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Leafy spurge (*Euphorbia esula*) control with several grass species[1]

MARK A. FERRELL, THOMAS D. WHITSON, DAVID W. KOCH, and A. E. GADE

Extension Pesticide Coordinator; Professor; Professor; Department of Plant Sciences, University of Wyoming, Laramie, WY 82071; Extension Educator, Cooperative Extension Service, Sundance, WY 82729.

Abstract:

Studies were established near Devil's Tower in Crook County, WY, to determine the potential of 11 grass species to compete with leafy spurge as an alternative to repetitive herbicide treatments. Of the 11 species, 'Bozoisky' Russian wildrye and 'Luna' pubescent wheatgrass showed the most promise for successful competition with leafy spurge and were selected for further study. Pubescent wheatgrass limited percent canopy cover of leafy spurge to 10 and 15% or less in tilled and no-till plots, respectively, 7 and 10 years after seeding. Russian wildrye limited percent canopy cover of leafy spurge to 21% or less in tilled and 7 and 27% in the no-till plots, respectively, 7 or 10 years after seeding. The control plots not seeded to a forage grass averaged 55% leafy spurge canopy cover.

Nomenclature:

Leafy spurge, *Euphorbia esula* L. #[2] EPHES; pubescent wheatgrass, *Thinopyrum intermedium* (Host, Barkworth and D. R. Dewey 'Luna'; Russian wildrye, *Psathyrostachys juncea* (Fisch.) Nevski 'Bozoisky.'

Additional index words:

Competition, competitive perennial grasses, weed control.

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Introduction

Herbicide research to control leafy spurge in Wyoming began in the 1950s with 2,4-D (Vore and Alley 1982). Picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid), which became available in 1963, has proven to be the most reliable and effective herbicide for control of leafy spurge with a single application. However, even with maximum-labeled rates, control can be maintained for only 3 to 5 years after which a retreatment program usually is implemented. Management is much more effective when perennial grasses are the predominant plant species in the ecosystem and proper grazing levels can be maintained. In North Dakota, cattle avoided areas with moderate and high densities of leafy spurge infestations until early fall when the milky latex in the spurge was at reduced levels (Lym and Kirby 1987). At this time, forage quality has declined substantially. Hein (1988) found that a leafy spurge canopy cover of 10% or less and shoot control of 90% or more were necessary for cattle utilization of at least 50%.

Although herbicides play an important part in the control of leafy spurge, other control methods are available and should be used in combination with herbicides for an integrated approach to weed control. Grass competition has long been recognized as an effective way to control leafy spurge. Crested wheatgrass has been used successfully in Saskatchewan, Canada, to decrease the rate of vegetative spread, limit density, reduce seed production, and suppress top growth of leafy spurge. When applications of 2,4-D were applied to grass pasture infested with leafy spurge not yet in flower, forage free, leafy spurge seeds could be harvested for hay (Selleck 1959). Crested wheatgrass can suppress leafy spurge because it emerges early and competes for early soil moisture (Morrow 1979). The purpose of this research was to evaluate the ability of Russian wildrye, pubescent wheatgrass, and various other grasses to compete with leafy spurge as an alternative to repetitive herbicide treatment in Wyoming.

Materials and methods

Devil's Tower A.

The first study was established near Devil's Tower in Crook County, WY, to evaluate the competitive effects of 11 perennial grass species on leafy spurge. Prior to grass seeding in 1986, two applications of glyphosate [*N*-(phosphonomethyl)glycine] at 1.6 kg ae/ha were broadcast with a truck-mounted sprayer delivering 135 L/ha at 250 kPa pressure to control existing vegetation. The first application was June 2, 1986 (temperature: air 20° C, soil surface 18° C, relative humidity 58%, wind calm). The second application was July 1, 1986 (temperature: air 30° C, soil surface 30° C, relative humidity 40%, wind 3 km/h from the west). Soils were classified as a Bidman silt loam (fine, montmorillonitic, mesic Ustollic Paleargids) with a textural analysis of slit loam (22% sand, 58% silt, 20% clay) with 1.8% organic matter, pH 6.3. Pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] at 2.0 and 0.55 kg ai/ha fluroxypyr ([(4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]acetic acid) were applied postermergence May 16, 1988, with a tractor-mounted sprayer delivering 195 L/ha at 250 kPa pressure (temperature: air 23º C, relative humidity 64%, wind northwest at 3 km/h). Plots 1.8 by 18 m were

