Autecology of Needle and Thread on the Northern Mixed Grass Prairie

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The autecology of Needle and Thread, *Hesperostipa comata*, 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).

Needle and Thread, *Hesperostipa comata* (Trin. & Rupr.) Barkworth, is a member of the grass family, Poaceae, tribe, Stipeae, Syn.: *Stipa comata* Trin. & Rupr., and is a native, long lived perennial, monocot, cool-season, mid grass, that is highly drought resistant. The first North Dakota record is Bergman 1910. Early aerial growth consists of basal leaves arising from crown tiller buds. Needle and thread consistently reaches the 3.5 (+) new leaf stage by 1 June, however, it rarely retains more than 2 full basal leaves during the early portion of the growing season, eliminating it as an indicator of physiological grazing readiness of native grasses. Basal leaf blades are 10-30 cm (3.9-11.8 in) long, 1-3 mm wide, tapering to a point, with strong ridges on upper surface. Leaves roll inward when dry. The split sheath has overlapping translucent margins. The indistinct collar is continuous and narrow. The ligule is a conspicuous membrane, 3-6 mm long, continuous with sheath margins, often split or frayed. The auricles are absent. This grass is generally considered to be exclusively a bunch grass, however, under proper management, short rhizome tillers can be produced. The extensive fibrous root system is primarily shallow with greater than 50% of the biomass in the top 18 cm (7 in) of soil. The main roots are 1 mm thick and branch profusely with numerous lateral roots. The lateral spread extends 36 cm (14 in) outward from the crown. Several main roots descend down to 91 cm (3 ft) deep with a few main roots extending to 1.8 m (5 ft) deep. Regeneration is primarily asexual propagation by crown tillers. Seedling success is low as a result of poor gemination and competition from established plants. Flower stalks are erect, 30-60 cm(12-24 in) tall. Inflorescence is a narrow panicle with several loosely spreading ascending branches, each with several one flowered spikelets. Flowers are rarely observable because of the prevalence of self fertilization (cleistogamy) within the closed sheath. Floret has a hard sharp pointed base and tip with a 10-13 cm (4-5 in) long awn that curls as it dries, twisting the seed into the soil. Flower period is late May to late June. The sharp pointed seed with a long awn can cause problems for livestock in hay, however, they rarely cause problems for grazing livestock. Leaves are highly palatable to livestock. Fire top kills aerial parts and fire 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 and tiller density. This summary information on growth development and regeneration of Needle and thread was based on works of Stevens 1963, Zaczkowski 1972, Dodds 1979, Great Plains Flora Association 1986, Zlatnik 1999, 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. Crude protein content of grasses and upland sedges was determined from a composite of 10 samples of each species collected systematically at biweekly intervals from mid May to early September, 1964-1969 on sandy, silty, overflow, and thin claypan ecological sites. Plant material was oven dried at 105°F. Analysis of the samples were made by the Cereal Technology Department, North Dakota State University, using standard crude protein determinations and reported in Goetz 1975.

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

Needle and thread 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 is visible between 8 and 19 April (tables 1 and 2). Needle and thread consistently produce 3.5 new leaves by 1 June, however, the first and second leaves dry and break off early. Tillers rarely retain more than two leaves during the growing season. 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 has reached 73% of maximum leaf height (table 2), and the lead tiller contain 15.2% crude protein and 0.265% phosphorus on silty ecological sites (table 1). Leaf growth in height is rapid during June (table 2). The flower stalk reaches the boot stage around 19-23-29 May, and reaches the flower (anthesis) stage between 6-23 June (tables 1, 3, 4, and 5). The flower period occurs during June (table 4). Needle and thread is cleistogamous and exposed flowers are rarely observed. At the end of June, the basal leaf growth has reached 97% of maximum height, seed stalk growth has reached 84.7% of maximum height, and the lead tiller still contains 12.0% crude protein (tables 1, 2, and 3). The seeds are maturing from 2 to 22 July and being shed from 16 to 26 July (tables 1 and 5). The lead tiller crude protein content had dropped below the requirements of lactating cows during the first week of July (tables 1and 6). Basal leaf maximum height is reached around 1 July and seed stalk maximum height is reached around 8 July (tables 2 and 3). Leaf dryness starts during late July and continues through August into early September (tables 1 and 5). The phosphorus content of lead tillers drops below the requirements of lactating cows during late July (tables 1 and 6). Needle and thread phenological development seems to be affected little by differences in characteristics of ecological sites (tables 7, 8, and 9). Lead tillers on several ecological sites drop below the crude protein requirements of lactating cows during early July. Leaf dryness starts to occur during early August. Leaf heights appear to be slightly shorter on sandy sites during April and May, then seem to catch up during June to the leaf heights on silty sites. Leaf heights on overflow sites seem to be the same as those on silty sites (tables 1, 2, 4, 5, 6, 7, 8, and 9). Unless the grazing management practice has properly manipulated the stimulation of an adequate quantity of Needle and thread vegetative secondary tillers, lactating cows will be grazing forage below their 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 10 and 11).

