Autecology of Russian Wildrye on the Northern Mixed Grass Prairie

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The autecology of Russian wildrye, *Psothyrostachys juncea*, 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).

Russian wildrye, *Psothyrostachys juncea* (Fisch.) Nevski., is a member of the grass family, Poaceae, tribe, Triticeae, syn.: *Elymus junceus* Fisch., and is a long lived perennial, monocot, cool-season, mid grass, that is exceptionally drought tolerant, tolerant of extremely cold temperatures, highly tolerant of saline soils, fairly tolerant of alkaline soils, and intolerant of spring flooding or high water tables. Russian wildrye was introduced into the United States from Siberia. It was brought to North Dakota in 1907, grown at the Dickinson Research Extension Center in 1913, and grown at the USDA-ARS at Mandan, ND. in 1927. It was introduced into Canada from Siberia in 1926. Early aerial growth consists of basal leaves from crown tiller buds. Basal leaf blades are 7-40 cm (3-16 in) long, 2-6 mm wide, soft, lax, numerous and dense. The split sheath has overlapping margins and open at the top. Previous years sheath bases are persistent and shredded into fibers. The collar is broad and continuous. The membrane ligule is 1 mm long with a blunt flat edge that has numerous small irregular cuts. The small auricles are 2 mm long, clasping, and clawlike. Some plants form no rhizomes, while other plants have several short rhizomes, while other plants have several short rhizomes that form clumps 20-30 cm (8-12 in) wide. Unfortunately, fields seeded with plant material that has nonaggressive short rhizomes is limited by around a 20 to 25 year life expectancy. All branches have an extensive network of dense, fibrous roots with a lateral spread of 1.2-1.5 m (4-5 ft) that descend downward to 2.5-3.0 m (8-10 ft) deep. About 75% of the root biomass is in the top 15-61 cm (6-24 in) of soil that provides high plant competition to most other species. Regeneration is primarily asexual propagation by crown and short rhizome tiller buds. Seedlings are weak, develop slowly and are successful only when competition from established plants is nonexistant. Flower stalks are erect, hollow, 60-100 cm (24-39 in) tall, mostly leafless and few in number. Inflorescence is a terminal spike 6-11 cm (2.4-4.3 in) long, 5-9 mm wide, that has closely spaced overlapping spikelets of 1 to 4 florets, with 2 or 3 spikelets per node. Flower period in the Great Plains is May and June. Basal leaves are palatable to livestock and seed stalks are not. Wildryes maintain slightly higher levels of protein and digestibility with advancing maturity better than other species of perennial grasses. Wildryes are best used for late season grazing from mid October to mid November. Fire top kills aerial parts and kills deeply into the crown when soil is dry. Fire halts the processes of the four major defoliation resistance mechanisms and causes great reduction in biomass production and tiller density. This summary information on growth development and regeneration of Russian wildrye was based on works of Stevens 1963, Dodds 1979, Great Plains Flora Association 1986, Ogle et al. 2005, Taylor 2005, and Johnson and Larson 2007.

Procedures

The 1951-1978 Study

The high demand for grass seed during the 1930's and the low seed quantity along with the scarcity of grass varieties available resulted in high quantities of native and introduced grass species to become available for reseeding abandoned or excess cropland acres. A major problem came with these grass seed varieties; they did not come with management instructions or directions on how to best utilize each species. Numerous forage yield from clipping trials were conducted. Hay cut was cut close to the ground at a near mature growth stage. Pasture cut was cut two inches above the ground, two or three times during the summer. All values reported were oven dried weight.

The 1972-1982 Study

Dr. W.C. Whitman designed a 3-pasture, repeat seasonal grazing system that used yearling steers during 1972 to 1976 and cow-calf pairs during 1978 to 1982 with crested wheatgrass pastures used during spring, native rangeland pastures used during summer and Russian wildrye pastures used during late summer and/or fall. One set of pastures was fertilized each spring with 50 lbs N/ac and the other set of pastures was unfertilized. The crested wheatgrass and Russian wildrye were seeded into sandy and loamy sands soils. This was before it was known that Russian wildrye prefers loam and clay loam soils and does not do well in sandy or loamy sands soils. Because the Russian wildrye grass density was low, both pastures were fertilized during 1972 to 1976. Livestock were weighed on and off each pasture type and at 28-day intervals when pastures were grazed longer than a month. Herbage samples were clipped prior to and shortly after being grazed using 0.76 X 1.5 meter frames inside and outside the exclosure cages distributed at a rate of one cage per every 0.75 acres of pasture.

