Autecology of Whorled milkweed on the Northern Mixed Grass Prairie

Llewellyn L. Manske PhD
Research Professor of Range Science
North Dakota State University
Dickinson Research Extension Center
Report DREC 17-1129

The autecology of Whorled milkweed, *Asclepias verticillata* L., 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).

Whorled milkweed, *Asclepias verticillata* L. is a member of the milkweek family, Asclepiadaceae, and is a native, long lived perennial, warm season dicot, herb. The first North Dakota record is Stevens 1955. Annual aerial growth has a single, slender, erect, unbranched stem 20-60 cm (7.9-23.6 in) tall arising from a persistent sparingly branched fibrous root crown (caudex) with other individual stems spaced a few inches apart as a result of the rhizome habit. Stem leaves are simple, linear 2-6 cm (0.8-2.4 in) long, 0.5-1.5 mm wide, sessile, with 3 to 6 verticillate (whorled) per node, crowded on the stem. Stems and leaves contain a white milky latex and also contain cardioactive glycosides and resins that can be poisonous when consumed at 2% of body weight. The root system has deep, fibrous roots that are compressed into bundles and fused together at root crown nodes (fascicled) with the rhizome nodes spaced a few inches apart. This root system has only a minor effect upon grass plants. Regeneration is by vegetative and sexual reproduction. Vegetative growth is by annual sprouts from the root crowns and by sprouts at the nodes of the rhizomes. Inflorescence has numerous tiny flowers clustered in umbels on top of pedicels that arise from leaf axils near the top of the stem, compounded by numerous other umbels on pedicels forming a cyme. Flowers are small, 4-5 mm wide, with greenish white corolla appearing during early July to mid August. Fruits are erect, narrow, spindle shaped pods with numerous seeds attached to silky hairs. Aerial parts are not grazed by livestock and are top killed by fire. Damage to aerial stems activates regrowth shoots from the crown and new sprouts develop from the rhizome nodes. This summary information on growth development and regeneration of whorled milkweed was based on works of Weaver and Fitzpatrick 1934, Weaver 1954, Stevens 1963, Zaczkowski 1972, Great Plains Flora Association 1986, Stubbendieck et al. 2003, Johnson and Larson 2007.

Procedures

The 1969-1971 Study

The range of flowering time of Whorled milkweed 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 Whorled milkweed 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 Whorled milkweed 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

Whorled milkweed resumes annual aerial growth as a single unbranched stem arising from a persistent branched fibrous caudex with a rhizome system and a deep fibrous root system. Stems and leaves contain a white milky latex that can be poisonous to humans and livestock when consumed at 2% of body weight, i.e. 24 lbs for a 1200 lb cow. Small greenish white flowers develop in multiple umbels forming a cyme. The flower period was observed to occur during 5 weeks from early July through the first week of August (table 1) (Zaczkowski 1972). The mean mature stem height ranged from of 20 cm to 60 cm (7.9-23.6 in) tall (Stevens 1963).

Plant species composition in rangeland ecosystems is variable during a growing season and dynamic among growing seasons. Whorled milkweed 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, Whorled milkweed was present during 38.9% and 28.0% of the years that density and basal cover data were collected, with a mean 1.84 stems/m^2 density and a mean 0.02% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Whorled milkweed was not present where basal cover data were collected and was present during 25.0% of the years with a mean 0.10 stems/m^2 density. During the later period (1998-2012), Whorled milkweed was present during 42.9% and 46.7% of the years with a mean 2.34 stems/m^2 density and a mean 0.04% basal cover, respectively. The percent present, stem density, and basal cover all

increased on the sandy site of the nongrazed treatment over time (tables 2, 3, and 4).

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

On the sandy site of the grazed seasonlong treatment, Whorled milkweed was not present where basal cover data were collected and was present during 15.8% of the years that density data were collected with a mean 0.11 stems/m^2 density during the total 30 year period. During the early period (1983-1992), Whorled milkweed was not present on the sandy site of the grazed seasonlong treatment. During the later period (1998-2012), Whorled milkweed was present during 20.0% of the years with a mean 0.14 stems/m^2 density. The percent present for the density data and stem density increased on the sandy site of the grazed seasonlong treatment over time (tables 2, 3, and 4). The percent present for density data and stem density 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, Whorled milkweed was present during 90.5% and 51.7% of the years that density and basal cover data were collected with a mean 3.38 stems/m^2 density and a mean 0.05% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Whorled milkweed was present during 66.7% and 25.0% of the years with a mean 1.37 stems/m^2 density and a mean 0.02% basal cover, respectively. During the later period (1998-2012), Whorled milkweed was present during 100.0% and 73.3% of the years with a mean 4.19 stems/m^2 density and a mean 0.06% basal cover, respectively. The percent present, stem density, and basal cover all increased 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, Whorled milkweed was present during 90.5% and 48.3% of the years that density and basal cover data were collected with a mean 1.85 stems/m^2 density and a mean 0.03% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Whorled milkweed was present during 66.7% and 22.2% of the years with a mean 1.38 stems/m^2 density and a mean 0.01% basal cover, respectively. During the later period (1998-2012), Whorled milkweed was present during 100.0% and 66.7% of the years with a mean 2.04 stems/m^2 density and a mean 0.04% basal cover, respectively. The percent present, stem density, and basal cover all increased on the sandy site of the grazed twice-over treatment over time (tables 2, 3, and 4). The percent present for the density data and the percent present for the basal cover data were similar on the sandy sites of the ungrazed and grazed twice-over treatments. The stem density and basal cover were greater on the sandy site of the ungrazed then those on the sandy site of the grazed twice-over treatments.

