Autecology of Missouri milkvetch on the Northern Mixed Grass Prairie

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The autecology of Missouri milkvetch, *Astragalus missouriensis*, 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).

Missouri milkvetch, *Astragalus missouriensis* Nutt., is a member of the legume (bean) family, Fabaceae, and is a native, perennial, dicot, herb. The first North Dakota record is Bolley 1891. Annual aerial growth has several short, loosely tufted stems, 5-13 cm (2-5 in) tall, with central stems erect, and outer radiating stems ascending to prostrate, arising from a branched crown (caudex). Stem leaves are alternate, odd pinnately compound 4-10 cm (1.6-3.9 in) long, with 9 to 17 elliptic to oblong leaflets, 7 to 13 mm long. Stems and leaves are covered with flattened long white hairs. The root system has a stout prominent taproot with numerous fibrous lateral roots. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the subterranian crown and sprouts from the crown branches. Inflorescence has 3 to 9 flowers in a cluster forming a raceme on top of a leafless erect, stout stalk. Flowers are perfect, pea shaped with 5 dark bluish purple petals 1.5-2 cm (0.6-0.8 in) long appearing during mid May to late June. Fruit is a fleshy, cylindrical, 2 chambered pod, 1.5-2.5 cm (0.6-1.0 in) long with a pointed beak and numerous small brown seeds. Aerial parts are occasionally eaten by livestock and wildlife and are top killed by fire. Damage to aerial parts activates regrowth shoots from the crown and the crown branches. This summary information on growth development and regeneration of Missouri milkvetch was based on works of Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Stubbendieck et al. 2003, and Larson and Johnson 2007.

Procedures

The 1969-1971 Study

The range of flowering time of Missouri milkvetch 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.

The 1983-2012 Study

A long-term study on change in abundance of Missouri milkvetch 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 Missouri milkvetch was determined with plant species stem density by 0.1 m^2 frame density method and with plant species basal cover by the ten-pin point frame method (Cook and Stubbendieck 1986).

The stem density method was used to count individual stems of each plant species rooted inside twenty five 0.1 m^2 quadrats placed along permanent transect lines at each sample site both inside (ungrazed) and outside (grazed) each exclosure. Stem density per 0.1 m^2 quadrat, relative stem density, percent frequency, relative percent frequency, and importance value were determined from the stem density data. Plant species stem density data collection was 1984, 1986 to 2012 on the twice-over treatment and was 1987 to 2012 on the long-term nongrazed and seasonlong treatments. However, stem density data was not collected during 1991, 1993 to 1997 on the sandy, shallow, and silty ecological sites of all three management treatments, stem density data was not collected during 1992 on the sandy ecological site of all three management treatments, and stem density data was not collected during 1999 on the sandy and silty ecological sites of the long-term nongrazed treatment.

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 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 or the stem density 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 density or 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 a growing season. Density importance value ranks the forbs and shrubs and 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

Missouri milkvetch resumes annual aerial growth during early spring with several, loosely tufted, short stems, erect to prostrate arising from a branched caudex with a prominent taproot and numerous fibrous lateral roots. Three to nine perfect, pea shaped flowers with dark bluish purple petals cluster on top of a leafless scape. The six week flower period extends from mid May to the end of June (table 1) (Zaczkowski 1972). The mean flower stalk height ranges from 5 cm to 20 cm (2.0-7.9 in) tall (Stevens 1963).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Missouri milkvetch was found to have low abundance on silty ecological sites. Patterns in the changes in individual plant species abundance was followed for 30 growing seasons during the 1983-2012 study on the sandy and shallow ecological sites of the long-term nongrazed, traditional seasonlong, and twice-over rotation management treatments.

On the sandy site of the nongrazed treatment, Missouri milkvetch was not present where basal cover data were collected and was present during 5.6% of the years that density data were collected with a mean 0.01 stems/m^2 during the total 30 year period. During the early period (1983-1992), Missouri milkvetch was not present on the sandy site of the nongrazed treatment. During the later period (1998-2012), Missouri milkvetch was present during 7.1% of the years with a mean 0.01 stems/m^2 density. The percent present for the density data and stem density changed slightly on the sandy site of the nongrazed treatment over time (tables 2, 3, and 4).

On the sandy site of the ungrazed seasonlong treatment, Missouri milkvetch was not present during the total 30 year period.

On the sandy site of the grazed seasonlong treatment, Missouri milkvetch was not present during the total 30 year period.

On the sandy site of the ungrazed twice-over treatment, Missouri milkvetch was not present where basal cover data were collected and was present during 6.9% of the years that basal cover data were collected with a 0.001% basal cover during the total

30 year period. During the early period (1983-1992), Missouri milkvetch was present during 12.5% of the years with a mean 0.003% basal cover. During the later period (1998-2012), Missouri milkvetch was not present on the sandy site of the ungrazed twice-over treatment. The percent present for basal cover data and basal cover decreased slightly on the sandy site of the ungrazed twice-over treatment over time (tables 2, 3, and 4).

On the sandy site of the grazed twice-over treatment, Missouri milkvetch was not present during the total 30 year period.

During the total 30 year period, Missouri milkvetch was present on the sandy sites of the nongrazed and ungrazed twice-over treatments at low abundance.

On the shallow site of the nongrazed treatment, Missouri milkvetch was not present during the total 30 year period.