Results

Hay yield trial on table 1 determined that Russian wildrye production was 92.4% basal leaves with few seed stalks. Total production was less than crested wheatgrass and smooth bromegrass. Stand density deteriorated from close to the ground hay cuts.

Forage yield trial on table 2 determined that most grass species generally have greater yields under the hay cut than the pasture cut. However, Russian wildrye was different, it had greater average production under the pasture cut than under the hay cut. Russian wildrye and Green needlegrass were practically not good grasses for hay production. Russian wildrye had greater percent crude protein and had almost 50% greater lbs/ac of protein under the pasture cut than the hay cut. These results suggest that Russian wildrye should be given increasing consideration for use in pasture seedings in western North Dakota.

Forage yield trial on table 3 determined that the yield increase of Russian wildrye with alfalfa was negligible and that very little alfalfa remained in the plots in 1962. The increase in hay production resulting from application of 67 lbs N/acre and 100 lbs N/acre would not have been economical. The increase in hay production resulting from application of 33 lbs N/acre was 53% greater than the unfertilized control and this increase would have been profitable on the basis of cost of nitrogen and returns from the additional hay production. However, that great of an increase only occurred one growing season. The increase over 5 growing seasons was 357 lbs of hay per acre for an average increase of 34% which would not be enough to more than just barely pay for the fertilizer.

Hay yield trial on table 4 compared the prereleased germplasm of variety Vinall with a commercially available seed source of Russian wildrye that determined a slightly greater mean hay yield for Vinall that was not significantly different.

Herbage yield trial on table 5 evaluated 21 of the currently available accessions of cool season grasses which included 6 different wildrye accessions. Canada wildrye and Russian wildrye were previously released varieties. Altai wildrye and Basin wildrye were not yet officially released varieties. The July harvest clip cut bunch grasses at crown height and Altai and Basin wildryes were cut at a 6 inch height. The hay yield of the wildryes tended to decrease annually indicating that the cutting height was too severe for the plants to fully recover. This would suggest that the wildryes should not be used for hay production. The two Basin wildrye selections required three growing seasons to become established enough to warrant harvesting. Canada (Great Plains) wildrye var. Mandan was released in 1946 and has very high aesthetic value as an ornamental grass, if barriers are used to confine its growth to small spaces, however, its productivity is not high enough to be a pasture grass. Both Altai and Russian wildryes start early growth before crested wheatgrass and might appear to be suitable as spring pastures, however, cattle prefer crested wheatgrass to the wildryes during the spring (Nyren et al. 1980). Altai and Russian wildryes are best used as late season pastures.

Data from test plots of wildrye grasses that are not grazed have completely different growth characteristics and much different nutrient quality curves than the same wildrye species that are fall grazed.

All grass tillers live for two growing seasons, first as a vegetative tiller and secondary as a reproductive lead tiller. Russian wildrye, like all cool season grasses, develop the new vegetative tillers during the previous late summer from mid August to hard frost. The apical meristem of advanced vegetative tillers that have been growing since early that spring are induced to develop flower bud