On the sandy site of the nongrazed treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 2.90% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0%

of the years with a mean 2.74% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 2.97% basal cover. The percent present remained at 100.0% and basal cover increased on the sandy site of the nongrazed treatment over time (tables 10 and 11).

On the sandy site of the ungrazed seasonlong treatment, Needle and thread was present during 40.0% of the years that basal cover data were collected with a mean 1.37% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was not present. During the later period (1998-2012), Needle and thread was present during 66.7% of the years with a mean 2.28% basal cover. Needle and thread was not present during the early period and all basal cover observations were made during the later period when basal cover had increased to typical abundance (tables 10 and 11).

On the sandy site of the grazed seasonlong treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 3.30% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 2.47% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 3.39% basal cover. The percent present remained at 100.0% and the basal cover increased on the sandy site of the grazed seasonlong treatment over time (tables 10 and 11). 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, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 2.69% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.12% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 2.01% basal cover. The percent present remained at 100.0% and the basal cover decreased on the sandy site of the ungrazed twice-over treatment over time (tables 10 and 11).

On the sandy site of the grazed twice-over treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 3.33% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 2.80% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 3.56% basal cover. The percent present remained at 100.0% and the basal cover increased on the sandy site of the grazed twice-over treatment over time (tables 10 and 11). The percent present was the same at 100.0% and the basal cover was greater on the sandy site of the grazed twice-over treatment than those on the sandy site of the ungrazed twice-over treatment.

On the shallow site of the nongrazed treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 4.37% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 4.75% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 4.28% basal cover. The percent present remained at 100.0% and basal cover decreased on the shallow site of the nongrazed treatment over time (tables 10 and 11).

On the shallow site of the ungrazed seasonlong treatment, Needle and thread was present during 38.5% of the years that basal cover data were collected with a mean 1.81% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was not present. During the later period (1998-2012), Needle and thread was present during 66.7% of the years with a mean 3.15% basal cover. Needle and thread was not present during the early period and all basal cover observations were made during the later period when basal cover had increased to typical abundance (tables 10 and 11).

On the shallow site of the grazed seasonlong treatment, Needle and thread was present during 96.2% of the years that basal cover data were collected with a mean 3.64% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.65% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 3.84% basal cover. The percent present remained the same and basal cover increased on the shallow site of the grazed seasonlong treatment over time (tables 10 and 11). The percent present and basal cover were greater 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, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 3.77% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.86% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 3.38% 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 10 and 11).

On the shallow site of the grazed twice-over treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 3.02% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.71% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 2.82% basal cover. The percent present remained at 100.0% and basal cover decreased on the shallow site of the grazed twice-over treatment over time (tables 10 and 11). The percent present remained the same at 100.0% and the basal cover was greater on the shallow site of the ungrazed twice-over treatment than that on the shallow site of the grazed twice-over treatment.

On the silty site of the nongrazed treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 4.43% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 4.93% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 3.85% basal cover. The percent present remained at 100.0% and the basal cover decreased on the silty site of the nongrazed treatment over time (tables 10 and 11).

On the silty site of the ungrazed seasonlong treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 3.98% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.43% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 4.39% basal cover. The percent present remained at 100.0% and basal cover increased on the silty site of the ungrazed seasonlong treatment over time (tables 10 and 11).

