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Natural Resources Conservation Service

Plant Materials Center

July 2009

Indiangrass

(*Sorghastrum nutans*)

Biomass Trials

North Dakota, South Dakota, and Minnesota

Who We Are

Plants are an important tool for conservation. The Bismarck Plant Materials Center (PMC) is part of the United States Department of Agriculture, Natural Resouces Conservation Service (USDA, NRCS). It is one of a network of 27 centers nationwide dedicated to providing vegetative solutions to conservation problems. The Plant Materials program has been providing conservation plant materials and technology since 1934.

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In this photo: Indiangrass seed that has been debearded. It is smooth and flows easily through a grass drill.

Indiangrass

(*Sorghastrum nutans*)

Biomass Trials

North Dakota, South Dakota, and Minnesota

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Indiangrass [*Sorghastrum nutans* (L.) Nash] is a tall, tufted, warm-season perennial grass with short, stout, scaly rhizomes. It has also been described as a bunchgrass. It grows to an average height of 3 to 5 feet. Inflorescence is a contracted panicle that is golden to reddish tan and softly hairy. The species occurs naturally from Canada to Mexico through the eastern and central United States (USDA NRCS 2004). It is codominant with big bluestem and switchgrass in tall grass prairies. It grows on a wide range of habitats, from prairies to woodlands, savannahs, and scrubland vegetation. In the drier area of its natural range, it prefers fertile bottomlands or lowlands where moisture is more available. It can grow in a wide array of soils ranging from sandy loam to clay loam. It is used for forage, erosion control and restoration.

Dry matter biomass yields and other plant performance documentation were compiled for Indiangrass and six other warm-season grass species from 1982 to 1992 at six sites in North Dakota, South Dakota, and Minnesota (Jacobson et al 1986). The effect of seed origin (parentage) on plant performance was apparent. Five varieties of Indiangrass were evaluated with origin varying from North Dakota to Oklahoma and Illinois. Winter injury was a problem for the more southern varieties when grown at the more northern locations. When winter injury was not an issue, the more southern seed sources generally had higher biomass production although stand longevity may have been impacted. Plant density (stand index) was related to winter injury and biomass yield. Northern

Figure 1. Locations of warm-season grass trials in North Dakota, South Dakota, and Minnesota

seed sources moved more than 200 miles southward from their origin generally did not perform well, and biomass was significantly less than local or more southern origin sources. Northern varieties required fewer days for seed maturity compared to the more southern origin seed sources.

Trial Sites

The trial sites were studied in cooperation with numerous partners (see acknowledgements inside front cover). They were located near Upham, North Dakota; Fergus Falls, Minnesota; Rochester, Minnesota; Lake Andes, South Dakota; Onida, South Dakota; and Fort Pierre, South Dakota (Fig. 1). Soils and precipitation information are included with the tables (pages 6-11). Growing seasons at the six locations varied from an average of 110 days at Upham, North Dakota, to an average of 150 days at Rochester, Minnesota. Average annual precipitation ranged from 15 to 30 inches. Seven to nine different species of warm-season grasses were evaluated at each site. Each species included two or more varieties or seed sources. Indiangrass is the only species presented in this report.

Methods and Materials

The experimental design was a randomized complete block with three replications for data collection. An evaluation array was seeded for demonstration purposes. Plot size varied from 12 to 15 feet in width, and from 60 to 100 feet in length. A clean, firm seedbed was prepared by disking, harrowing, and roller packing. The plots were seeded using a grass seed drill. Herbicides were used for weed control. Biomass residue was removed each spring either by mowing and raking, or burning. No fertilizer was applied.

All plots were planted into a clean, firm seedbed

Data collection at all six locations included stand ratings, plant height, weed contamination, stand index density, phenology, and annual biomass production. Only biomass production, stand density, and phenology are presented and discussed in this report.