arranged in a randomized complete block, split-plot design with four replications. One-half of the main plot was rototilled to a depth of 15 cm on August 12, 1986, and the other half left untilled. Grasses were seeded 1.3 cm deep with pure live seeds at a rate of 11 kg/ha with a nine-row, 1.8-m, powertill drill with 20-cm row spacing on August 12, 1986. Evaluations included percent leafy spurge control, grass stand establishment, grass yield, percent live canopy cover, and nutritive value.

Grass species seeded were Luna pubescent wheatgrass; 'Ephraim' crested wheatgrass [*Agropyron cristatum* (L.) Gaertner]; mountain rye (*Secale montanum* Guss.); 'Sherman' big bluegrass (*Poa ampla* Merr.); hybrid wheatgrass (experimental line RS1); quackgrass × bluebunch wheatgrass [*Elytrigia repens* (L.) Nevski × *Pseudoroegneria spicata* (Pursh) A. Love], 'Newhy'; 'Manchar' smooth bromegrass (*Bromus inermis* Leyss.); 'Oahe' intermediate wheatgrass [*Thinopyrum intermedium* (Host) Barkworth & D. R. Dewey]; 'Secar' bluebunch wheatgrass; 'Rosana' western wheatgrass [*Pascopyrum smithii* (Rydb.) A, Löve]; Bozoisky Russian wildrye; 'Critana' thickspike wheatgrass [*Elymus lanceolatus* (Scribn. & J. G. Smith) Gould]. Control plots, where existing vegetation was not treated prior to seeding, were also seeded with forage grass species; however, the seeding in these areas failed.

Leafy spurge shoot control and grass stand establishment were estimated visually and recorded annually from 1988 through 1992. The plots were harvested annually for biomass of seeded grass in August or September 1988 through 1992 by clipping two 0.25-ml quadrats per plot. Grass was oven dried at 60º C and reported on a dry weight basis. A point-frame containing 10 equidistant points spaced at 0.5 cm was used to estimate live canopy cover using Levy and Madden's point method of pasture analysis (Carter 1962). Ten random point-frames taken 3 m apart per plot were used to estimate percent live canopy coven. Point-frame readings were taken on July 8, 1992. Crude protein and total digestible nutrients were determined on samples of seeded grasses taken on August 8, 1989. Grasses were hand-sampled at ground level, values presented are means of five samples, and analyses are on a dry-matter basis.

Devil's Tower B.

The second study was located approximately 400 m from the first study. Pubescent wheatgrass and Russian wildrye were seeded in the second study because they were the best of the 11 species evaluated in the initial study based on productivity, their ability to establish in low moisture areas, and their ability to compete with leafy spurge.

In the second study, two applications of 1.7 and 1.1 kg ae/ha glyphosate were applied before seeding to an area uniformly infested with leafy spurge to remove the existing vegetation. Applications were made with a tractor-mounted sprayer delivering 122 L/ha at 135 kPa pressure. The first application was May 18, 1989 (temperature: air 22º C, soil surface 27º C, relative humidity 48%, wind south at 16 km/h). The second application was July 19, 1989 (temperature: air 24º C, soil surface 42º C, relative humidity 55%, wind calm). Soils were the same as the first study. An application of 2.2 kg ae/ha 2,4-D [(2,4-dichlorophenoxy)acetic acid] was required on August 9, 1989, to control annual broadleaf weeds. An additional postemergence application of 6.7 g ai/ha metsulfuron {2-[[[[(4-methoxy-6-methyl-1,3,5-treazin-2-yl)amino] carboxyl]amino]sulfonyl]benzoic