primordia after mid August, becoming the new lead tillers. The next spring, new basal leaves develop on these lead tillers from leaf buds that had developed the previous late summer while the tiller was still a vegetative tiller. During May and June, the basal leaves and seed stalks of lead tillers have priority over development of other tiller types. After the lead tillers reach the flower stage, vegetative crown tillers increase in growth rate. The lead tillers produce almost all of the herbage weight during May and June, vegetative crown tillers produce the additional herbage weight during July and most of August. Fall tillers produce the additional herbage weight after mid August during September and October. The quantity of crude protein in the herbage during the late grazing period of mid October and mid November depends on the percent composition of vegetative crown tillers and fall tillers. When wildrye tussocks are severely defoliated during June or July, the vegetative and fall tillers are greatly restricted in any future development. When greater than 50% of the herbage biomass is removed during the late season grazing period or after mid November, the quantity of vegetative and fall tillers are greatly reduced causing basal cover and herbage biomass production to decrease substantially. Fall grazing from mid October to mid November of wildrye pastures that removes less than 50% of the herbage biomass stimulates the quantity of vegetative tillers and fall tillers which increases the basal cover, the herbage biomass, and the crude protein content of the next falls grazable forage.

Unfortunately this was not known during the 1972-1982 grazing study. During the 1972 to 1976 period, yearling steers grazed the three pasture repeat seasonal fertilized and unfertilized systems of crested wheatgrass for spring, native range for summer, and Russian wildrye for fall; both of the wildrye pastures were fertilized.

The forage production (1972-1976) on the fertilized Russian wildrye pastures averaged 1741 lbs/ac which was lower than the forage produced on the fertilized and unfertilized crested wheatgrass and native range pastures. To offset this deficiency in forage quantity, the Russian wildrye pastures had increased utilization to 79% (table 6).

The steers coming off the fertilized crested wheatgrass and native range pastures had a slight advantage in gain per head, gain per day, gain per acre than the steers coming off the unfertilized system (table 7). However, these steer gains on the Russian wildrye pastures were insufficient, which had several causes. The number of steers, the number of days grazed, and the percent utilization were excessive for the below potential level of forage production. Ten steers should have had 36 days of grazing and 12 steers should have had 30 days of grazing.

During the 1978 to 1982 period, minus the data from the drought growing season of 1980, cow-calf pairs grazed the 3 pasture repeat seasonal system; only one of the Russian wildrye pastures was fertilized. The mean forage production on the fertilized pasture was 2781 lbs/ac and on the unfertilized pasture was 1599 lbs/ac. The fertilizer increased the herbage biomass 74% (table 8). The calf gain per day was slightly higher on the unfertilized system, however, the calves on the fertilized system had slightly greater gain per head and gain per acre because they remained an average of 12 days longer on the pasture (table 9). The cow weight performance was positive on both systems with slightly greater gains on the fertilized system, however, the cow weight performance should have been better on both systems. These problems had several causes. The number of days grazed and the percent utilization were excessive for the levels of forage production on both systems. The ten cow-calf pairs on the unfertilized Russisn wildrye pasture should have had 25 days of grazing and the ten cow-calf pairs on the fertilized pasture should have had 43 days of grazing. Removal of greater than 50% of the aboveground herbage during the late season grazing period reduced the quantity of vegetative and fall tillers causing a reduction in basal cover, herbage biomass production, and crude protein content the following fall grazing period. The Russian wildrye plants could not produce at the biological potential because the percent utilization was greater than 50% while the steers and cow-calf pairs grazed.

Russian wildrye plants do not do well in sandy soil. During the discussed grazing study of 1972 to 1982 , both the crested wheatgrass and Russian wildrye were seeded into sandy soils. Fertilization of Russian wildrye pastures on sandy soils did not result in producing a good stand of grass. Nitrogen fertilization of grasslands gives the illusion of increasing herbage biomass production. Unfertilized grasslands have a smooth bell shaped curve of herbage biomass with the leaves of the lead tillers providing most of the biomass weight during May and June. The vegetative tillers increase in growth rate and add biomass during July and August, and fall tillers add biomass weight during September and October. The height of the herbage curves is dependent on the quantity and ratio of lead tillers, vegetative tillers, and fall tillers. When nitrogen fertilizer is added, grass biomass production is

adjusted earlier in time to occur at a greater rate. The individual leaves of the lead tillers develop faster and earlier, vegetative tillers develop faster and earlier. The typical up slope of the grass growth curve has the peak aboveground biomass pushed earlier and higher than the unfertilized curve and it then becomes much narrower also. The early growth causes early and rapid senescence resulting in an early accelerated down slope of the growth curve. The grass time period of biomass growth is greatly shortened but with a higher peak. The quantity of herbage biomass after the peak is greatly reduced from that of the unfertilized growth curve and the nutritional quality of that herbage is greatly decreased. Livestock weight performance grazing herbage after the short duration peak is greatly decreased below the weight performance on unfertilized grassland during the same time period.

