Autecology of Prairie Junegrass on the Northern Mixed Grass Prairie

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The autecology of Prairie Junegrass, *Koeleria macrantha*, is one of the prairie plant species included in a long ecological study conducted at the NDSU Dickinson Research Extension Center during 67 growing seasons from 1946 to 2012 that quantitatively describes the changes in growth and development during the annual growing season life history and the changes in abundance through time as affected by management treatments for the intended purpose of the development and establishment of scientific standards for proper management of native rangelands of the Northern Plains. The introduction to this study can be found in report DREC 16-1093 (Manske 2016).

Prairie Junegrass, *Koeleria macrantha* (Ledeb.) Schult, is a member of the grass family, Poaceae, tribe, Poeae, Syn.: *Koeleria pyramidata* (Lam.) Beauv., *Koeleria cristata* (L.) Pers., and is a native, perennial, monocot, cool-season, mid grass, that is cold and heat tolerant, and drought resistant. The first North Dakota record is Bell 1907. Early aerial growth consists of basal leaves arising from crown tiller buds. Prairie Junegrass consistently reaches the 3.5 new leaf stage by 1 June and is an excellent indicator of physiological grazing readiness of native grasses. Basal leaf blades are 8-18 cm (3-7 in) long, 1-3 mm wide, thick, with broad ribs above and a boat prow shaped tip. The split sheath has overlapping translucent margins with short hairs. The indistinctive collar is continuous. The ligule is membranous, 1.5 mm long, often split, continuous with sheath margins, and fringed with hairs. The auricles are absent. The fibrous root system is primarily shallow, with the greatest concentration in the top 3 cm (1.2 in) of soil. The lateral spread is 20-25 cm (8-10 in) outward from the crown. Most main roots are 0.2 mm thick and remain in the top 46 cm (1.5 ft) of soil, with a few main roots descending down to 76 cm (2.5 ft). Regeneration is primarily asexual propagation by crown tillers. Seedling success is low, primarily because of low seed production, and resulting from poor seedling vigor and high mortality. Flower stalks are erect, 30-60 cm (12-24 in) tall. Inflorescence is a narrow, condensed, panicle, 5-15 cm (2-6 in) long, that opens during flowering becoming plume like, then contracting to narrow spike shape after flowering. Spikelets contain 2 florets. Flowers period is early June to mid July. Leaves are highly palatable to livestock. Fire top kills aerial parts and can consume the entire crown when the soil is dry. Fire halts the processes of the four major defoliation resistance mechanisms and causes great reductions in biomass production and tiller density. This summary information on growth development and regeneration of Prairie Junegrass was based on works of Weaver 1954, Stevens 1963, Zaczkowski 1972, Dodds 1979, Great Plains Flora Association 1986, Simonin 2000, Ogle et al. 2006, Larson and Johnson 2007, and Stubbendieck et al. 2011.

Procedures

The 1946-1947 Study

Grass and upland sedge species samples to determine crude protein and phosphorus content were collected weekly during the growing seasons of 1946 and 1947 from two seeded domesticated grasslands and a native rangeland pasture at the Dickinson Research Extension Center located at Dickinson in western North Dakota. Current year's growth of lead tillers of each species was included in the sample; previous year's growth was separated and discarded. Ungrazed samples were collected for each species except for Kentucky bluegrass, which only grew along a watercourse where almost all of the plants had been grazed and remained in an immature vegetative stage, however, a small number of plants escaped grazing and developed normally providing the phenological development data. Crude protein (N X 6.25) content was determined by the procedure outlined in the Official and Tentative Methods of Analysis (A.O.A.C. 1945). Phosphorus content was determined by the method outlined by Bolin and Stamberg (1944). Data were reported as percent of oven-dried weight.

Plant condition by stage of plant development and growth habit was collected for each species on sample dates. These data are reported as phenological growth stage in the current report. The grass nutritional quality and phenological growth data were published in Whitman et al. 1951.