acid} plus 1.1 kg ae/ha 2,4-D (LVE) was made May 14, 1990, for annual mustard (*Brassica* sp.) control. Plots 10 by 53 m were arranged in a randomized complete block design with two factors and four replications. One factor was grass variety and the other tillage vs. no tillage. Plots were rototilled to a depth of 15 cm and rolled on August 7, 1989. Grasses were seeded with a 1.7-m, eight-row, no-till drill, equipped with 0.5-cm depth bands on August 8, 1989. Pubescent wheatgrass was seeded at a rate of 12 kg/ha of pure live seeds and Russian wildrye at a rate of 8 kg/ha pure live seeds. Row spacing was 20 cm for both grasses. The study areas received an average annual precipitation of 30 to 50 cm/year . In an effort to simulate a pasture situation, plots were grazed annually with sheep (*Ovis* sp.) in August or September. However, plot size was not large enough and the grazing period was too short to determine animal performance.

Data were subjected to analysis of variance using the general linear models procedure and the protected LSD mean separation. Since the studies were established at the same location in different years the results are reported separately.

Results and discussion

Devil's Tower A.

All grasses were competitive against leafy spurge in the areas that were tilled prior to seeding (Table 1). However, no-till grass seedings were slower to establish and not as competitive as those in tilled seed beds. The mountain rye seeding did not establish successfully. It was invaded and replaced by Kentucky bluegrass (*Poa pratensis* L.), intermediate wheatgrass, and leafy spurge.

Table 1. Leafy spurge infestation at Devil's Tower A.

	Leafy spurge infestation[b]									
	1988		1989		1990		1991		1992	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	%									
Luna pubescent wheatgrass	3	16	7	28	7	25	10	31	15	34
Ephraim crested wheatgrass	5	21	10	44	13	55	11	45	20	37
Mountain rye	21	42	50	69	51	80	36	92	46	85
Sherman big bluegrass	4	11	9	22	10	35	14	40	19	52
Newhy hybrid wheatgrass	6	40	11	67	12	85	12	89	16	97
Manchar smooth bromegrass	8	32	21	60	22	75	20	90	21	100
Oahe intermediate wheatgrass	3	32	9	49	14	54	14	61	16	60
Secar bluebunch wheatgrass	17	36	24	65	35	76	24	76	35	84
Rosana western wheatgrass	9	35	12	52	12	66	15	75	17	82
Bozoisky Russian wildrye	3	37	7	56	7	59	6	72	5	75
Critana thickspike wheatgrass	6	30	22	71	22	64	14	50	20	57
LSD (0.05)[c]	16		18		21		21		26	

[a]Grasses seeded August 12, 1986.
[b]Evaluations by visual estimation in comparison with a control plot September 14, 1988; August 8, 1989; September 13, 1990; June 20, 1991; July 8, 1992.
[c]Comparison of means is valid between till and no-till and grass genotypes within the same year. Means are averages of four replications.

In 1988 2 years after seeding, all grasses in the tilled plots except mountain rye and Secar bluebunch wheatgrass had reduced leafy spurge infestations to 9% or less (Table 1). Further reductions in leafy spurge infestation have not occurred. In the no-till plots, only Luna pubescent wheatgrass and Sherman big bluegrass established well and competed against leafy spurge. With tillage before seeding, all grasses except mountain rye, Manchar smooth bromegrass, and Secar bluebunch wheatgrass had limited leafy spurge infestations to 20% or less in 1992.

Except for mountain rye, initial stands of grasses in tilled seedbeds were fair to excellent from 1988 through 1992 (Table 2). Mountain rye was the only grass that failed to maintain a stand. Sherman big bluegrass and hybrid wheatgrass improved in stand density, Critana thickspike wheatgrass declined, and the other grass stands remained stable over the 5-year evaluation period. Grasses maintaining excellent stands from 1988 through 1992 were Luna pubescent wheatgrass, hybrid wheatgrass, Oahe intermediate wheatgrass, and Bozoisky Russian wildrye. These grasses were also very competitive against leafy spurge (Table 1). Grass stands were only fair to poor in the no-till plots from 1988 through 1992. Luna pubescent wheatgrass maintained the best stand in the no-till plots, with stands ranging from 70 to 76%.