Stand index density was determined by estimating the number of plants in a 9-inch by 16-inch quadrat. Ten quadrats were systematically counted near the center line of each plot. A density index rating was developed. Values ranging from 0 to 40 plants per square foot were used to estimate density for each subsample.

Dry matter yield was documented at all sites beginning the second year following establishment. Biomass production was determined by clipping a 2-foot by 10-foot subplot in each plot with a forage harvester. Sampling dates were as close as possible to the end of the growing season (first killing frost). The sample plots were systematically located within each plot across the treatment and clipped to a stubble height of approximately 2 inches. After weighing the large samples, small (100 gram) grab-samples were weighed, oven-dried at 60 degrees C for 48 hours, and used for dry matter determinations. Biomass production is reported in pounds per acre.

Estimating plant density in 10 quadrats/plot to determine stand index

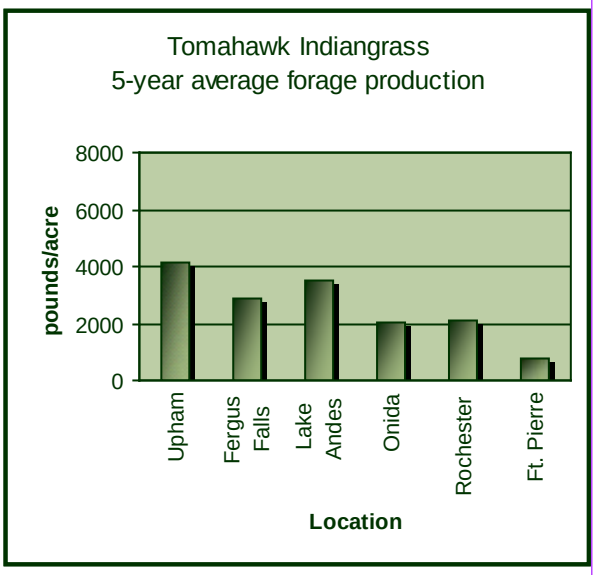
The drill was carefully cleaned between seeding plots to avoid contamination

Harvesting 10-foot by 2-foot strips to determine biomass yield

Variety/Seed Source Origins (USDA SCS 1994)

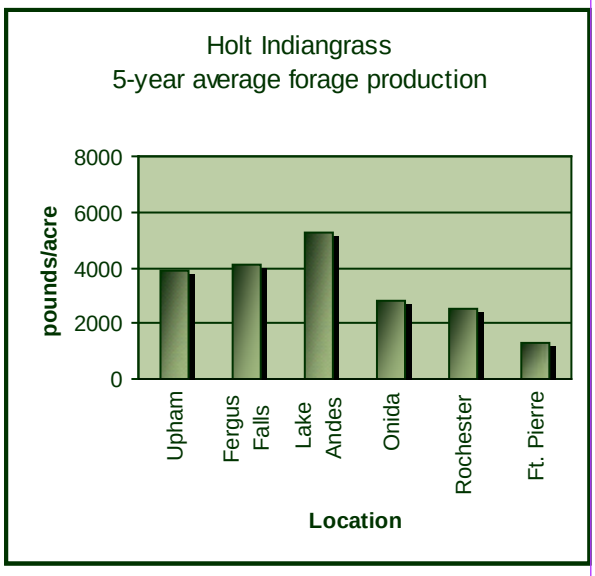
Tomahawk

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 Bismarck PMC 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. Chromosome number is 2n=40. 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.