The 1955-1962 Study

Grass and upland sedge tiller growth in height of leaves and stalks were collected from ungrazed plants during the growing seasons of 1955-1962. Basal leaves were measured from ground level to the tip of the extended leaves. Culm leaves were measured from ground level to the apex of the uppermost leaf. Stalk measurements were from ground levels to the tip of the stalk or to the tip of the inflorescence after it had developed. An average of 10 plants of each species were measured at approximate 7 to 10 day intervals from early May until early September. In addition, phenological growth stages were recorded to include stalk initiation, head emergence, flowering (anthesis), seed development, seed maturity, earliest seed shedding, and an estimation of percent of leaf dry in relation to total leaf area. The grass growth in height and phenological data were reported in Goetz 1963.

The 1964-1969 Study

Phenological data of grass and upland sedge at anthesis stage was determined by recording observation dates. Leaf senescence by date was determined as an estimation of percentage of dry leaf in relation to total leaf area. Grass and upland sedge tiller growth in height of leaves were collected from ungrazed plants during the growing seasons of 1964-1966. Basal leaves were measured from ground level to the tip of the extended leaf. Culm leaves were measured from ground level to the apex of the uppermost leaf. An average of 20 plants at approximately 7 to 10 day intervals during the growing season from mid April to late August from control treatment on sandy, silty, overflow, and thin claypan ecological sites. Phenological data of anthesis stage, leaf senescence, and growth in leaf height were reported in Goetz 1970.

The 1969-1971 Study

The range of flowering time of grasses and upland sedges were determined by recording daily observations of plants at anthesis on several prairie habitat type collection locations distributed throughout 4,569 square miles of southwestern North Dakota. The daily observed flowering plant data collected during the growing seasons of 1969 to 1971 from April to August were reported as flower sample periods with 7 to 8 day duration in Zaczkowski 1972.

The 1983-2012 Study

A long-term change in grass and upland sedges species abundance study was conducted during active plant growth of July and August each growing season of 1983 to 2012 (30 years) on native rangeland pastures at the Dickinson Research Extension Center ranch located near Manning, North Dakota. Effects from three management treatments were evaluated: 1) long-term nongrazing, 2) traditional seasonlong grazing, and 3) twice-over rotation grazing. Each treatment had two replications, each with data collection sites on sandy, shallow, and silty ecological sites. Each ecological site of the two grazed treatments had matching paired plots, one grazed and the other with an ungrazed exclosure. The sandy, shallow, and silty ecological sites were each replicated two times on the nongrazed treatment, three times on the seasonlong treatment, and six times on the twice-over treatment.

During the initial phase of this study, 1983 to 1986, the long-term nongrazed and seasonlong treatments were at different locations and moved to the permanent study locations in 1987. The data collected on those two treatments during 1983 to 1986 were not included in this report.

Abundance of each grass and upland sedge species was determined with plant species basal cover by the ten-pin point frame method (Cook and Stubbendieck 1986). The point frame method was used to collect data at 2000 points along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Basal cover, relative basal cover, percent frequency, relative percent frequency, and importance value were determined from the ten-pin point frame data. Point frame data collection period was 1983 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and on the seasonlong treatments. However, point frame data was not collected during 1992 on the sandy ecological sites of all three treatments.

During some growing seasons, the point frame method did not document the presence of a particular plant species which will be reflected in the data summary tables as an 0.00 or as a blank spot.

The 1983-2012 study attempted to quantify the increasing or decreasing changes in individual plant species abundance during 30 growing seasons by comparing differences in the importance values of individual species during multiple year periods. Importance value is an old technique that combines

relative basal cover with relative frequency producing a scale of 0 to 200 that ranks individual species abundance within a plant community relative to the individual abundance of the other species in the community during the growing season. Basal cover importance value ranks the grasses, upland sedges, forbs, and shrubs in a community. The quantity of change in the importance value of an individual species across time indicates the magnitude of the increases or decreases in abundance of that species relative to the changes in abundance of the other species.