Table 2. **Grass stand establishment at Devil's Tower A.**

	Grass stand establishment[b]									
	1988		1989		1990		1991		1992	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	%									
Luna pubescent wheatgrass	90	70	90	71	94	74	93	76	85	73
Ephraim crested wheatgrass	83	55	86	14	84	14	84	20	75	34
Mountain rye	18	5	11	4	1	0	2	0	0	0
Sherman big bluegrass	74	79	88	83	89	80	84	79	75	55
Newhy hybrid wheatgrass	74	13	85	10	85	6	90	5	86	4
Manchar smooth bromegrass	80	18	80	23	78	16	73	11	74	6
Oahe intermediate wheatgrass	71	16	91	53	93	48	91	43	84	48
Secar bluebunch wheatgrass	64	15	64	2	58	3	75	5	64	11
Rosana western wheatgrass	76	26	58	19	61	18	74	18	64	20
Bozoisky Russian wildrye	83	30	90	10	88	13	88	13	90	19
Critana thickspike wheatgrass	81	29	61	15	64	20	70	33	65	26
LSD (0.05)[c]	13		21		23		19		20	

[a]Grasses seeded August 12, 1986.
[b]Evaluations by visual estimation, % grass stand: September 14, 1988; August 8, 1989; September 13, 1990; June 20, 1991; July 8, 1992.
[c]Comparison of means is valid between till and no-till and grass genotypes within the same year. Means are averages of four replications.

Grass production was variable depending on annual moisture (Table 3). The results from this study were similar to the North Dakota study in that grasses providing the

greatest forage yield did not necessarily provide the greatest leafy spurge reduction (Lym and Tober 1997). Sherman big bluegrass, Oahe intermediate wheatgrass, and Luna pubescent wheatgrass averaged over 1,500 kg/ ha in 1992, compared to only 780 kg/ha for Bozoisky Russian wildrye, even though all these grasses limited leafy spurge infestations to 19% or less (Table 1). Russian wildrye has a very extensive root system with the majority of roots in the top 30 cm of soil (Rogler and Schaaf 1963). Evidently, the high proportion of roots explains the lower production level than with other grasses yet shows the demonstrated high drought tolerance and competitiveness of the species. Very few weeds are able to establish in good stands of Russian wildrye.

Table 3. Grass yield at Devil's Tower A.

	Yield[b]									
	1988		1989		1990		1991		1992	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	kg/ha									
Luna pubescent wheatgrass	564	307	2,323	1,189	1,234	814	2,139	1,301	1,529	1,151
Ephraim crested wheatgrass	532	243	1,606	463	936	522	1,210	632	952	564
Mountain rye	411	251	488	133	888[c]	541[c]	0	0	0	0
Sherman big bluegrass	665	376	3,357	2,372	1,033	853	2,107	1,001	1,721	1,154
Newhy hybrid wheatgrass	580	160	3,232	693	1,435	428	1,700	656	1,452	312
Manchar smooth bromegrass	329	172	1,415	678	716	192	874	291	456	177
Oahe intermediate wheatgrass	729	170	3,554	2,299	1,383	822	2,608	1,231	1,604	778
Secar bluebunch wheatgrass	217	144	1,084	189	976	316	1,621	271	1,304	218
Rosana western wheatgrass	470	195	1,510	433	816	318	1,369	137	911	205
Bozoisky Russian wildrye	585	179	1,577	246	632	256	1,044	491	780	205
Critana thickspike wheatgrass	542	236	1,783	773	778	503	1,110	483	663	505
LSD (0.05)[d]	448									

[a]Grasses seeded August 12, 1986.
[b]Evaluations September 14, 1988; August 8, 1989; September 13, 1990; September 12, 1991; September 24, 1992.
[c]Mountain rye production was 0 kg air-dry grass/ha for 1990 for till and no-till. Production values are for bluegrass/ intermediate wheatgrass mix which invaded the plot.
[d]Comparison of yields is valid between till and no-till and grass genotypes for all years. Means are averages of four replications.