On the silty site of the grazed seasonlong treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 2.71% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.25% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 2.63% basal cover. The percent present remained at 100.0% and basal cover decreased on the silty site of the grazed seasonlong treatment over time (tables 10 and 11). The percent present was the same at 100.0% and the basal cover was greater on the silty site of the ungrazed seasonlong treatment than that on the silty site of the grazed seasonlong treatment.

On the silty site of the ungrazed twice-over treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 2.38% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 3.96% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 0.63% basal cover. The percent present remained at 100.0% and basal cover decreased greatly on the silty site of the ungrazed twice-over treatment over time (tables 10 and 11).

On the silty site of the grazed twice-over treatment, Needle and thread was present during 100.0% of the years that basal cover data were collected with a mean 2.15% basal cover during the total 30 year period. During the early period (1983-1992), Needle and thread was present during 100.0% of the years with a mean 2.76% basal cover. During the later period (1998-2012), Needle and thread was present during 100.0% of the years with a mean 1.41% basal cover. The percent present remained at 100.0% and basal cover decreased on the silty site of the grazed twice-over treatment over time (tables 10 and 11). The percent present was the same at 100.0% and basal cover was greater during the early period and was lower during the later period on the silty site of the ungrazed twice-over treatment than those on the silty site of the grazed twice-over treatment.

On the sandy site, Needle and thread was present during 88.0% of the years with a mean 2.72% basal cover. On the shallow site, Needle and thread was present during 86.9% of the years with a mean 3.32% basal cover. On the silty site, Needle and thread was present during 100.0% of the years with a mean 3.13% basal cover. Technically, the percent present and basal cover values on the three ecological sites were not significantly different indicating that Needle and thread was not affected differently by the three different ecological sites. Numerically, basal cover was greater on the shallow site and percent present was greater on the silty site.

On the sandy site of the nongrazed treatment, Needle and thread was present during 100.0% of the years with a mean 2.90% basal cover. On the sandy site of the seasonlong treatment, Needle and thread was present during 70.0% of the years with a mean 2.33% basal cover. On the sandy site of the twice-over treatment, Needle and thread was present during 100.0% of the years with a mean 3.01% basal cover. The percent present was 100.0% on the sandy site of the nongrazed and twice-over treatments and basal cover was greater on the twice-over treatment. On the shallow site of the nongrazed treatment, Needle and thread was present during 100.0% of the years with a mean 4.37% basal cover. On the shallow site of the seasonlong treatment, Needle and thread was present during 67.3% of the years with a mean 2.73% basal cover. On the shallow site of the twice-over treatment, Needle and thread was present during 100.0% of the years with a mean 3.40% basal cover. The percent present was 100.0% on the shallow site of the nongrazed and twice-over treatments and basal cover was greater on the nongrazed treatment.

On the silty site of the nongrazed treatment, Needle and thread was present during 100.0% of the years with a mean 4.43% basal cover. On the silty site of the seasonlong treatment, Needle and thread was present during 100.0% of the years with a mean 3.34% basal cover. On the silty site of the twice-over treatment, Needle and thread was present during 100.0% of the years with a mean 2.27% basal cover. The percent present was 100.0% on the silty site of the nongrazed, seasonlong, and twice-over treatments and basal cover was greater on the nongrazed treatment.

Needle and thread was present on the not grazed treatments during 86.5% of the years with a mean 3.08% basal cover. Needle and thread was present on the grazed treatments during 99.4% of the years with a mean 3.02% basal cover. Technically, the percent present and basal cover values were not significantly different indicating that Needle and thread was not affected differently by being grazed or not grazed.

During the drought growing season of 1988, Needle and thread had 4.6% basal cover on the nongrazed treatment, had 4.1% basal cover on the grazed seasonlong treatment, and had 3.7% basal cover on the grazed twice-over treatment. Technically, not significantly different, indicating that Needle and thread was not affected differently by drought conditions on the three different management treatments.