Results

Prairie Junegrass increases growth activity shortly after snow melt. Leaf growth in cool season grasses continues very slowly during the entire winter. The top portion of these carryover leaves become exposed to low temperatures causing the cell walls to rupture. The lower portion of the carryover leaves have intact cell walls and regreen with active chlorophyll when liquid water becomes available in the soil for at least during the daylight hours. The green portions of the carryover leaves provide a large quantity of carbohydrates and fixed energy used in the production of new leaves. Growth of new leaves of Prairie Junegrass is visible between 8 and 13 April (tables 1 and 2). Prairie Junegrass produces 3.5 new leaves on 1 June consistently. Unlike Needle and thread that sheds its early new leaves, Prairie Junegrass retains its early new leaves for several weeks. Lead tillers at the 3.5 new leaf stage are physiologically capable of positive response to partial defoliation of 25% to 33% of leaf weight by graminivores. On 1 June, the tallest basal leaf of Prairie Junegrass has reached 85% of maximum leaf height (table 2), and the lead tiller contains 15% crude protein and 0.22% phosphorus on silty ecological sites (table 1). Leaf growth in height is rapid during May, about one fourth that rate during June, and slower still during July (table 2). The flower stalk reaches the boot stage around 16-20-22 May, reaches head emergence on 5 to 6 June, and reaches flower (anthesis) between 19 and 26 June (tables 1, 3, 4, and 5). The 5 week flower period occurs during early June to mid July (table 4). At the end of June, the basal leaf growth has reached 93.0% of maximum height, seed stalk growth has reached 100.0% of maximum height, and the lead tiller still contains 11.3% crude protein (tables 1, 2, and 3). The seeds are developing from 26 June to 17 July and being shed during 16 July to 11 August (tables 1 and 5). The lead tiller crude protein content drops below the requirements of lactating cows during the first week of July and drops below their phosphorus requirements during the second week of July (tables 1 and 6). Maximum basal leaf height is reached at the end of July with a crude protein content of only 7.0% (tables 1 and 2). Leaf dryness starts during mid August and continues into September (tables 1 and 5). Leaf dryness appears to be more rapid on the sandy and the thin claypan sites (table 7) than that on the silty site (table 5). Flower stage appears to be similar and sandy and thin claypan sites (table 7) as on silty sites (tables 1, 4, and 5). Unless the grazing management practices has properly manipulated the stimulation of an adequate quantity of Prairie Junegrass vegetative secondary tillers, lactating cows will be grazing forage below their nutrient requirements after early July.

Grass species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Patterns in the changes of individual grass species abundance was followed for 30 growing seasons during the 1983-2012 study on the sandy, shallow, and silty ecological sites of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments (tables 8 and 9).

On the sandy site of the nongrazed treatment, Prairie Junegrass was present during 84.0% of the years that basal cover data were collected with a mean 0.66% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 60.0% of the years with a mean 0.33% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 0.97% basal cover. The percent present and basal cover increased on the sandy site of the nongrazed treatment over time (tables 8 and 9).

On the sandy site of the ungrazed seasonlong treatment, Prairie Junegrass was present during 40.0% of the years that basal cover data were collected with a mean 0.65% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was not present. During the later period (1998-2012), Prairie Junegrass was present during 66.7% of the years with a mean 1.09% basal cover. Prairie Junegrass was not present during the early period and all basal cover observations were made during the later period indicating moderate abundance (tables 8 and 9).

On the sandy site of the grazed seasonlong treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 1.74% basal cover during the

total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 0.89% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 2.41% basal cover. The percent present remained at 100.0% and basal cover increased on the sandy site of the grazed seasonlong treatment over time (tables 8 and 9). The percent present and basal cover were greater on the sandy site of the grazed seasonlong treatment than those on the sandy site of the ungrazed seasonlong treatment.

On the sandy site of the ungrazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 0.36% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 0.79% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 0.36% basal cover. The percent present remained at 100.0% and basal cover decreased on the sandy site of the ungrazed twice-over treatment over time (tables 8 and 9).

On the sandy site of the grazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 1.35% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 1.30% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 1.56% basal cover. The percent present remained at 100.0% and basal cover increased on the sandy site of the grazed twice-over treatment over time (tables 8 and 9). The percent present was the same at 100.0% and basal cover was greater on the sandy site of the grazed twice-over treatment than that on the sandy site of the ungrazed twice-over treatment.

