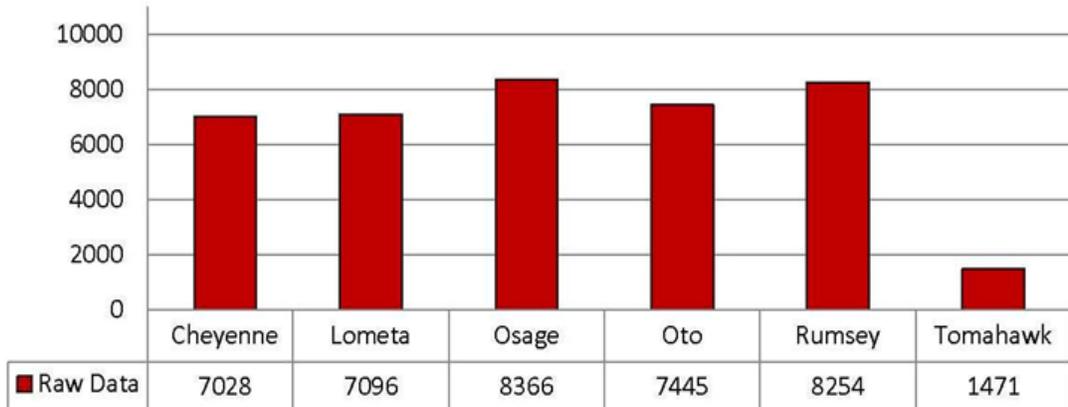
Rumsey produced an average yield of 9,000 pounds per acre which was one-third more than the next highest variety. All varieties were in the 90% range in percent stand the second year after planting, except for Lometa (80%) and Tomahawk (48%). Rumsey was the tallest at 5.3 ft. based on the average forage height. Rumsey and Cheyenne were latest for seed head emergence; average date was August 22nd.

University of Northern Iowa, Tallgrass Prairie Center, Cedar Falls, Iowa

Cheyenne produced an average yield of 10,600 pounds per acre followed by Oto and Rumsey at 8,850 pounds per acre and 8,700 pounds per acre, respectively. Percent stand after the second growing season Oto had 65%; all other varieties had less percent cover with the least being Tomahawk with 18%. Rumsey and Cheyenne were the tallest at 4.0 ft. based on average forage height. Rumsey and Cheyenne were the latest for seed head emergence; first date was September 7th) Lometa, a central Texas variety, did not establish at this site.

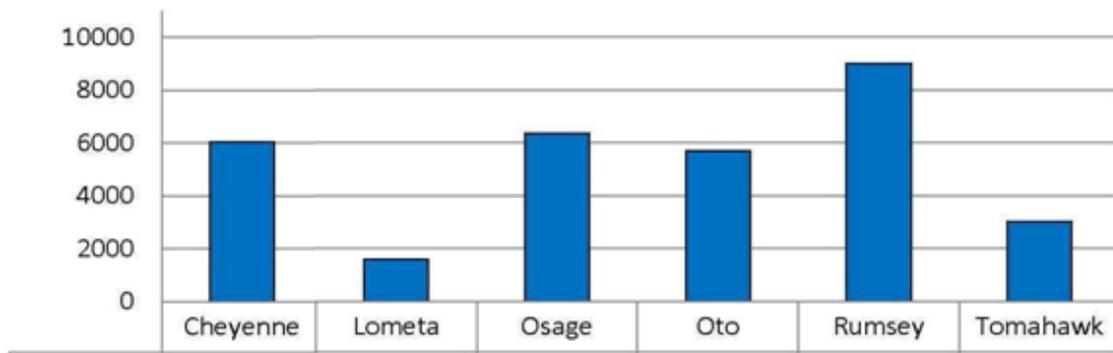
Mount Vernon, Missouri

3-Year Dry Matter Yields #/Acre



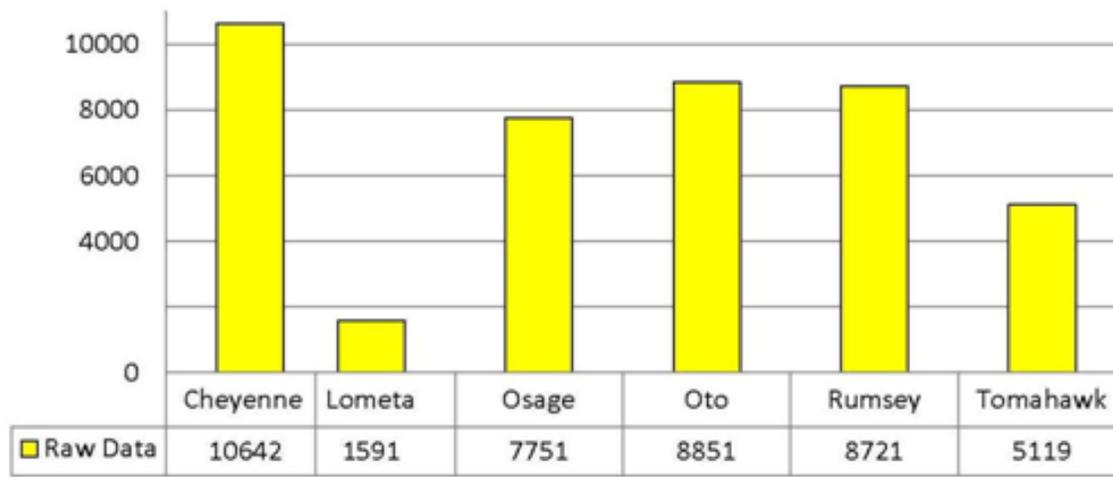
Perry, Illinois

3-Year Dry Matter Yields #/Acre



Cedar Falls, Iowa

3-Year Dry Matter Yields #/Acre



Results and Discussion

Dry matter yields at all locations were dependent on seasonal precipitation patterns. Seed origin is also critical in overall performance. Previous studies at the Bismarck Plant Materials Center have shown that generally, warm-season grass species can be moved about 300 miles north or 200 miles south of their original collection location and still remain productive.. East and west movement is affected by moisture and elevation (USDA, NRCS Northland News 2004/2005).