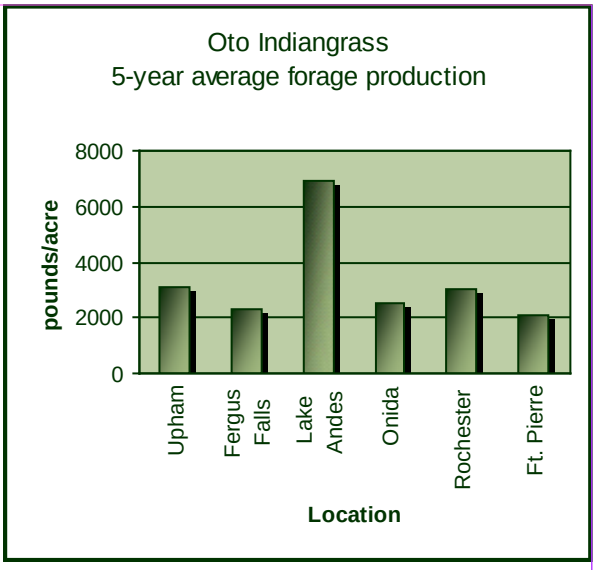
Holt

Holt is moderately early maturing; and superior in leafiness and yield to early maturing strains from the northern and western sandhill region of Nebraska. It originated from collections from native prairie ecotypes of the sandhills and adjacent areas in the Elkhorn Valley of Holt County in northeastern Nebraska. It is typical of Indiangrass ecotypes of north central and northeastern Nebraska. It was grown at Lincoln, Nebraska, since 1942 and cooperatively released in 1960 by the Nebraska Agricultural Experiment Station, and the USDA-ARS, University of Nebraska, Lincoln.



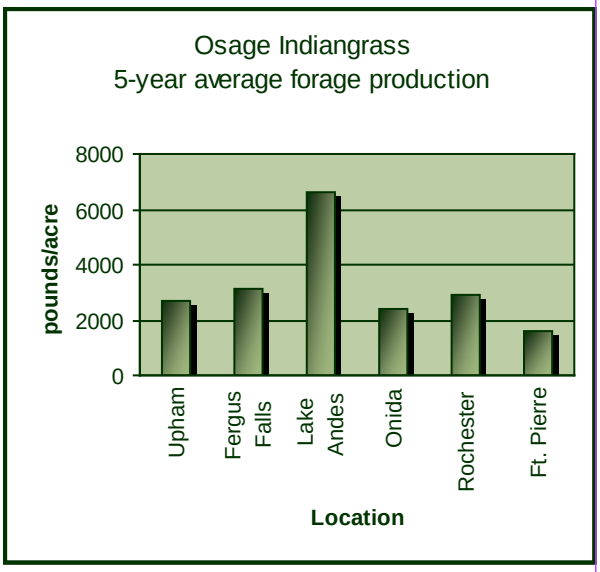
Oto

Oto matures late in the season with seed harvest at early frost in southern Nebraska. It originated from collections from natural grasslands of Nebraska and Kansas in 1953-1954. Fifteen accessions (collections) 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-ARS in 1970.



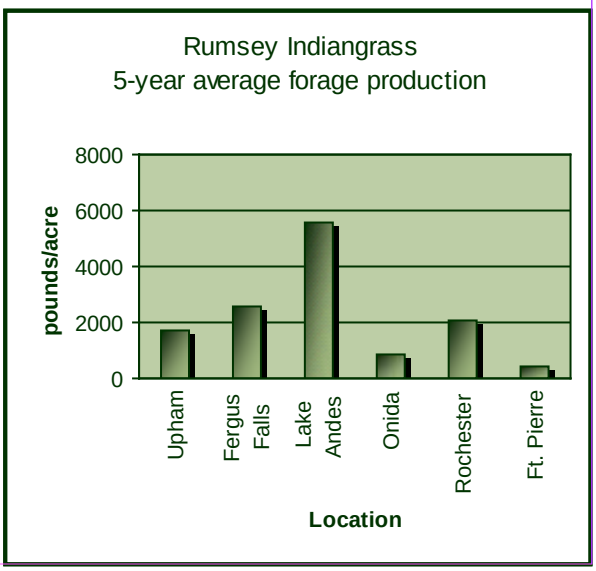
Osage

Osage originated from seed collected in 1953 from eastern and central Kansas and Oklahoma. Recurrent selection for leafiness, vigor, freedom 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.