On the shallow site of the nongrazed treatment, Prairie Junegrass was present during 84.6% of the years that basal cover data were collected with a mean 0.85% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 66.7% of the years with a mean 0.78% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 1.09% basal cover. The percent present and basal cover increased on the shallow site of the nongrazed treatment over time (tables 8 and 9).

On the shallow site of the ungrazed seasonlong treatment, Prairie Junegrass was present during 38.5% of the years that basal cover data were collected with a mean 1.29% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was not present. During the later period (1998-2012), Prairie Junegrass was present during 66.7% of the years with a mean 2.23% basal cover. Prairie Junegrass was not present during the early period and all basal cover observations were made during the later period indicated good abundance (tables 8 and 9).

On the shallow site of the grazed seasonlong treatment, Prairie Junegrass was present during 84.6% of the years that basal cover data were collected with a mean 1.47% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 83.3% of the years with a mean 1.26% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 86.7% of the years with a mean 1.95% basal cover. The percent present and basal cover increased on the shallow site of the grazed seasonlong treatment over time (tables 8 and 9). The percent present was greater, basal cover during the early period was greater, and basal cover during the later period was lower on the shallow site of the grazed seasonlong treatment than those on the shallow site of the ungrazed seasonlong treatment.

On the shallow site of the ungrazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 1.76% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 2.58% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 1.51% basal cover. The percent present remained at 100.0% and basal cover decreased on the shallow site of the ungrazed twice-over treatment over time (tables 8 and 9).

On the shallow site of the grazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 2.55% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 2.83% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 2.67% basal cover. The percent present remained at 100.0% and basal cover decreased slightly on the

shallow site of the grazed twice-over treatment over time (tables 8 and 9). The percent present remained the same at 100.0% and basal cover was greater on the shallow site of the grazed twice-over treatment than that on the shallow site of the ungrazed twice-over treatment.

On the silty site of the nongrazed treatment, Prairie Junegrass was present during 92.3% of the years that basal cover data were collected with a mean 0.54% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 83.3% of the years with a mean 0.34% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 0.66% basal cover. The percent present and basal cover increased on the silty site of the nongrazed treatment over time (tables 8 and 9).

On the silty site of the ungrazed seasonlong treatment, Prairie Junegrass was present during 92.3% of the years that basal cover data were collected with a mean 1.31% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 66.7% of the years with a mean 1.16% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 1.57% basal cover. The percent present and basal cover increased on the silty site of the ungrazed seasonlong treatment over time (tables 8 and 9).

On the silty site of the grazed seasonlong treatment, Prairie Junegrass was present during 92.3% of the years that basal cover data were collected with a mean 1.56% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 66.7% of the years with a mean 0.91% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 2.13% basal cover. The percent present and basal cover increased on the silty site of the grazed seasonlong treatment over time (tables 8 and 9). The percent present were the same and basal cover during the early period was lower and basal cover during the later period was greater on the silty site of the grazed seasonlong treatment than those on the silty site of the ungrazed seasonlong treatment.

On the silty site of the ungrazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 0.76% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 1.45% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 0.47% basal cover. The percent present remained at 100.0% and basal cover decreased on the silty site of the ungrazed twice-over treatment over time (tables 8 and 9).

On the silty site of the grazed twice-over treatment, Prairie Junegrass was present during 100.0% of the years that basal cover data were collected with a mean 1.71% basal cover during the total 30 year period. During the early period (1983-1992), Prairie Junegrass was present during 100.0% of the years with a mean 1.76% basal cover. During the later period (1998-2012), Prairie Junegrass was present during 100.0% of the years with a mean 1.86% basal cover. The percent present remained at 100.0% and basal cover increased on the silty site of the grazed twice-over treatment over time (tables 8 and 9). The percent present was the same at 100.0% and basal cover was greater on the silty site of the grazed twice-over treatment than that on the silty site of the ungrazed twice-over treatment.