Percent live canopy cover (Table 4) corroborates leafy spurge infestation (Table 1) for data taken July 8, 1992. Areas seeded to Bozoisky Russian wildrye and Luna pubescent wheatgrass had the lowest leafy spurge live canopy cover (2 to 4%) and infestation (5 to 15%) in the tilled plots. Areas seeded to Luna pubescent wheatgrass had the lowest leafy spurge canopy cover (12%) in the no-till plots.

Luna pubescent wheatgrass was the most competitive grass in this study. Luna pubescent wheatgrass is closely related to intermediate wheatgrass but is considered to be better adapted to droughty, infertile, and saline soils (Hafenrichter *et al*. 1968). It was developed in New Mexico by the USDA/NRCS (Onsager 1987). Luna provided fair long

term competition against leafy spurge in the no-till plots and was among the top competitors in the tilled plots (Table 1). It also maintained good grass stands in tilled and no-till plots (Table 2) and was among the top forage producers (Table 3). Sherman big bluegrass, Oahe intermediate wheatgrass, and Bozoisky Russian wildrye were also highly competitive.

Table 4. Percent live, canopy cover for Devil's Tower A.

	Live canopy cover[b]					
	Leafy spurge		Grass		Bare Ground	
Grass genotypes[a]	Till	No-Till	Till	No-Till	Till	No-Till
Luna pubescent wheatgrass	4	12	62	52	34	36
Ephraim crested wheatgrass	8	19	46	42	46	39
Sherman big bluegrass	20	15	63	56	17	29
Newhy hybrid wheatgrass	16	35	56	42	28	23
Manchar smooth bromegrass	10	36	60	40	30	24
Oahe intermediate wheatgrass	9	30	67	47	24	23
Secar bluebunch wheatgrass	21	32	57	52	22	16
Rosana western wheatgrass	6	23	70	55	24	22
Bozoisky Russian wildrye	2	23	59	49	39	28
Critana thickspike wheatgrass	12	20	60	55	28	25
Control[c]	25	31	51	46	24	23
LSD (0.05)[d]	8	8	8	8	7	7

[a]Grasses seeded August 12, 1986. Due to stand failure no data was taken for mountain rye.
[b]Evaluations July 8, 1992.
[c]Grasses in the control were mainly Kentucky bluegrass and Oahe intermediate wheatgrass.
[d]Comparison of means is valid within the same column. Means are averages of four replications.

Although Bozoisky Russian wildrye did not provide acceptable competition against leafy spurge in the no-till plots, it was very competitive in the tilled plots (Table 1). It also maintained an excellent stand (Table 2) and was a good forage producer in the tilled plots (Table 3). Russian wildrye is a cool-season perennial bunchgrass that has been seeded throughout the western U.S. and Canada. Once established, it has excellent drought and cold tolerance and has remained productive for 25 years (Smoliak and Dormaar 1985). Russian wildrye has dense basal leaves high in nutritive value and palatability to grazing animals. Also, its nutritive value during the late summer and early fall is higher than many other grasses, including crested and intermediate wheatgrass. Bozoisky, the Russian wildrye cultivar used in this study, was recently obtained from the USSR. It has been significantly more productive and easier to establish on semi-arid range sites than other Russian wildrye (Onsager 1987). Bozoisky Russian wildrye, along with Rosana western wheatgrass, had the highest crude protein and total digestible nutrients (TDNs) of all grasses sampled in August 1989 (Table 5).

There were no differences in nutritive value between grasses grown on tilled and no-till plots. Because of its competitive nature in the tilled plots and its late-season nutritive value, Russian wildrye is a good choice where late-season grazing is desired.