Rumsey

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



Upham, North Dakota

Average annual precipitation for the 5 years of biomass harvest was near normal. Tomahawk and Holt, the two northernmost varieties, had the highest biomass yields in 1983, 1984, and 1985, and had the highest 5-year averages of 4,156 lbs/ac, and 3,869 lbs/ac, respectively. Tomahawk and Holt also had the highest average stand index ratings, 17 and 16 respectively. Oto, Osage, and Rumsey showed signs of moderate to severe winter injury the second growing season. Varieties with winter injury tended to rebound due to reduced plant populations. Plants were larger and more vigorous in years three through five. There is anticipation, however, that additional harvesting or grazing of these varieties would further reduce stands. Rumsey had the most winter injury, and was rated lowest for biomass and stand index. Phenology ratings were taken in early August, and at that time, Tomahawk already had first seed ripening, compared to Holt which was just starting to flower. Oto, Osage and Rumsey were at the vegetative growth stage. The first killing frost on this site is often as early as late August.

Upham, North Dakota (MLRA 55A, north central North Dakota)
Average Annual Precipitation: 16.08 inches
Soils: Great Bend silty clay loam

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1983	1984	1985	1986	1987	Avg	Rank	1982-1984*	Early Aug.
Precip. deviation	(0.98)	(0.9)	(1.63)	(-0.09)	(-1.23)				
Tomahawk	4918a	2419ab	4410a	5729a	3304a	4156	1	17	6
Holt	4330a	3190a	4219a	4937a	2668a	3869	2	16	4
Oto	1695b	1750b	3178ab	4980a	3866a	3094	3	11	1
Osage	716b	1736b	3610a	3493ab	3725a	2656	4	9	1
Rumsey	538b	588c	1989b	1747b	3852a	1743	5	8	1

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1984):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy
***** Data is an average from these years

Tomahawk continues to perform well 10 years after seeding

Severe winter injury on Osage Indiangrass

Fergus Falls, Minnesota

The soils on this site are a well drained loam complex formed in calcareous glacial till. Two years of well below normal precipitation in 1983 (-3.96) and 1987 (-7.2) reduced the 5-year average biomass yields. Holt had the best average biomass yield of more than 4,000 lbs/ac over the five year period. Stand index ratings were similar, with the most northern variety Tomahawk having the highest rating with 20. Rumsey had severe winter injury and had the lowest average stand index rating of 4. Tomahawk had ripe seed in early September compared to Holt which was at first anthesis, and Oto, Osage, and Rumsey which were still at the vegetative growth stage.

Fergus Falls, Minnesota (MLRA 102A, west central Minnesota)
Average Annual Precipitation: 23.52 inches
Soils: Barnes and Langhei loam

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1983	1984	1985	1986	1987	Avg	Rank	1983-1984*	Early Sept.
Precip. deviation	(-3.96)	(1.54)	(.85)	(6.23)	(-7.2)				
Tomahawk	4566ab	3852a	2234a	2917a	973a	2908	3	20	7
Holt	5428a	5791a	4562a	3111a	1743a	4127	1	14	4
Oto	4623ab	3041a	2079a	1028a	818a	2318	5	19	1
Osage	3834ab	5262a	3300a	1901a	1494a	3158	2	13	1
Rumsey	1993b	3570a	3844a	1822a	1712a	2588	4	4	1

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1983):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy
***** Data is an average from these years


The experimental design was a randomized complete block at all sites


Holt Indiangrass performed well at Fergus Falls and was ranked first in average biomass yield