Russian wildrye should be seeded on loam or clay loam soils, not fertilized, and grazed from mid October to mid November leaving greater than 50% of the herbage at the end of the period with no grazing after mid November.

Discussion

Russian wildrye, *Psothyrostachys juncea*, is an introduced cool-season, mid grass, monocot, of the grass family that is drought tolerant, winter hardy, tolerant of saline and alkaline soils, and intolerant of spring flooding or high water tables. Russian wildrye prefers loam and clay loam soils and does not do well on sandy or loamy sands soils. Early season aerial growth of basal leaves arise from crown tiller buds. Carryover leaves provide carbohydrates and energy for new leaf growth. Some plants form no rhizomes, while other plants produce several short rhizomes. Plants that produce rhizome tillers are better. Vegetative growth of crown tillers form tussocks. Leaves of lead tillers develop from leaf buds developed on vegetative tillers the previous late summer after mid August just before the apical meristem was induced to develop flower bud primordia which will emerge the following May or June. Basal leaves and seed stalks of lead tillers have priority over development of other tiller types. After the lead tillers reach the flower stage, vegetative crown tillers increase in growth rate. The lead tillers produce almost all of the herbage weight during May and June, vegetative crown tillers produce the additional herbage weight during July and August. Fall tillers produce the additional herbage weight after mid August during September and October. The quantity of crude protein in the herbage during the late grazing period from mid October to mid November depends on the percent composition of vegetative crown tillers and fall tillers. When grazing removes greater than 50% of the aboveground herbage biomass during the grazing period or any grazing after mid November, a large portion of the vegetative crown tillers and fall tillers do not survive until the following spring. That loss causes the basal cover to decrease and the quantity of available crude protein is greatly reduced for that next fall grazing period resulting in a great reduction in cow and calf weight performance.

Fall grazing of Russian wildrye pastures that removes less than 50% of the aboveground herbage biomass stimulates the quantity of vegetative tillers and fall tillers which increase the crude protein content of the next falls grazable forage. Data from test plots of wildrye grasses that are not grazed have very different growth characteristics, fewer vegetative and fall crown tillers, and much different nutrient quality curves than the same wildrye species that are fall grazed and leaving more than 50% of the herbage biomass.

Cutting Russian wildrye for hay greatly reduces the number of vegetative crown tillers produced, resulting in progressive decreases in basal cover, herbage biomass, and nutritional quality. Russian wildrye should not be considered as a grass for hay production. The best use of Russian wildrye is as fall pastures grazed from mid October to mid November and no later.

Fertilization of mineral nitrogen on Russian wildrye synchronizes lead and vegetative tiller growth to occur rapidly in the early portion of the growing season and then causes premature rapid senescence of those tillers resulting in low nutritional quality herbage later that growing season and reduced livestock weight performance. If the soil needs amendments, use aged composted manure.

Russian wildrye was introduced into North America from Siberia. Scientists in the United States and Canada worked many decades to figure out how best to use Russian wildrye. The wildrye grasses require management different from North American traditional grass management. Which has resulted in low acceptance and use of wildryes, like Altai and Russian, as late season pastures grazed from mid October to mid November. However, as scientists learn more about the correct management of Russian wildrye, it will increase in use and provide high quality forage for cows and calves during the late season window that has no other perennial grass forage plant available.

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Table 1. Hay yield trial in lbs/ac, Dickinson Experiment Station, plots seeded spring 1951, 1952-1955.

	Year				
	1952	1953	1954	1955	Mean
Russian wildrye	759	1082	841	626	827

Data from Whitman, Dickinson Station Annual Report, 1955.

Table 2. Forage yield from clipping trial in lbs/ac, Dickinson Experiment Station, plots seeded spring 1951, 1953-1958.