On the sandy site, Prairie Junegrass was present during 84.8% of the years with a mean 0.95% basal cover. On the shallow site, Prairie Junegrass was present during 81.5% of the years with a mean 1.58% basal cover. On the silty site, Prairie Junegrass was present during 95.4% of the years with a mean 1.18% basal cover. The percent present was greater on the silty site and basal cover were greater on the shallow site.

On the sandy site of the nongrazed treatment, Prairie Junegrass was present during 84.0% of the years with a mean 0.66% basal cover. On the sandy site of the seasonlong treatment, Prairie Junegrass was present during 70.0% of the years with a mean 1.20% basal cover. On the sandy site of the twice-over treatment, Prairie Junegrass was present during 100.0% of the years with a mean 0.86% basal cover. On the sandy site, Prairie Junegrass percent present was greater on the twice-over treatment and basal cover was greater on the seasonlong treatment.

On the shallow site of the nongrazed treatment, Prairie Junegrass was present during 84.6% of the years with a mean 0.85% basal cover. On the shallow site of the seasonlong treatment, Prairie Junegrass was present during 61.5% of the years with a mean 1.38% basal cover. On the shallow site of the twice-over treatment, Prairie Junegrass was present during 100.0% of the years with a mean

2.16% basal cover. On the shallow site, Prairie Junegrass percent present and basal cover was greater on the twice-over treatment.

On the silty site of the nongrazed treatment, Prairie Junegrass was present during 92.3% of the years with a mean 0.54% basal cover. On the silty site of the seasonlong treatment, Prairie Junegrass was present during 92.3% of the years with a mean 1.43% basal cover. On the silty site of the twice-over treatment, Prairie Junegrass was present during 100.0% of the years with a mean 1.24% basal cover. On the silty site, Prairie Junegrass percent present was greater on the twice-over treatment and basal cover was greater on the seasonlong treatment.

Prairie Junegrass was present on the nongrazed treatment during 87.0% of the years with a mean 0.68% basal cover. Prairie Junegrass was present on the seasonlong treatment during 74.6% of the years with a mean 1.34% basal cover. Prairie Junegrass was present on the twice-over treatment during 100.0% of the years with a mean 1.42% basal cover. The percent present and basal cover were greater on the twice-over treatment.

Prairie Junegrass was present 100.0% of the years on the sandy, shallow, and silty ecological site of the twice-over with the greatest mean of 1.42% basal cover.

Discussion

Prairie Junegrass, *Koeleria macrantha*, is a native, perennial, cool season, mid grass, monocot, of the grass family that is common on healthy mixed grass prairie plant communities. Prairie Junegrass can grow on sandy, shallow, silty, and thin claypan ecological sites. It has greater percent present on the silty site and greater basal cover on the shallow site. The greatest percent present and basal cover were on the twice-over management treatment. Early season activity starts with regreening with active chlorophyll the portions of the carryover leaves that have intact cell walls from the previous growing season vegetative tillers, secondary tillers, and fall tillers. The green portion of the carryover leaves provides large quantities of carbohydrates and fixed energy for the production of new leaves. New leaves of Prairie Junegrass are visible between 8 and 13 April. Prairie Junegrass lead tillers are derived from carryover vegetative tillers and produce 3.5 new leaves on 1 June consistently, and can be used as a reliable indicator of grazing readiness. Lead tillers at the 3.5 new leaf stage are physiologically capable of positive response to partial defoliation of 25% to 33% of leaf weight by graminivores. The tallest basal leaf is at 85.0% of maximum height on 1 June and the lead tiller contains 15.1% crude protein and 0.22% phosphorus on the silty ecological site during early June. The flower stalks reach the boot stage around 16 to 22 May, reach head emergence on 5 to 6 June, and reach the early flower stage around 19 to 26 June, with a 5 week flower period from early June to mid July. Leaf growth in height is rapid during May, growth is slower during June, and slower still during July. Basal leaves reach 93.0% of maximum height by end of June and reach 100.0% of maximum height by late July. Seeds are developing between 26 June and 17 July and being shed during 16 July to 11 August. Seed stalks reach maximum height at the end of June and lead tillers contain 11.3% crude protein and 0.234% phosphorus. Lead tillers drop below the crude protein requirements of lactating cows during the first week of July and drop below the phosphorus requirements during the second week of July. Leaf dryness starts 14 August and continues through August into September. Lead tillers of Prairie Junegrass contribute little to forage value after mid July.