See summary chart on previous page, the yields were best at the north location, Cedar Falls, Iowa, than they were at the central location at Perry, Illinois, and the south location, Mount Vernon, Missouri. At the north location Cheyenne was the best variety for yield. Rumsey was the best variety for yield at the central and south location. Rumsey and Osage were the best varieties at the south location.

Varieties of northern origin, when moved too far south mature early and become susceptible to foliar diseases due to higher precipitation and humid climate. This was evident in the seed head emergence and forage height at the south location in Mount Vernon, Missouri. The variety Tomahawk (North Dakota and South Dakota) produced an average first seed head emergence on June 25 with an average forage height of 2.9 ft.; however, Rumsey (Southern Illinois) and Osage (Eastern Oklahoma and Kansas) produced an average first seed head emergence on August 23 and 21, respectively, with an average forage height of 5.0 ft. and 4.5 ft., respectively. This was again evident in the seed head emergence and forage height at the north location in Cedar Falls, Iowa. The variety, Tomahawk from North Dakota and South Dakota, produced an average first seed head emergence on July 23 at this location and an average forage height of 2.6 ft. Cheyenne (western Oklahoma) compared with a first seed head September 7 and an average height of 4.0 ft.

Southern origin varieties, when moved too far north may experience a reduction in developing a stand or no seed production or winter kill; this was evident in the Lometa variety from central Texas at the north location in Cedar Falls, Iowa.

At the north location (Cedar Falls, Iowa) the variety Oto had 65 percent stand after the second growing season; all other varieties had less percent cover with the least being Tomahawk with 18%.

At the central location (Perry, Illinois) all varieties were in the 90% range in percent stand the second year after planting, except for Lometa (80%) and Tomahawk (48%). Rumsey was the tallest at 5.3 feet forage height.

At the south location (Mount Vernon, Missouri) all varieties were 85% percent stand after the second growing season, except for Tomahawk (North Dakota and South Dakota) 67% and Lometa (Central Texas) 55%.

Source of Varieties

Indiangrass (USDA NRCS.1994 Grass Varieties in US Ag Handbook 170)

Cheyenne

Native Rangeland near Supply, Oklahoma, 1942.

Lometa

Original seed collected in 1964 near Lometa, Texas, by Harry Schofield, an NRCS employee.

Osage

Seed collected from eastern and central Kansas and Oklahoma in 1953.

Oto

Collections from natural grasslands of Nebraska and Kansas in 1953-54.

Rumsey

Collected from a native stand in Jefferson County, Illinois; evaluated, selected, and increased at the Plant Materials Center, NRCS, Elsberry, Missouri.

Tomahawk

Composite of three seed collections from native stands near Ludden, Dickey County, North Dakota; and Britton, Marshall County, and Hecla, Brown County, South Dakota.

Key Establishment and Management Considerations

BIG BLUESTEM and INDIANGRASS

Soils/Adaptation: Plant performance is best on moderate to fine texture deep well drained soils, but are adapted to wide range of soils.

Seeding: Big bluestem and indiangrass have light fluffy elongated seed with 144,240 seeds per pound for big bluestem and 174,720 seeds per pound for indiangrass (USDA plants database). Seeding rates range from 5 to 10 pounds pure live seed (PLS) per acre.

Weed Control: Abundant broadleaf weeds and annual grasses need to be controlled by mowing and/or herbicide application. Dense stands of foxtail (*Setaria* species) and crabgrass (*Digitaria* species) can be very competitive and significantly reduce stand establishment.

Grazing/Haying: Palatability and digestibility of big bluestem and indiangrass are good for beef livestock when harvested at a height of 16 inches. Allow for 8 inches of stubble in early summer and 12 inches in late summer for regrowth. (USDA, NRCS 2006b). For big bluestem and indiangrass, cut during the boot stage to obtain maximum quantity and quality for hay.

Fertilization: Fertilizer applied during the seeding year does not increase stand density but will increase seedling vigor and encourage weed competition. To limit weed growth, apply nitrogen mid-July, with no more than 30 pounds of nitrogen (N) per acre in the seeding year. Annual fertilizer applications of 60 pounds N, 30 pounds phosphate and 30 pounds potash per acre are adequate for maximum yield. (USDA NRCS 2003. Five Keys Grass Seeding, Bismarck, North Dakota).

Burning: Burning of plant residues is beneficial, prior to initiation of spring growth. Burning provides more uniform growth initiation, improved nutrient cycling, and more vigorous growth.

References

News 2004/2005, USDA, NRCS Plant Materials Center, Bismarck, North Dakota. p. 13-14.

USDA, NRCS Elsberry Plant Materials Center. 1994-1998 Technical report.

USDA, NRCS. 2003. Five keys to successful grass seeding. Plant Materials Center, Bismarck, North Dakota. 6 p.

USDA, NRCS. 2006b. *The PLANTS Database*, National Plant Data Center, Baton Rouge, Louisiana 70874-4490 Available at: <http://plants.usda.gov>. Accessed 18 December 2006.

USDA, SCS. 1994. Grass varieties in the United States. Agriculture Handbook No. 170 Washington, D.C. p. 194-199.