Lake Andes, South Dakota

Three years of well above average rainfall influenced biomass production at this site. The soils are a fertile Agar silt loam. Above average precipitation amounts totaled 12.9 inches (1984), 10.7 inches (1986), and 3.71 (1987). This was the most southern of the test sites, and the more southern varieties performed best, except for Rumsey which again suffered severe winter injury. Rumsey had an initial stand index rating of 2. It bounced back in years three through five and had comparable biomass yields to the other three southern varieties. Stand index ratings were comparable for the other four varieties and ranged from 15 to 22. Oto had the highest 5-year average biomass yield of almost 7,000 lbs/ac. Tomahawk was ranked last in biomass yield with an average of 3,508 lbs/ac for 5 years. The abundant rainfall in 1986 resulted in biomass yields in the 9,000 to 10,000 lbs/ac range for all varieties except Tomahawk which was about half that amount. Tomahawk again had the earliest maturity and had mature seed in early September. Holt at this time was at 50 percent anthesis compared to Oto, Osage, and Rumsey which were still at the first emergence of inflorescence growth stage.

Lake Andes, South Dakota (MLRA 55C, southeast South Dakota)
Average Annual Precipitation: 21.37 inches
Soils: Agar silt loam

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1984	1985	1986	1987	1988	Avg	Rank	1984	Early Sept.
Precip. deviation	(12.9)	(-.21)	(10.7)	(3.71)	(1.0)				
Tomahawk	2890b	2413b	4824b	2825a	4587a	3508	5	16	8
Holt	3412b	4021ab	9860ab	4777a	4181a	5250	4	15	5
Oto	8098a	5828a	10223a	5479a	5063a	6938	1	20	3
Osage	7097a	6382a	9720ab	4857a	5013a	6614	2	22	3
Rumsey	3612b	3813ab	9077ab	5539a	5719a	5552	3	2	3

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1984):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy


Rumsey had severe winter injury such as this the first two years but biomass yield was good in years three through five


The more southern varieties performed better at Lake Andes

Onida, South Dakota

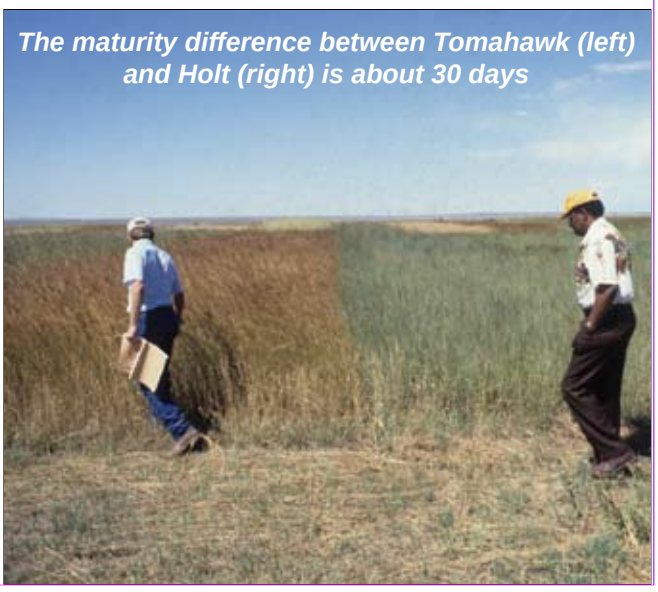
The soil at the site is a Lowry silt loam, which is fertile but droughty. Average annual precipitation was near normal for 3 years, considerably above normal in 1986 (5.27 inches), and below normal in 1988 (-4.07 inches). Holt, Oto, and Osage had similar and the best 5-year average biomass production. Yields ranged from 2,402 to 2,800 lbs/ac. Rumsey was last in biomass yield with 861 lbs/ac. It also had winter injury resulting in the lowest stand index rating of 8. The other four varieties had similar stand index ratings ranging from 19 to 26. Phenology was comparable to the other sites with Tomahawk having mature seed in early September, while Holt had first ripe seed, and Oto had inflorescences first emerging. Osage and Rumsey were still at the jointing growth stage.