Vegetative tillers are derived mostly from secondary carryover tillers that were most likely fall tillers from the previous growing season and some are derived from early season initiated tillers. Vegetative tillers have slightly slower growth rates than lead tillers during the early portion of the growing season. Vegetative tillers reach the 3.5 new leaf stage shortly after the lead tillers and become independent. When lead tiller growth rates decrease greatly during early July, the vegetative tiller growth rates do not slow down. Grazing management practices that have less than 100 lbs/ac of available mineral nitrogen have less than a third of the quantity of vegetative tillers as grazing management practices that can produce greater than 100 lbs/ac available mineral nitrogen. Vegetative tillers provide around three fourths of the forage weight after mid July.

Secondary tillers are derived from growing season initiated tillers. With most useful tillers initiated during May and June. Few secondary tillers are initiated during the period when lead tillers have high resource demand as they progress through the flower stage and seed production. Most of the secondary tillers on traditional grazing practices are at less than the 3.5 new leaf stage and are terminated during the high resource demand period resulting in only about 3% surviving secondary tillers compared to the quantity of surviving tillers on the twice-over system. Surviving secondary tillers become independent of the lead tillers when the fourth new

leaf is near full development. These early initiated secondary tillers contribute to the forage weight after mid or late July. The quantity of vegetative and secondary tillers, and the quantity and quality of forage after mid July depends on the type of grazing management practices used during June and the first two weeks of July. Traditional grazing practices have low quantities of forage value vegetative and secondary tillers after mid July, and lactating cows are grazing forage that is below their nutrient requirements. Prairie Junegrass is a valuable asset on the Northern Mixed Grass Prairie.

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Table 1. Koeleria macrantha, Prairie Junegrass, weekly percent crude protein, percent phosphorus, and phenological growth stages of ungrazed lead tillers in western North Dakota, 1946-1947.

Sample Date	Crude Protein %	Phosphorus %	Phenological Growth Stages
Apr 1			
13	17.8	0.298	Early leaf greenup
19	20.0	0.352	
25	19.1	0.336	
May 4	20.1	0.286	Active leaf growth
10	16.7	0.243	
16	18.1	0.266	Flower stalk developing
23	13.9	0.200	
28	15.1	0.216	
Jun 6	12.9	0.241	Flower stalk emerging
13	13.6	0.266	
19	14.2	0.244	Flowering (Anthesis)
26	11.3	0.234	Seed developing
Jul 2	9.6	0.210	
8	8.6	0.187	Seed maturing
16	7.5	0.155	Seed mature
24	6.3	0.159	
30	7.0	0.154	Drying
Aug 6	5.3	0.117	
13	6.4	0.140	
20	5.6	0.123	
26	6.2	0.106	
Sep 3	4.8	0.083	Drying
12	4.3	-	
21			
29			
Oct			
Nov 5			Drying

Data from Whitman et al. 1951.

Table 2. Mean leaf height in cm and percent of maximum leaf height attained by Koeleria macrantha, Prairie Junegrass, 1955-1962.

	April				
	1	8	15	22	29
cm		1.0	4.5	5.6	6.7
%		8.0	37.0	46.0	55.0
	May				
	1	8	15	22	29
cm	6.8	6.8	8.8	10.0	10.3
%	55.0	55.0	72.0	81.0	84.0
	June				
	1	8	15	22	29
cm	10.5	10.6	10.8	10.9	11.5
%	85.0	86.0	88.0	89.0	93.0
	July				
	1	8	15	22	29
cm	11.7	12.0	12.1	12.2	12.3
%	95.0	98.0	98.0	99.0	100.0
	August				
	1	8	15	22	29
cm					
%					

Data from Goetz 1963.