	Years						Crude Protein		
	1953	1954	1955	1956	1957	1958	Mean	%	lbs/ac
Russian wildrye									
Summer									
Pasture cut	1125	608	753	380	625	593	681	16.3	111
Near Mature									
Hay cut	1058	833	627	267	621	525	655	11.8	75

Data from Whitman et al. 1961.

Table 3. Hay yield from clipping trial in lbs/ac, Alone, with Alfalfa, or Fertilized, Dickinson Experiment Station, plots seeded 1957.

	Years					
	1958	1959	1960	1961	1962	Mean
Russian wildrye						
Alone	941	778	1287	643	1338	997
with Alfalfa	1111	841	1312	616	1395	1055
Fertilized						
33 lbs N	1224	975	1710	821	2041	1354
67 lbs N	1613	971	1823	761	2077	1449
100 lbs N	1984	1086	1997	777	2746	1718

Data from Whitman, Dickinson Station Annual Report, 1962.

Table 4. Hay yield from clipping trial in lbs/ac, Dickinson Experiment Station, plots seeded 1958, 1959-1965.

	Years							
	1959	1960	1961	1962	1963	1964	1965	Mean
Russian wildrye								
2355 (Vinall)	1368	2086	686	1727	1929	913	1478	1455
Commercial	1404	1913	756	1530	1574	1008	1522	1387

Data from Whitman, Dickinson Station Annual Report, 1965.

Table 5. Herbage yield from clipping trial in lbs/ac, Dickinson Experiment Station, plots seeded spring 1972, 1973-1978.

		Years						
		1973	1974	1975	1976	1977	1978	Mean
Altai wildrye	(Sask.)	1517			4412			2965 ab
Altai wildrye	(Mandan)	1950			4258	2346	949	2812 b
Basin wildrye	(Mandan)			5284	3416	1510	1698	2924 b
Basin wildrye	(Pullman)			3705	4005	1614	1147	2487 b
Canada wildrye	(Mandan)	1420	3927	2871	1384	797	588	1972 b
Russian wildrye	(Vinall)	459	3912	2765	1449	998	1908	1828 b

Trial means followed by the same letter are not significant at the 95% level.
Data from Nyren et al. 1980.

Table 6. Steer stocking rate and forage utilization on two fertilized late season Russian wildrye pastures, 1972-1976.

Russian wildrye	# Days Grazed	# Months Grazed	# Head	# AUM's	ac/AUM	Forage Produced lbs/ac	Forage Utilized lbs/ac	Utilization %	Forage per Steer lbs/d
Fertilized 16 ac									
1972	56	1.84	10	18.36	1.12	1526	900	59	25.7
1973	71	2.33	12	27.93	0.75	1630	1565	96	29.4
1974	70	2.30	12	27.54	0.77	1622	1330	82	25.3
1975	54	1.77	12	21.25	0.95	2283	1781	78	22.0
1976	69	2.26	12	27.15	0.77	1645	1283	78	25.8
Mean	64	2.10	11.6	24.34	0.85	1741	1375	79	29.6

Data from Nyren et al. 1983.

Table 7. Steer weight performance on late season Russian wildrye pastures, 1972-1976. Both Russian wildrye pastures fertilized with 50 lbs N/ac, steers from unfertilized crested wheatgrass and native range and steers from fertilized crested wheatgrass and native range pastures, 1972-1976.

Russian wildrye	Dates Grazed	# Days	# Head	Gain per Head, lbs	Gain per Days, lbs	Gain per Acre, lbs
Unfertilized 16 ac						
1972	1 Sep-26 Oct	56	10	81.9	1.45	51.2
1973	23 Aug-1Nov	71	12	60.4	0.84	45.3
1974	4 Sep-11 Nov	70	12	35.5	0.51	26.6
1975	3 Sep-27 Oct	54	12	45.8	0.85	68.7
1976	13 Aug-21 oct	69	12	10.0	0.13	7.5
Mean	27 Aug-30 Oct	64	11.6	46.8	0.76	39.9
Fertilized 16 ac						
1972	1 Sep-26 Oct	56	10	83.5	1.50	52.2
1973	23 Aug-1 Nov	71	12	79.9	1.12	59.9
1974	4 Sep-11 Nov	70	12	24.5	0.35	18.4
1975	3 Sep-27 Oct	54	12	31.7	0.59	47.6
1976	13 Aug-21 Oct	69	12	33.3	0.49	25.0
Mean	27 Aug-30 Oct	64	11.6	50.6	0.81	40.6

Data from Nyren et al. 1983.