During the total 30 year period, Whorled milkweed had low to no abundance on the sandy sites of the ungrazed and grazed seasonlong treatments and had good abundance on the sandy sites of the ungrazed and grazed twice-over treatments.

On the shallow site of the nongrazed treatment, Whorled milkweed 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 0.001% basal cover during the total 30 year period. During the early period (1983-1992), Whorled milkweed was not present on the shallow site of the nongrazed treatment. During the later period (1998-2012), Whorled milkweed was present during 6.7% of the years with a mean 0.002% basal cover. The percent present for the basal cover data and the basal cover increased slightly on the shallow site of the nongrazed treatment over time (tables 2, 3, and 4).

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

On the shallow site of the grazed seasonlong treatment, Whorled milkweed was not present where basal cover data were collected and was present during 5.0% of the years that density data were collected with a mean 0.01 stems/m^2 density. During the early period (1983-1992), Whorled milkweed was not present on the shallow site of the grazed seasonlong treatment. During the later period (1998-2012), Whorled milkweed was present during 6.7% of the years with a mean 0.01 stems/m^2 density. The percent present for the density data and the stem density increased slightly on the shallow site of the grazed seasonlong treatment over time (tables 2, 3, and 4). The percent present for the density data and stem density were slightly larger 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, Whorled milkweed was present during 22.7% and 3.5% of the years that density and

basal cover data were collected with a mean 0.06 stems/m^2 density and a mean 0.001% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Whorled milkweed was not present where basal cover data were collected and was present during 42.9% of the years with a mean 0.16 stems/m^2 density. During the later period (1998-2012), Whorled milkweed was not present where basal cover data were collected and was present during 13.3% of the years with a mean 0.01 stems/m^2 density. The percent present for the density data and stem density decreased 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, Whorled milkweed was present during 9.1% and 3.3% of the years that density and basal cover data were collected with a mean 0.01 stems/m^2 density and a mean 0.001% basal cover during the total 30 year period, respectively. During the early period (1983-1992), Whorled milkweed was present during 14.3% and 10.0% of the years with a mean 0.01 stems/m^2 density and a mean 0.002% basal cover, respectively. During the later period (1998-2012), Whorled milkweed was not present where basal cover data were collected and was present during 6.7% of the years with a mean 0.01 stems/m^2 density. The percent present for the density data, the percent present for the basal cover data, stem density, and basal cover all decreased 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 stem density were greater on the shallow site of the ungrazed twice-over treatment than those on the shallow site of the grazed twice-over treatment.

On the sandy sites, Whorled milkweed was present during 47.1% and 42.7% of the years that density and basal cover data were collected with a mean 1.44 stems/m^2 density and a mean 0.02% basal cover, respectively. On the shallow sites, Whorled milkweed was present during 7.4% and 2.1% of the years that density and basal cover data were collected with a mean 0.02 stems/m^2 density and a mean 0.001% basal cover, respectively. Whorled milkweed can grow on the sandy and shallow ecological sites. It appears to grow much better on the sandy sites than on the shallow sites.

Whorled milkweed was present on the sandy sites of the nongrazed treatment during 38.9% and 28.0% of the years that density and basal cover data were collected with a mean 1.84 stems/m^2 density and a mean 0.02% basal cover. Whorled milkweed was present on the sandy sites of the seasonlong treatments during 7.9% and 0.0% of the years with a mean 0.06 stems/m^2 density and a mean 0.0% basal cover. Whorled milkweed was present on the sandy sites of the twice-over treatments during 90.5% and 50.0% of the years with a mean 2.62 stems/m^2 density and a mean 0.04% basal cover. Whorled milkweed had greater abundance on the sandy sites of the twice-over treatments than the nongrazed and seasonlong treatments on the sandy sites.