Table 5. Nutritive value of 11 grasses seeded into pasture for long-term competition against leafy spurge.

Grass genotypes[a]	Crude protein	Total digestible nutrients
	%	
Luna pubescent wheatgrass	4.1	43
Ephraim crested wheatgrass	4.6	45
Mountain rye	3.3	45
Sherman big bluegrass	3.8	40
Newhy hybrid wheatgrass	4.3	42
Manchar smooth bromegrass	4.9	46
Oahe intermediate wheatgrass	3.8	42
Secar bluebunch wheatgrass	4.7	45
Rosana western wheatgrass	5.8	45
Bozoisky Russian wildrye	5.8	49
Critana thickspike wheatgrass	4.4	38
LSD (0.05)[b]	0.8	4

[a]Grasses sampled on August 8, 1989. Grasses were hand-sampled at ground level, values are means of five subsamples, analyses are on a dry-matter basis, and there were no differences between till and no-till plots.
[b]Comparison of means is valid within the same column.

Devil's Tower B.

Bozoisky Russian wildrye and Luna pubescent wheatgrass were extremely competitive against leafy spurge in both tilled and no-till plots from 1991 through 1994 (Table 6). In 1995 and 1996 leafy spurge infestations increased in the no-till plots, particularly for Bozoisky Russian wildrye.

Table 6. Leafy spurge infestation at Devil's Tower B.

	Leafy spurge infestation[b]											
	1991		1992		1993		1994		1995		1996	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	%											
Bozoisky Russian wildrye	1	5	1	3	4	11	3	5	10	29	10	25
Luna pubescent wheatgrass	1		1	1	1	4	1	1	9	14	2	5
LSD (0.05)[c]	2		1		3		NS		7		6	

[a]Grasses seeded August 8, 1989.
[b]Evaluations by visual estimation September 13, 1991; July 8, 1992; June 22,1993; June 16, 1994; September 17, 1996.
[c]Comparison of means is valid between till and no-till and grass genotypes within years.

Stand establishment for Luna pubescent wheatgrass was excellent and has been maintained from 1991 through 1996 for both tilled and no-till plots (Table 7). Bozoisky Russian wildrye established rapidly with excellent stands in the tilled plots and maintained good establishment through 1996. Bozoisky Russian wildrye stands were slower to establish in the no-till plots and deteriorated in 1995 and 1996. The reason for the reduction in stand in the no-till plots was probably due to infestations of downy brome (*Bromus tectorum* L.) as well as leafy spurge. No data were available in 1994 due to cattle grazing the area before data could be collected.

Table 7. Number of grass plants per 6 m of row at Devil's Tower B.

	Grass plants/6 m of row[b]											
	1991		1992		1993		1994		1995		1996	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	Number											
Bozoisky Russian wildrye	37	21	56	28	54	25	—	—	24	10	32	6
Luna pubescent wheatgrass	34	25	34	27	37	28	—	—	39	32	48	46
LSD (0.05)[c]	5		11		7		no data		NS		13	

[a]Grasses seeded August 8, 1989.
[b]Evaluations September 13, 1991; July 8, 1992; June 22, 1993; 1994 no data; September 17, 1996.
[c]Comparison of means is valid between till and no-till and grass genotypes within years.

Luna pubescent wheatgrass yield was excellent in both tilled and no-till plots when rainfall was adequate, with averages over 2,000 kg/ha from 1991 through 1994 (Table 8). Bozoisky Russian wildrye yields were only about half those of the Luna pubescent wheatgrass from 1991 through 1993. Due to inadequate rainfall the yield for both grasses was dramatically reduced in 1996. No data were collected for 1994 or 1995.

Table 8. Grass yield at Devil's Tower B.