Table 8. Cow-calf stocking rate and forage utilization on late season Russian wildrye pasture, 1978-1982.

Cow-calf pairs	# Days Grazed	# Months Grazed	# Head	# AUM's	ac/AUM	Forage Produced lbs/ac	Forage Utilized lbs/ac	Utilized %	Forage per cow-calf lbs/d
Unfertilized 16 ac									
1978	46	1.51	10	15.10	1.06	1760	1320	75	45.91
1979	34	1.11	10	11.15	1.44	1280	1033	81	48.61
1981	56	1.84	8	14.69	1.09	1612	1483	92	52.96
1982	38	1.25	10	12.46	1.28	1743	944	54	39.75
Mean	43.5	1.43	9.5	13.55	1.18	1599	1195	75.5	46.81
Fertilized 16 ac									
1978	55	1.80	10	18.03	0.89	2727	1963	72	57.11
1979	41	1.34	10	13.44	1.19	1754	1386	79	54.09
1981	82	2.69	8	21.51	0.74	3071	2764	90	67.41
1982	45	1.48	10	14.75	1.08	3570	1399	39	49.74
Mean	55.8	1.83	9.5	17.38	0.92	2781	1878	70.0	57.09

Data from Manske et al. 1984.

Table 9. Cow and calf weight performance on late season Russian wildrye pasture, 1978-1982.

Russian wildrye	Dates Grazed	# Days	# Head	Initial wt lbs	Final wt lbs	Gain per Head lbs	Gain per Day lbs	Gain per Acre lbs
Calf								
Unfertilized 16 ac								
1978	14 Aug-29 Sep	46	10	328	410	82	1.78	51.3
1979	20 Jul-23 Aug	34	10	275	352	77	2.26	48.1
1981	29 Jul-22 Sep	56	8	286	412	126	2.25	63.0
1982	20 Aug-27 Sep	38	10	317.5	403.0	85.5	2.25	53.4
Mean	5 Aug-17 Sep	43.5	9.5	301.6	394.3	92.6	2.13	54.0
Fertilized 16 ac								
1978	15 Sep-9 Nov	55	10	342	426	84	1.53	52.5
1979	20 Jul-30 Aug	41	10	291	368	77	1.88	48.1
1981	5 Aug-26 Oct	82	8	296	459	163	1.99	81.5
1982	20 Aug-4 Oct	45	10	323.5	409.0	85.5	1.90	53.4
Mean	15 Aug-10 Oct	55.8	9.5	313.1	415.5	102.4	1.84	58.9
Cow								
Unfertilized 16 ac								
1978	14 Aug-29 Sep	46	10	1070	1084	14	0.30	9
1979	20 Jul-23 Aug	34	10	1080	1098	18	0.53	11
1981	29 Jul-22 Sep	56	8	1161	1180	19	0.34	19
1982	20 Aug-27 Sep	38	10	1041.5	1068.5	27	0.71	16.9
Mean	5 Aug-17 Sep	43.5	9.5	1088.1	1107.6	19.5	0.47	14.0
Fertilized 16 ac								
1978	15 Sep-9 Nov	55	10	1008	1092	84	1.53	52
1979	20 Jul-30 Aug	41	10	1084	1124	40	0.98	26
1981	5 Aug-26 Oct	82	8	1044	1127	83	1.01	41
1982	20 Aug-4 Oct	45	10	1048.5	1062.5	14	0.31	8.8
Mean	15 Aug-10 Oct	55.8	9.5	1046.1	1101.4	55.3	0.96	32.0

Data from Manske et al. 1984.

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