Whorled milkweed was present on the shallow sites of the nongrazed treatment during 0.0% and 3.9% of the years with a mean 0.0 stems/m^2 density and a mean 0.001% basal cover. Whorled milkweed was present on the shallow sites of the seasonlong treatments during 2.5% and 0.0% of the years with a mean 0.003 stems/m^2 density and a mean 0.0% basal cover. Whorled milkweed was present on the shallow sites of the twice-over treatments during 15.9% and 3.4% of the years with a mean 0.03 stems/m^2 density and a mean 0.001% basal cover. Whorled milkweed abundance was low on the shallow sites of each management treatment with the higher abundance on the twice-over treatments.

Discussion

Whorled milkweed, *Asclepias verticillata*, is a native, late succession, warm season, longlived perennial, dicot, forb of the milkweed family that should be present on healthy mixed grass prairie plant communities. Whorled milkweed can grow on sandy and shallow ecological sites. It grows better on the sandy site and it grows best on sandy sites managed with the twice-over rotation treatment. Whorled milkweed has low abundance on shallow sites. Annual aerial growth consists of a single unbranched stem arising from a perennating caudex. Spacing of individual stems, at a few inches apart, results from the rhizome habit. The root system had deep fibrous bundles of fused roots arising from the crown and rhizome nodes. Tiny greenish white flowers are clustered in multiple umbels forming a cyme. The observed flower period was 5 weeks from early July to the end of the first week in August (1969-1971 study). The mean mature stem height ranged from 20 cm to 60 cm (7.9-23.6 in) tall (Stevens 1963).

The perennating fibrous caudex, a rhizome system with closely spaced nodes, a deep complex root system, and the ability to activate vegetative sprouts from nodes helps Whorled milkweed to persist through the harsh conditions of the Northern Mixed Grass Prairie.

Acknowledgment

I am grateful to Sheri Schneider for assistance in the production of this manuscript and for development of the tables.

Table 1. Flower period of Asclepias verticillata, Whorled milkweed.

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

Flower Period Data from Zaczkowski 1972.

Table 2. Autecology of Asclepias verticillata, Whorled milkweed, 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	14.99	11.42
1988-1992	2.30	0.00	0.00	3.34	3.20
1993-1998	0.00	0.00	4.20	15.27	15.35
1999-2003	0.00	0.00	2.00	14.10	10.29
2004-2009	9.00	0.00	0.00	18.07	12.03
2010-2012	20.89	0.00	0.00	13.98	4.83
Shallow					
1983-1987	0.00	0.00	0.00	1.74	0.17
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	0.31	0.00
2004-2009	0.00	0.00	0.17	0.07	0.04
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 Asclepias verticillata, Whorled milkweed, 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	0.02	0.17
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.62	0.39
1999-2003	0.10	0.00	0.00	0.63	0.29
2004-2009	0.30	0.00	0.00	0.99	0.44
2010-2012	0.95	0.00	0.00	0.37	0.12
Shallow					
1983-1987	0.00	0.00	0.00	0.00	0.03
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.02	0.00
1999-2003	0.00	0.00	0.00	0.00	0.00
2004-2009	0.05	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					

Table 4. Autecology of Asclepias verticillata, Whorled milkweed, 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	0.24	0.25
1988-1992	0.01	0.00	0.00	0.03	0.02
1993-1998	0.00	0.00	0.04	0.31	0.28
1999-2003	0.00	0.00	0.03	0.53	0.23
2004-2009	0.28	0.00	0.00	0.42	0.22
2010-2012	0.53	0.00	0.00	0.26	0.10
Shallow					
1983-1987	0.00	0.00	0.00	0.03	0.02
1988-1992	0.00	0.00	0.00	0.00	0.00
1993-1998	0.00	0.00	0.00	0.07	0.04
1999-2003	0.01	0.00	0.00	0.05	0.04
2004-2009	0.03	0.00	0.00	0.09	0.06
2010-2012	0.10	0.00	0.00	0.03	0.01
Silty					
1983-1987	Few Plants Present				
1988-1992					
1993-1998					
1999-2003					
2004-2009					
2010-2012					

Literature Cited

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

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

Johnson, J.R., and G.E. Larson. 2007. Grassland plants of South Dakota and the Northern Great Plains. South Dakota University. B 566 (rev.). Brookings, SD.

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.

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

Stubbendieck, J., M.J. Coffin, and L.M. Landholt. 2003. Weeds of the Great Plains. Nebraska Department of Agriculture. Lincoln, NE.

Weaver, J.E., and T.J. Fitzpatrick. 1934. The prairie. Ecological Monographs 4(2):109-295.

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

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.