Table 3. Mean stalk height in cm and percent of maximum stalk height attained by Koeleria macrantha, Prairie Junegrass, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm				10.0	11.5
%				36.9	42.4
	June				
	1	8	15	22	29
cm	14.0	15.0	20.8	21.9	27.1
%	51.7	55.4	76.8	80.8	100.0
	July				
	1	8	15	22	29
cm					
%					
	August				
	1	8	15	22	29
cm					
%					

Data from Goetz 1963.

Table 4. First flower and flower period of Koeleria macrantha, Prairie Junegrass.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest			19			
Mean			26			
Flower Period						
1969-1971			XX XX	X		

First Flower Data from Goetz 1963 and Whitman et al. 1951.
Flower Period Data from Zaczkowski 1972.

Table 5. Flower stalk seed development and percent leaf dryness of Koeleria macrantha, Prairie Junegrass.

	Flower Stalk Development			Seed Development	
Data Period	Boot	Emerge	Flower	Mature	Shed
1955-1962	20 May	5 Jun	26 Jun	17 Jul	11 Aug

		Percent Leaf Dryness			
Data Period	Leaf Tip	0-25	25-50	50-75	75-100
	Dry	%	%	%	%
1955-1962	15 Jul	14 Aug		22 Aug	9 Sep

Data from Goetz 1963.

Table 6. Intake nutrient requirements as percent of dry matter for range cows with average milk production.

	Dry Gestation	3rd Trimester	Early Lactation	Lactation (Spring, Summer, Fall)
1000 lb cows				
Dry matter (lbs)	21	21	24	24
Crude protein (%)	6.2	7.8	10.5	9.6
Phosphorus (%)	0.11	0.15	0.20	0.18
1200 lb cows				
Dry matter (lbs)	24	24	27	27
Crude protein (%)	6.2	7.8	10.1	9.3
Phosphorus (%)	0.12	0.16	0.19	0.18
1400 lb cows				
Dry matter (lbs)	27	27	30	30
Crude protein (%)	6.2	7.9	9.8	9.0
Phosphorus (%)	0.12	0.17	0.19	0.18

Data from NRC 1996.

Table 7. Mean date of first flower and date of percentage categories of leaf senescence for Prairie Junegrass, 1964-1966.

Ecological Site	Anthesis	Leaf Tip Dry	Leaf 0-25% Dry	Leaf 25%-50% Dry	Leaf 50%-75% Dry
Sandy	24 Jun	3 Jul	27 Jul	9 Sep	-
Silty	23 Jun	24 Jun	27 Jul	-	-
Overflow	No Data				
Thin claypan	24 Jun	7 Jul	18 Jul	25 Aug	-

Data from Goetz 1970.

Table 8. Autecology of Koeleria macrantha, Prairie Junegrass, with growing season changes in basal cover, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.75	0.00	2.07	1.09	1.71
1988-1992	0.23	0.00	0.60	0.47	0.79
1993-1998	0.05	0.00	0.59	0.66	0.71
1999-2003	0.25	1.73	1.97	0.20	1.27
2004-2009	1.15	1.89	3.10	0.45	1.94
2010-2012	2.12	1.08	2.35	0.57	1.72
Shallow					
1983-1987	1.55	0.00	4.23	4.65	4.81
1988-1992	0.62	0.00	0.66	0.92	0.83
1993-1998	0.21	0.00	0.25	0.94	1.43
1999-2003	0.56	2.52	1.32	1.42	2.36
2004-2009	1.47	4.08	2.73	1.96	3.51
2010-2012	1.53	2.17	2.03	1.13	2.26
Silty					
1983-1987	0.75	4.15	3.87	2.33	2.71
1988-1992	0.26	0.56	0.32	0.75	0.80
1993-1998	0.35	0.65	0.59	0.37	1.07
1999-2003	1.02	1.48	2.28	0.57	1.98
2004-2009	0.40	2.15	2.51	0.58	2.33
2010-2012	0.77	0.93	1.66	0.19	1.19