On the shallow site of the ungrazed seasonlong treatment, Missouri milkvetch was not present during the total 30 year period.

On the shallow site of the grazed seasonlong treatment, Missouri milkvetch was not present where density data were collected and was present during 3.9% of the years that basal cover data were collected with a mean 0.003% basal cover during the total 30 year period. During the early period (1983-1992), Missouri milkvetch was present during 16.7% of the years with a mean 0.01% basal cover. During the later period (1998-2012), Missouri milkvetch was not present on the shallow site of the grazed seasonlong treatment. The percent present for the basal cover data and basal cover decreased slightly on the shallow site of the grazed seasonlong treatment over time (tables 2, 3, and 4).

On the shallow site of the ungrazed twice-over treatment, Missouri milkvetch was present during 18.2% and 6.9% of the years that density and basal cover data were collected with a mean 0.02 stems/m^2 density and a mean 0.002% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Missouri milkvetch was not present on the shallow site of the ungrazed twice-over treatment. During the later period (1998-2012), Missouri milkvetch was present during 26.7% and 13.3% of the years with a mean 0.03 stems/m^2 density and a mean 0.003% basal cover, respectively. The percent present, stem density, and basal cover increased slightly on the shallow site of the ungrazed twice-over treatment over time (tables 2, 3, and 4).

On the shallow site of the grazed twice-over treatment, Missouri milkvetch was present during 4.6% and 3.3% of the years that density and basal cover data were collected with a mean 0.02 stems/m^2 density and a mean 0.003% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Missouri milkvetch was not present where basal cover data were collected and was present during 14.3% of the years with a mean 0.07 stems/m^2 density. During the later period (1998-2012), Missouri milkvetch was not present where density data were collected and was present during 6.7% of the years with a mean 0.007% basal cover. The percent present for the density data and stem density decreased slightly and the percent present for the basal cover data and basal cover increased slightly on the shallow site of the grazed twice-over treatment over time (tables 2, 3, and 4). The percent present for the density data and percent present for basal cover data were greater on the shallow site of the ungrazed twice-over treatment than those on the shallow site of the grazed twice-over treatment and stem density and basal cover were slightly greater on the shallow site of the grazed twice-over treatment than those on the shallow site of the ungrazed twice-over treatment.

During the total 30 year period, the percent present for the density data for Missouri milkvetch on the shallow site of the ungrazed twice-over treatment was greater than that on the shallow site of the grazed twice-over treatment and the percent present for the basal cover data was greater on the ungrazed twice-over treatment than that on the shallow site of the grazed twice-over treatment and of the grazed seasonlong treatment. The stem density on the shallow site of the grazed twice-over treatment was greater than that on the shallow site of the ungrazed twice-over treatment. The basal cover was similar on the shallow sites of the ungrazed and grazed twice-over treatments and on the shallow site of the grazed seasonlong treatment. Missouri milkvetch had greater abundance on the ungrazed twice-over treatment than on the grazed twice-over and grazed seasonlong treatments.

Discussion

Missouri milkvetch, *Astragalus missouriensis*, is a native, late succession, perennial, dicot forb of the legume family that is commonly present on healthy mixed grass prairie plant communities. Missouri milkvetch can grow on sandy and shallow ecological sites at low abundance.

Annual aerial growth resumes with several short stems arising from a branched caudex with the central stems erect and the outer stems ascending to prostrate. The root system has a stout taproot with numerous fibrous lateral roots. The inflorescence is a raceme of several dark bluish purple pea shaped flowers clustered on top of a leafless erect scape. The six week flower period extends from mid May to late June (1969-1971 study). The mean flower stalk height ranges from 5 cm to 20 cm (2.0-7.9 in) tall (Stevens 1963). Missouri milkvetch has low abundance on the sandy sites of the nongrazed and ungrazed twice-over treatments and low abundance on the shallow sites of the ungrazed and grazed twice-over and grazed seasonlong treatments.

The branched caudex, stout taproot, and extensive lateral root system help Missouri milkvetch to persist through the harsh conditions of the Northern Mixed Grass Prairie.

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Table 1. Flower period of Astragalus missouriensis, Missouri milkvetch.

	Apr	May	Jun		Jul	Aug	Sep
Flower Period 1969-1971		XX	XX	XX			

Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Astragalus missouriensis, Missouri milkvetch, with growing season changes in density importance value, 1983-2012.

Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	0.00	0.00	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.30	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Shallow					
1983-1987	0.00	0.00	0.00	0.00	0.84
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.08	0.00
2004-2009	0.00	0.00	0.00	0.08	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 3. Autecology of Astragalus missouriensis, Missouri milkvetch, 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	0.00	0.00	0.00	0.04	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.03	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Shallow					
1983-1987	0.00	0.00	0.56	0.00	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.10	0.00
1999-2003	0.00	0.00	0.00	0.01	0.18
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty			0.00		
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Table 4. Autecology of Astragalus missouriensis, Missouri milkvetch, with growing season changes in density, 1983-2012.					
Ecological Site Year Period	Nongrazed	Seasonlong		Twice-over	
		Ungrazed	Grazed	Ungrazed	Grazed
Sandy					
1983-1987	0.00	0.00	0.00	0.00	0.00
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.01	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Shallow					
1983-1987	0.00	0.00	0.00	0.00	0.02
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.00	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.00	0.00	0.00	0.00	0.00
2010-2012	0.00	0.00	0.00	0.00	0.00
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

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