Onida, South Dakota (MLRA 53C, central South Dakota)
Average Annual Precipitation: 17.47 inches
Soils: Lowry silt loam

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1985	1986	1987	1988	1989	Avg	Rank	1984-1985*	Early Sept.
Precip. deviation	(.13)	(5.27)	(-1.86)	(-4.07)	(.33)				
Tomahawk	365a	5127b	2991a	507a	1217a	2041	4	20	8
Holt	1014a	6183ab	4256a	1333a	1212a	2800	1	26	6
Oto	1353a	7439a	2753a	520a	457ab	2504	2	23	3
Osage	869a	6071ab	3644a	943a	483ab	2402	3	19	2
Rumsey	224a	1477c	1887a	521a	197b	861	5	8	2

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1986):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy
***** Data is an average from these years


The more southern varieties were taller


The maturity difference between Tomahawk (left) and Holt (right) is about 30 days

Rochester, Minnesota

The soils are a well drained, rolling silt loam. This site, with 29.58 inches, had the highest average annual precipitation of the six test sites. Precipitation was quite variable from year to year. It was below normal in 1987 (-2.63), 1988 (-8.19), and 1989 (-6.85). Precipitation was substantially above normal in 1990 (14.36), and 1991 (7.33). Biomass yield was significantly less than expected on this site for all entries. The droughty soils with low fertility may have been a factor. Oto, Osage, and Holt had the highest average five-year yields and ranged from 2,509 to 3,034 lbs/ac. Rumsey again had the lowest stand index rating of 4. Oto, Osage, and Holt also had the highest 5-year average stand index ratings ranging from 11 to 15. All five varieties were reported to have different phenology ratings in early September, ranging from first seed ripe for Tomahawk to jointing for Oto.

Rochester, Minnesota (MLRA 105, southeast Minnesota)
Average Annual Precipitation: 29.58 inches
Soils: Mount Carrol silt loam

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1987	1988	1989	1990	1991	Avg	Rank	1985-1987*	Early Sept.
Precip. deviation	(-2.63)	(-8.19)	(-6.85)	(14.36)	(7.33)				
Tomahawk	2814b	2514a	1764a	2388a	1184a	2133	4	7	6
Holt	5451ab	1595a	1777a	2454a	1266a	2509	3	13	5
Oto	9136a	1376a	1552a	2339a	769a	3034	1	15	2
Osage	8752a	1715a	1462a	1503a	1059a	2898	2	11	3
Rumsey	3461b	1715a	2914a	1171a	1151a	2082	5	4	4

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1988, 1989):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy
* Data is an average from these years

Holt had mature seed in October


Osage performed well given its southern origin

Fort Pierre, South Dakota

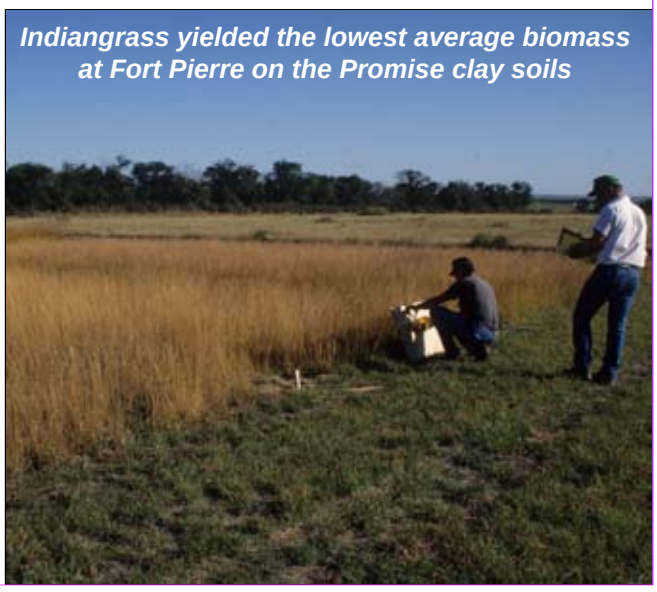
The soil at the site is Promise clay, which is fertile with low permeability. Infiltration is less than 0.2 inches per hour. Three consecutive years (1988, 1989, and 1990) of significantly lower than normal rainfall greatly reduced annual and the 5-year average biomass yields. Oto and Osage had the highest 5-year average biomass yields of 2,091 lbs/ac and 1,634 lbs/ac, respectively. Tomahawk and Rumsey were ranked last with each averaging less than 1,000 lbs/ac. Rumsey also showed signs of winter injury, and had the lowest stand index rating of 13. Holt, Oto, and Osage had the highest average stand index ratings ranging from 24 to 31. Phenology was comparable to the other sites with Tomahawk maturing first with 50 percent ripe seed in early September. Holt was the second most mature and was at 50 percent anthesis compared to the other three varieties which were still jointing.

