Autecology of Big Bluestem on the Northern Mixed Grass Prairie

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The autecology of Big bluestem, *Andropogon gerardii*, 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).

Big bluestem, *Andropogon gerardii* Vitman, is a member of the grass family, Poaceae, tribe, Andropogoneae, syn.: *Andropogon furcatus* Muhl. ex Willd., and is a native, long lived perennial, monocot, warm-season, tall grass, that has a tolerance to shade and a low tolerance to saline and sodic soils. The first North Dakota record is Stevens 1941. Early aerial growth consists of basal leaves arising from fall produced tiller buds on rhizome branches. Basal leaf blades are 8-50 cm (3.1-19.7 in) long, 2-10 mm wide, tapering to a point with prominent midrib and constricted base with long silky hairs. The split sheath is flattened with soft hairs and purplish base. The collar is indistinct and medium broad. The ligule is a fringed membrane, 0.4-3.0 mm long, with a blunt rounded shape surrounded by long soft hairs. The auricles are absent. The rhizomes are coarse 2.5-5.0 mm (0.1-0.2 in) thick, scaly, from 2.5-5.0 cm (1-2 in) to 15-25 cm (6-10 in) long frequently branched forming a close matted network. The extensive root system has numerous reddish brown main roots, 0.5-3 mm thick, arising from stem crowns and rhizome nodes vertically and obliquely downward, branching profusely with numerous lateral roots 5-15 cm (2-6 in) long, thoroughly occupying the top 76 cm (2.5 ft) of soil with a few long main roots extending down to 1.5-2.1 m (5-7 ft) deep in loose soil. Regeneration is primarily asexual propagation by short rhizome tillers. Seedlings are rare. Flower stalks are stout, coarse, solid center of pith, 1-2 cm (39-79 in) tall, and grooved on one side. Inflorescence are numerous spicate racemes with 2 to 6 (usually 3) branches 4-7 cm (1.6-2.8 in) long arising from one pont at end of a stem branch. Spikelets are in pairs, with one sessile, fertile with twisted awn, the other on short pedicel, sterile, and awnless with numerous white hairs between spikelets. Flower period is from late July to late August. Aerial parts are highly palatable to livestock. Fire consumes aerial parts halting the processes of the four major defoliation resistance mechanisms and causing great reductions in biomass production and tiller density. This summary information on growth development and regeneration of Big bluestem was based on works of Weaver 1954, Stevens 1963, Zaczkowski 1972, Dodds 1979, Great Plains Flora Association 1986, Uchytil 1988, Wennerberg 2004, 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 1969-1971 Study

The range of flowering time of grasses and upland sedges was 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.

Results

Big bluestem resumes basal leaf growth from fall produced tiller buds on rhizome branches. Growth of new Big bluestem leaves is visible by 22 May (table 2). Rapid leaf growth starts 6 June and continues through June. Big bluestem produces 3.5 new leaves around mid June, with crude protein content at 15.5%, and a high phosphorus content at 0.371% (table 1). 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 gramnivores. During mid June, leaf height is 55% of maximum at 11.4 cm (4.5 in) tall (table 2). Early stalk growth becomes active during early July, develops to the boot stage between 8 and 17 July, reaches head emergence by 29 July, produces the first flowers on 24 July, mean first flowers occur on 4 August, with a 3 week flower period from late July to mid August (tables 1, 3, 4, and 5). The flower stalks are at 22.4% height in mid July, at 53.6% height in late July, at 83.6% height in mid August, and at 100% maximum height in late August (table 3). The lead tillers contain 10.2% crude protein in early July, at 10.7% in mid July, and drops below the requirements of lactating cows during the fourth week of July (tables 1 and 6). Leaf growth is at 87% height in early July, at 90% height in mid July, and at 100% maximum height in early August (table 2). Seeds are developing by 6 August, seeds are maturing during 26 August, reaches mature stage during 30 August to 12 September, and start being shed on 7 September (tables 1 and 5). Leaf dryness starts on 20 July, continues through August into September (table 5). Lead tillers drop below the phosphorus requirements of lactating cows during the fourth week of September (tables 1 and 6). Unless the grazing management practice has properly manipulated the stimulation of an adequate quantity of Big bluestem vegetative tillers, lactating cows will be grazing forage below their requirements after July.