Discussion

Needle and thread, *Hesperostipa comata*, is a native, long-lived perennial, cool season, mid grass, monocot, of the grass family that is common on healthy mixed grass prairie plant communities. Needle and thread can grow on sandy, shallow, silty, and overflow ecological sites. Data from 5 studies and 49 growing seasons did not identify an ecological site nor management treatment preference for Needle and thread. Needle and thread is drought resistant. Needle and thread tillers live for two growing seasons. 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 and/or 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 Needle and thread are visible between 8 and 19 April. Needle and thread lead tillers are derived from carryover vegetative tillers and produces 3.5 new leaves by 1 June consistently, except the first and second leaves may be missing and sometimes a broken stub remains. 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 73.0% of maximum height on 1 June and the lead tiller contains 15.2% crude protein and 0.265% phosphorus on silty ecological sites during early June. The flower stalks reach the boot stage around 19 to 29 May and reach the flower stage around 6-23 June, with a four week flower period during June. Leaf growth and stalk growth in height is rapid during June. Basal leaves reach 97.0% of maximum height, seed stalks reach 84.7% of maximum height, and lead tillers contain 12.0% crude protein at the end of June. Basal leaves and seed stalks reach maximum height and the lead tillers drop below the crude protein requirements of lactating cows during the first week of July. Seeds mature during 2 to 22 July and are shed during 16 to 26 July. The phosphorus content drops below a lactating cows requirements at the end of July. Leaf dryness starts during early August and continues through September. Lead tillers of Needle and thread contribute little to forage value after mid July.

Vegetative tillers are derived mostly from 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 mid 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 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 terminated during the high resource demand period resulting in only about 3% surviving secondary tillers compared to those on the twice-over system. Surviving secondary tillers become independent of the lead tillers when the fourth leaf is near full development. These secondary tillers contribute to the forage weight after mid 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. Needle and thread is a valuable asset on the Northern Mixed Grass Prairie.

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Table 1. Hesperostipa comata, Needle and thread, 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			
19	21.0	0.284	Early leaf greenup
25	25.3	0.263	
May 4	18.0	0.231	Active leaf growth
10	16.7	-	
16	16.4	0.274	
23	16.4	0.226	Flower stalk developing
28	14.2	0.236	
Jun 6	15.2	0.265	
13	13.3	0.251	Seed developing
19	13.8	0.234	
26	12.0	0.219	
Jul 2	10.6	0.222	Seed maturing
8	9.7	0.209	
16	9.2	0.184	Seed Shedding
24	8.5	0.188	
30	7.0	0.161	Drying
Aug 6	7.0	0.149	
13	6.2	0.144	
20	7.0	0.156	
26	5.7	0.146	Drying
Sep 3	6.4	0.137	
12	5.6	0.130	
21	-	-	
29	6.2	0.111	Drying
Oct			
Nov 5	5.4	0.010	Drying

Data from Whitman et al. 1951.

Table 2. Mean leaf height in cm and percent of maximum leaf height attained by Hesperostipa comata, Needle and thread, 1955-1962.

			April		
	1	8	15	22	29
cm		2.5	4.0	4.2	4.6
%		12.0	19.0	20.0	22.0
			May		
	1	8	15	22	29
cm	5.0	7.0	8.4	12.3	13.0
%	24.0	34.0	40.0	59.0	62.0
			June		
	1	8	15	22	29
cm	15.3	16.2	17.0	18.6	20.2
%	73.0	78.0	81.0	89.0	97.0
			July		
	1	8	15	22	29
cm	20.9				
%	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 Hesperostipa comata, Needle and thread, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm					17.7
%					39.2
	June				
	1	8	15	22	29
cm	19.0	25.1	30.4	36.6	38.2
%	42.1	55.7	67.4	81.2	84.7
	July				
	1	8	15	22	29
cm	42.8	45.1			
%	94.2	100.0			
	August				
	1	8	15	22	29
cm					
%					

Data from Goetz 1963.

Table 4. First flower and flower period of Hesperostipa comata, Needle and thread.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest			6			
Mean			23			
Flower Period						
1969-1971			XX XX			

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 Hesperostipa comata, Needle and thread.

	Flower Stalk Development			Seed Development	
Data Period	Boot	Emerge	Flower	Mature	Shed
1955-1962	19 May	9 Jun	23 Jun	22 Jul	26 Jul

		Percent Leaf Dryness			
Data Period	Leaf Tip Dry	0-25 %	25-50 %	50-75 %	75-100 %
1955-1962	31 Jul	17 Aug	25 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 Needle and thread, 1964-1966.