Fort Pierre, South Dakota (MLRA 63A, central South Dakota)
Average Annual Precipitation: 18.08 inches
Soils: Promise clay

Variety	(pounds/acre) Biomass[1]							Stand Index[2]	Phenology[3]
	1988	1989	1990	1991	1992	Avg	Rank	1986-1987*	Early Sept.
Precip. deviation	(-7.3)	(-4.77)	(-5.74)	(.87)	(.79)				
Tomahawk	205b	81a	488b	1655a	1494b	785	4	17	7
Holt	594a	242a	515b	2069a	2991ab	1282	3	25	5
Oto	238b	214a	2081a	2780a	5142a	2091	1	31	2
Osage	256b	312a	888b	2050a	4662ab	1634	2	24	2
Rumsey	607a	376a	729b	549b	0	452	5	13	2

Statistical Analyses: Duncan's New Multiple Range Test, means with same letter are not significantly different (P=.05)
[1]**Biomass:** flail-type forage harvester, 2' x 10' strip in each plot clipped to a 2-inch stubble height
[2]**Stand Index:** Estimate of plant density in 10 (1.0 sq ft) quadrats per plot. Full frame=40
[3]**Phenology (1990):** 1=vegetative; 2=jointing; 3=first emergence of inflorescence; 4=first anthesis,10 culms or more; 5=50% anthesis; 6=first seed ripe; 7=50% seed ripe; 8=seed mature; 9=complete dormancy
* Data is an average from these years


The plots were burned each spring so only new growth was harvested as biomass


Indiangrass yielded the lowest average biomass at Fort Pierre on the Promise clay soils

Results and Discussion

Biomass yields of Indiangrass at all six locations were heavily dependent on seasonal precipitation patterns. Seed origin and soils differences also affected overall performance. Rumsey, originating from southern Illinois, suffered winter injury at all six locations. Tomahawk, the northernmost variety in the test (central North Dakota) performed best at Upham, the northernmost evaluation site. Previous studies at the Bismarck PMC have shown that generally warm-season grass species can be moved about 300 miles north or 200 miles south of their original collection location without serious impact on performance. East and west movement is affected by moisture and elevation (USDA NRCS 2006). Varieties with the highest biomass yield varied across the plot locations, but generally the more southern origin seed sources produced the most biomass, if winter injury was not a problem. Additional winter injury is anticipated when the southern origin varieties are grazed or hayed. Indiangrass that is locally adapted should be used for native or natural area plantings. Production of viable offspring (seed) and winter survival are important components of local adaptation. Winter survival is associated with the plants ability to "harden off" and have enough regrowth to capture and store the necessary carbohydrates.

Flowering dates varied depending on the origin of the variety

Stand index densities were rated at all six sites. Generally, the varieties with the highest biomass yields also had the highest stand index ratings. The exception was Rumsey. Following winter die-back, the remaining plants of Rumsey responded with higher biomass because of the decrease in plant competition. Winter injury was less noticeable the second year with older plants. Osage and Oto also received winter injury at the northernmost evaluation site at Upham.