Discussion

Big bluestem, *Andropogon gerardii*, is a native, long-lived perennial, warm season, tall grass, monocot, of the grass family that can flourish on special landscape positions on healthy mixed grass prairie plant communities. Big bluestem has developed its greatest abundance in the tall grass prairie where precipitation rates are greater than the evapotranspiration rates. On the mixed grass prairie, the evapotranspiration rates are greater than the precipitation rates. Big bluestem can grow in the mixed grass prairie on landscape locations where the precipitation in combination with the water runin are greater than the evapotranspiration demand. Some of these landscape positions are concave slopes of uplands, lower slopes of convex uplands, and outer rings of wet meadows on subirrigated landscapes.

Big bluestem resumes basal leaf growth from fall produced tiller buds on rhizome branches. New leaves of Big bluestem are visible by 22 May. Leaf growth is rapid during June. Leaf growth is at 36% height during early June, at 55% height on mid June, at 80% height on late June, at 90% height on mid July, and at 100% maximum height during early August. Early stalk growth becomes active during early July. Stalk growth is at 22.4% height in mid July, at 53.6% height on late July, at 83.6% on mid August, and at 100.0% maximum height during late August. The stalk is at boot stage between 8 and 17 July, at head emergence around 29 July, early first flowers appear between 24 July and 4 August, with a

3 week flower period from late July to mid August. Seeds are developing from 6 August, seeds are maturing around 26 August, reach the mature stage between 30 August and 12 September, and start being shed on 7 September. Crude protein content of lead tillers is at 14.6% during early June, is at 15.5% during mid June when the 3.5 new leaf stage is reached, is at 10.2% during early July, at 10.7% during mid July, and drops below the requirements of lactating cows during the fourth week of July. Lead tillers drop below the phosphorus requirements of lactating cows during the fourth week of September. Big bluestem readily increases vegetative tiller production with the removal of 25% to 33% of leaf weight by graminivores when lead tillers are at vegetative growth stages between the 3.5 new leaf stage and the flower stage. Big bluestem also increases vegetative tiller density from mowing before the flower stage is reached. The presence of Big bluestem growing on any landscape position is a valuable asset on the Northern Mixed Grass Prairie.

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Table 1. Andropogon gerardii, Big bluestem, 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			
25			
May 4			
10			
16			
23			
28			
Jun 6	14.6	0.438	Early leaf greenup
13	15.5	0.371	
19	13.6	0.360	
26	13.2	0.375	Active leaf growth
Jul 2	10.2	0.293	
8	12.0	0.320	Flower stalk developing
16	10.7	0.319	
24	11.6	0.315	Flowering (Anthesis)
30	7.9	0.261	
Aug 6	8.9	0.247	Seed developing
13	8.0	0.227	
20	6.5	0.219	
26	7.2	0.219	Seed maturing
Sep 3	7.2	0.220	
12	-	-	Seed mature
21	4.8	0.189	Drying
29	-		
Oct			
Nov 5	5.1	0.109	Drying

Data from Whitman et al. 1951.

Table 2. Mean leaf height in cm and percent of maximum leaf height attained by Andropogon gerardii, Big bluestem, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm				3.0	7.3
%				15.0	35.0
	June				
	1	8	15	22	29
cm	7.3	11.0	11.4	13.7	16.5
%	36.0	52.0	55.0	67.0	80.0
	July				
	1	8	15	22	29
cm	18.0	18.4	18.6	19.3	20.0
%	87.0	89.0	90.0	94.0	97.0
	August				
	1	8	15	22	29
cm	20.6				
%	100.0				

Data from Goetz 1963.

Table 3. Mean stalk height in cm and percent of maximum stalk height attained by Andropogon gerardii, Big bluestem, 1955-1962.

	April				
	1	8	15	22	29
cm					
%					
	May				
	1	8	15	22	29
cm					
%					
	June				
	1	8	15	22	29
cm					
%					
	July				
	1	8	15	22	29
cm		15.0	15.0	29.7	35.9
%		22.4	22.4	44.3	53.6
	August				
	1	8	15	22	29
cm	42.1	47.7	56.0	64.5	67.0
%	62.9	71.2	83.6	96.3	100.0

Data from Goetz 1963.

Table 4. First flower and flower period of Andropogon gerardii, Big bluestem.

	Apr	May	Jun	Jul	Aug	Sep
First Flower						
1955-1962						
Earliest				24		
Mean					4	
Flower Period						
1969-1971				X	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 Andropogon gerardii, Big bluestem.

	Flower Stalk Development			Seed Development	
Data Period	Boot	Emerge	Flower	Mature	Shed
1955-1962	17 Jul	29 Jul	4 Aug	30 Aug	7 Sep

		Percent Leaf Dryness			
Data Period	Leaf Tip	0-25	25-50	50-75	75-100
	Dry	%	%	%	%
1955-1962	11 Jul	20 Jul	7 Aug	20 Aug	11 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.

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