Table 9. Autecology of Koeleria macrantha, Prairie Junegrass, with growing season changes in basal cover importance value, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	7.22	0.00	15.72	9.44	10.93
1988-1992	2.24	0.00	5.27	4.36	6.88
1993-1998	0.56	0.00	5.13	4.77	5.63
1999-2003	2.58	2.93	14.70	2.27	9.79
2004-2009	11.56	17.15	22.71	5.48	15.91
2010-2012	18.84	11.15	18.38	6.54	14.72
Shallow					
1983-1987	10.97	0.00	28.40	32.16	28.17
1988-1992	4.24	0.00	5.11	7.49	8.14
1993-1998	1.33	0.00	2.48	8.17	11.11
1999-2003	5.15	3.64	9.02	11.46	16.70
2004-2009	16.37	30.56	18.43	16.42	25.18
2010-2012	13.78	16.96	13.75	10.63	15.76
Silty					
1983-1987	6.09	34.31	25.53	15.91	16.88
1988-1992	2.27	4.86	2.80	6.67	7.95
1993-1998	3.50	5.08	5.28	3.59	8.05
1999-2003	9.16	11.85	16.28	6.19	16.09
2004-2009	4.24	16.72	19.07	6.00	17.26
2010-2012	7.89	8.48	12.14	2.22	8.78

Literature Cited

Association of Official Agricultural Chemists. 1945. Official and tentative methods of analysis. Ed. 6. Washington, DC. 932pp.

Bolin, D.W. and O.E. Stamberg. 1944. Rapid digestion method for determination of phosphorus. Ind. and Eng. Chem. 16:345.

Cook, C.W., and J. Stubbendieck. 1986. Range research: basic problems and techniques. Society for Range Management, Denver, CO. 317p.

Dodds, D.L. 1979. Common grasses and sedges in North Dakota. NDSU Extension Service R-658. Fargo, ND.

Goetz, H. 1963. Growth and development of native range plants in the mixed prairie of western North Dakota. M. S. Thesis, North Dakota State University, Fargo, ND. 165p.

Goetz, H. 1970. Growth and development of Northern Great Plains species in relation to nitrogen fertilization. Journal of Range Management 23:112-117.

Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas, Lawrence, KS.

Larson, G.E., and J.R. Johnson. 2007. Plants of the Black Hills and Bear Lodge Mountains. 2nd Edition. South Dakota State University, Fargo, ND. 219p.

Manske, L.L. 2016. Autecology of prairie plants on the Northern Mixed Grass Prairie. NDSU Dickinson Research Extension Center. Range Research Report DREC 16-1093. Dickinson, ND.

National Research Council. 1996. Nutrient requirements of beef cattle. 7th rev. ed. National Academy Press, Washington, DC.

Ogle, D.G., L. St. John, M. Majens, D. Tilley, T.A. Jones, S. Parr. 2006. Koeleria macrantha (Ledeb) J.A. Schultes. Plant Database. USDA. Natural Resources Conservation Service. Boise, ID. http://plants/usda.gov/

Simionin, K. 2000. Koeleria macrantha. Fire Effects Information System. USDA. Forest Service. http://www.fs.fed.us/database/feis/

Stevens, O.A. 1963. Handbook of North Dakota plants. North Dakota Institute for Regional Studies. Fargo, ND.

Stubbendieck, J., S.L. Hatch, and N.M. Bryan. 2011. North American wildland plants. 2nd Ed. University of Nebraska Press. Lincoln, NE.

Weaver, J.E. 1954. North American Prairie. Johnson Publishing Co. Lincoln, NE.

Whitman, W.C., D.W. Bolin, E.W. Klosterman, H.J. Klostermann, K.D. Ford, L. Moomaw, D.G. Hoag, and M.L. Buchanan. 1951. Carotene, protein, and phosphorus in range and tame grasses of western North Dakota. North Dakota Agricultural Experiment Station. Bulletin 370. Fargo, ND. 55p.

Zaczkowski, N.K. 1972. Vascular flora of Billings, Bowman, Golden Valley, and Slope Counties, North Dakota. PhD. Thesis. North Dakota State University, Fargo, ND. 219 p.