	Grass yield[b]											
	1991		1992		1993		1994		1995		1996	
Grass genotypes[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	kg/ha											
Bozoisky Russian wildrye	1,639	1.172	1,548	1,368	1,347	1,248	–	–	–	–	323	114
Luna pubescent wheatgrass	3,435	2,443	2,376	2,391	3,634	2,990	–	–	–	–	1,551	1,672
LSD (0.05)[c]-	593		NS		326		no data		no data		NS	

[a]Grasses seeded August 8, 1989
[b]Evaluations September 12, 1991; July 8, 1992; September 28, 1993; 1994 no data; 1995 no data; September 17, 1996.
[c]Comparison of means is valid between till and no-till and grass genotypes within years.

Percent live canopy cover taken June 18, 1996, indicates that Bozoisky Russian wildrye and Luna pubescent wheatgrass continue to be competitive against leafy spurge 10 years after seeding at the Devil's Tower A location and 7 years after seeding in the Devil's Tower B location (Table 9). Leafy spurge live canopy cover in the Bozoisky Russian wildrye and Luna pubescent wheatgrass tilled plots for the Devil's Tower A location was 14 and 10%, respectively, compared to 61% for the control. Even in the no-till plots leafy spurge percent live canopy cover was 21 and 27% for Bozoisky Russian wildrye and Luna pubescent wheatgrass, respectively, compared to 56% for the control. Leafy spurge live canopy cover in the Bozoisky Russian wildrye and Luna pubescent wheatgrass tilled plots for the Devil's Tower B location was only 5 and 3%, respectively, compared to 58% for the control. In the no-till plots, leafy spurge percent live canopy cover was only 20 and 7% for Bozoisky Russian wildrye and Luna pubescent wheatgrass, respectively, compared to 44% for the control. The greater competitiveness of no-till seedings of Bozoisky Russian wildrye and Luna pubescent wheatgrass in the Devil's Tower B than in the Devil's Tower A study was probably due to a more complete establishment of grasses in the 'B' study and possibly a larger plot size.

Table 9. Percent live canopy cover for Devil's Tower A and B locations, 10 and 7 years, respectively, after seeding Bozoisky Russian wildrye and Luna pubescent wheatgrass.

	Live canopy cover[b]											
	Leafy spurge				Grass				Bare ground			
	Devil's Tower A		Devil's Tower B		Devil's Tower A		Devil's Tower B		Devil's Tower A		Devil's Tower B	
Grass genotype[a]	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till	Till	No-till
	%											
Bozoisky Russian wildrye	14	21	5	20	19	0	36	18	19	14	7	7
Other grasses[c]	—	—	—	—	43	65	0	15	—	—	—	—
Luna pubescent wheatgrass	10	27	3	7	72	49	79	73	13	10	8	6
Other grasses[c]	—	—	—	—	6	14	0	4	—	—	—	—
Control	61	56	58	44	26	22	39	56	13	22	3	0
LSD (0.05)[d]	8				NS				NS			

[a]Grasses seeded August 12, 1986, for Devil's Tower A and August 9, 1989, for Devil's Tower B
[b]Evaluations June 18, 1996.
[c]Other grasses were mainly Kentucky bluegrass and Oahe intermediate wheatgrass at the Devil's Tower A location and Kentucky bluegrass at the Devil's Tower B location.
[d]Comparison of means is valid between till and no-till and grass genotypes across locations.

The grass percent live canopy cover had declined to 19% for Bozoisky Russian wildrye in the tilled plots for the Devil's Tower A location and had dropped to 0 in the no-till plots (Table 9). However, Kentucky bluegrass and Oahe intermediate wheatgrass have replaced the Bozoisky Russian wildrye and continue to provide some competition against leafy spurge. The percent live canopy cover continues to be very good for Luna pubes-

cent wheatgrass in the tilled plots for the Devil's Tower A and B locations and no-till plots for the Devil's Tower B location.

This research indicates that several grasses have potential for competing with leafy spurge. Luna pubescent wheatgrass was the most competitive in these studies and may be the best grass to seed, especially in a no-till situation. If late season grazing is important and the area can be tilled before seeding then Bozoisky Russian wildrye would be a good choice. Further studies comparing seeding rates and row spacing may be helpful in optimizing the competitive nature of these grasses against leafy spurge.

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