Ecological Site	Anthesis	Leaf Tip Dry	Leaf 0-25% Dry	Leaf 25%-50% Dry	Leaf 50%-75% Dry
Sandy	26 Jun	25 Jun	19 Aug	9 Sep	1 Oct
Silty	6 Jul	7 Jun	11 Aug	15 Aug	1 Oct
Overflow	24 Jun	26 Jun	6 Aug	17 Aug	9 Sep
Thin claypan	No Data				

Data from Goetz 1970.

Table 8. Mean leaf height in cm for Needle and thread, 1964-1966.

Ecological Site	15 Apr	30 Apr	15 May	31 May	15 Jun	30 Jun	15 Jul	31 Jul	15 Aug	31 Aug	Maximum Height
Sandy	2.50	3.99	5.99	8.99	16.41	19.89	26.49	26.49	26.49	26.49	26.70
Silty	3.00	5.11	11.00	16.00	21.31	23.60	28.70	26.01	24.51	24.51	28.91
Overflow	2.90	5.11	11.00	16.00	21.31	23.60	28.70	26.01	24.51	24.51	28.91
Thin claypan	No Data										

Data from Goetz 1970.

Table 9. Percent crude protein for Needle and thread, 1964-1966.

Ecological Site	1 Jun	15 Jun	1 Jul	15 Jul	1 Aug	15 Aug	1 Sep	Mean
Sandy	14.2	13.8	7.9	8.1	6.7	6.4	5.9	9.0
Silty	12.3	9.9	7.7	7.9	6.9	6.7	6.1	8.2
Overflow No Data								
Thin claypan No Data								

Data from Goetz 1975.

Table 10. Autecology of Hesperostipa comata, Needle-and-thread, with growing season changes in basal cover, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	1.75	0.00	3.47	2.68	3.21
1988-1992	2.99	0.00	2.23	3.55	2.28
1993-1998	2.54	0.00	3.60	3.61	3.26
1999-2003	1.96	0.75	4.01	1.69	3.30
2004-2009	3.25	2.94	2.53	1.83	3.40
2010-2012	4.72	4.27	4.42	3.10	4.95
Shallow					
1983-1987	5.25	0.00	4.50	3.73	4.42
1988-1992	4.65	0.00	3.48	3.97	3.00
1993-1998	3.81	0.00	2.97	4.46	2.21
1999-2003	3.13	1.06	4.27	3.82	2.90
2004-2009	4.48	3.74	2.99	2.86	2.28
2010-2012	6.58	6.48	5.18	3.88	4.01
Silty					
1983-1987	4.35	2.50	3.00	3.41	2.81
1988-1992	5.05	3.61	3.29	4.40	2.70
1993-1998	4.89	3.34	2.11	4.18	2.84
1999-2003	2.75	3.21	3.09	0.64	1.29
2004-2009	4.42	4.38	1.62	0.48	1.23
2010-2012	5.37	6.84	4.36	0.75	2.01

Table 11. Autecology of Hesperostipa comata, Needle-and-thread, 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	16.59	0.00	25.62	21.98	21.40
1988-1992	23.84	0.00	19.57	28.02	20.65
1993-1998	26.31	0.00	21.62	25.04	24.78
1999-2003	17.88	5.89	29.73	17.98	25.85
2004-2009	30.36	27.80	20.96	22.05	28.55
2010-2012	38.30	40.47	34.55	35.02	38.28
Shallow					
1983-1987	41.62	0.00	32.42	26.96	28.76
1988-1992	40.64	0.00	30.70	36.03	28.31
1993-1998	34.00	0.00	23.45	28.08	17.89
1999-2003	25.92	7.36	30.83	29.52	19.99
2004-2009	38.77	31.28	21.21	25.71	17.66
2010-2012	50.02	50.40	32.51	33.05	27.63
Silty					
1983-1987	33.45	21.87	21.81	23.87	18.30
1988-1992	38.85	29.22	27.47	33.06	25.20
1993-1998	40.66	24.15	16.41	28.09	17.35
1999-2003	24.75	23.33	23.30	6.72	10.90
2004-2009	42.77	36.98	13.36	6.24	10.47
2010-2012	49.43	54.14	29.15	8.27	14.28

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