Phenology was similar across sites even though annual rainfall varied greatly. Tomahawk had mature seed in early August at Upham, and in early September at the remaining five sites. Holt was the next variety to mature at all the sites and varied from first anthesis to first seed ripe when Tomahawk had mature seed. Oto, Osage, and Rumsey were similar at all the sites during the evaluation period and varied from the vegetative growth stage to the first emergence of inflorescence growth stage. None of these three varieties produced mature seed at any of the six test sites.

Variety Recommendations for North Dakota, South Dakota, and Minnesota

Variety	Origin	Average Number of Days to Ripe Seed after July 15	Where Adapted
Tomahawk	south central North Dakota, north central South Dakota	60	ND, SD, MN
Holt	northeastern Nebraska	90	SD; south half of MN; southeast and south central ND
Oto	Nebraska, Kansas	110	south half of SD; south quarter of MN; not recommended in ND
Osage	eastern and central Kansas and Oklahoma	120	not recommended in ND, SD, MN
Rumsey	southern Illinois	120	not recommended in ND, SD, MN

Indiangrass seed with awns

Indiangrass seed with awns removed (debearded)

Key Establishment and Management Considerations

- **Soils/Adaptation:** Plant performance is best on moist, well drained, moderate to fine textured deep soils in areas of greater than 14 inches of average annual precipitation. Indiangrass will decline from stands during periods of drought on dry sites.

- **Seeding:** Indiangrass seed is similar to big bluestem seed in appearance and has approximately 193,000 seeds per pound. The seed also has hairy appendages (awns). Using debearded seed (awns removed) greatly improves seed flow through a grass drill. The extent of debearding may vary among seed lots. If seed is not debearded it should be planted through the chaffy seed box found on most grass drills. The NRCS recommended drilled seeding rate for North Dakota is 7 lbs/ac (approximately 30 seeds/sq ft) in the east and 5.5 lbs/ac (approximately 25 seeds/sq ft) in the west (Sedivec et al 2001). Rates are calculated based on Pure Live Seed (PLS). Broadcast seeding rates are higher than the recommended drilled seeding rates, and are generally doubled. Seeding rates vary across the United States, generally increasing from west to east. Spring seeding is recommended. A firm seedbed is essential for a shallow seeding depth (½ – ¾ inch). Germination is greatly reduced when seeds are planted deeper than one inch (USDA NRCS 2003).

- **Weed Control:** Abundant broadleaf weeds and annual grasses need to be controlled by mowing and/or herbicide application. Dense stands of foxtail (*Setaria* species) can be very competitive and significantly reduce stand establishment. Herbicides generally are more effective than mowing in controlling annual grasses.

- **Fertilization:** Biomass yield, quality and seed production can be improved with fertilization if nitrogen or other nutrients are limiting. A soil test is recommended.

- **Grazing/Haying/Mowing:** Indiangrass is considered a high quality forage species for all classes of livestock. It will provide good grazing during the summer months. A stubble height of 6 inches is recommended to assure stand longevity. A rotational grazing system can extend immature plant growth through early fall, reduce trampling loss, enhance utilization, and increase nutritional quality and palatability. Indiangrass can make good hay; however, it typically is not recommended in pure stands for hayland in the Northern Plains. It may be mixed with big bluestem or other warm-season species (USDA NRCS 2008).

- **Burning:** Indiangrass benefits from burning of plant residue prior to initiation of spring growth. Advantages to burning include low impact residue removal, weed control, more uniform growth initiation and seed ripening, improved nutrient cycling, and more vigorous growth. Burning annually at the Bismarck PMC has increased long-term seed yields.

- **Seed Harvest:** Seed shattering may occur shortly after the first seed is ripe. Conventional grain harvesting equipment can be used with proper setting adjustments, screen sizes, and reduced air flow. The awns on the seed may cause problems with seed flowing through the combine. Seed strippers work well for harvesting Indiangrass seed. Seed is subject to heating, and moisture levels may require drying. Air drying is recommended as heat may cause damage to the seed. Fields should be as weed free as possible prior to harvest to aid in the seed cleaning process.

A prescribed burn is an important management tool

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