Comparative Performance of Some Native and Introduced Grasses in Southern Saskatchewan, Canada

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Abstract

This study reports on the poor performance of selected native grass species compared to that of certain adapted introduced and domesticated grasses. Of 12 grass species native to Canada and northern U.S.A., 7 showed very poor initial establishment. Subsequent winterkilling eliminated them. Of the 5 surviving native grass species only 2 attained a fair forage yield level compared to those of 5 domesticated grasses, and then only after the 3rd or 4th years of age. Most of the native species showed limited competition with weeds. Nutrient content, particularly crude protein, of the native grasses was not sustained as well as that in some of the tame grasses with advancing seasonal growth stages.

The species of grasses used for seeding in any region are those adapted to the climate within that region. For agricultural use they are, of course, mainly destined for use as hay, pastures, revegetating portions of deteriorated rangelands, conservation, watershed protection, and reclamation projects.

Most success has been achieved from the use of introduced or improved domesticated (tame) species of grasses seeded with or without an accompanying adapted tame legume. Within the Northern Great Plains of North America this reliance on tame forages may be even more important, particularly in the arid to semiarid regions, because of the adverse climate, moisture deficiency in particular, along with unreliable snow cover and frequency of drought.

A great many papers and reports could be cited, as did Vallentine (1978) in his bibliography covering the 1935-77 period, that repeatedly attest to the superiority of adapted tame species for ease of seeding, successful establishment, and greater subsequent dry matter production.

However, despite this large amount of evidence, there still are proponents for seeding native species, among them professional ecologists, who adhere to the belief that these naturally occurring grass species have as much as, or more potential than the domesticated species and cultivars. It is contended by some of these adherents that if identical care, attention, and management were given to native grass seed plantings as is given to tame grass plantings, they would likely perform as well if not better. This contention is held despite the fact that native grass seed of local origin is not available.

We had been challenged to provide data to the contrary. For this reason, this study was devised and initiated in 1978 to obtain an assessment of the then available native grass seed.

Methods

In the early winter of 1978 we reviewed the list of seeds available in a brochure of a seed company in Kansas, U.S.A., that specializes

in native grass seed. We carefully identified and selected species of 12 native grasses that also occur as components in native vegetation in our immediate region (entries 1 to 12 in Table 1). The last 5 (entries 13 to 17) constituted the check species of tame grasses, one of which, entry 14, is a domesticated native grass (common and botanical names are listed in Table 1).

The 17 grasses were seeded to a depth of 2 cm in early May 1978 on land that had been fallowed during the previous growing season. Seeding rate was 60 viable seeds per metre length of row. Spacing between rows was 60 cm. Three rows constituted a plot and these were 6 m long. Only the centre row was subsequently sampled for yield and chemical analyses. Treatments were randomized with a four-replicated stacked block arrangement.

Measurements recorded included establishment success, survival after the first winter, subsequent yields for 3 successive years and other general observation ratings pertaining to occurrence of weeds and plant vigor.

In 1979, the first harvest year, one-third of the centre row was harvested in mid-June, another one-third in mid-July and the remaining one-third in mid-August. In 1980 and again in 1981 the entire centre row was harvested twice, the first cut in June and the second in August. Oven-dried weights were determined.

Results

The first 7 species listed (Table 2) virtually failed to establish. Some of these showed fair initial emergence but the seedlings desiccated and died, presumably before survival rooting could occur. Subsequent winter injury or killing eliminated the stands, such as they were, completely. Thus, the test for the 1979-81 period was comprised of the 5 surviving native and 5 tame species.

Yields

The yield data shown for 1979 (Table 3) were those recorded from the August 15 sampling. In this respect, it constituted the total seasonal growth for that first year. In 1980 and 1981 the yields shown were from 2 cuttings, the first in late June and the second in mid- to late August.

By the fourth growing season in 1981 the 2 Indian ricegrasses still had not produced very much dry matter. Western wheatgrass made a rather dramatic yield increase in its fourth year but was still substantially less than were the yields obtained from green needlegrass and the 5 tame check grasses. Green needlegrass made it, so to speak, in its fourth growing year. Thickspike wheatgrass plateaued in yield almost from the start but was only half of that obtained from others. Siberian wheatgrass, which closely resembles the crested wheatgrass group and is an introduced grass, gave consistently good yields from the start. Likewise, both slender wheatgrass and crested wheatgrass reached their plant maturity and higher yield potential by the second growing year in 1979. Typically, the 2 tame *Elymus* species displayed a modest start in yield potential but had developed to mature plants with good yields in their fourth year.

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Table 1. Identity of grasses used in the test showing source and geographic origin.

Common name	Botanical name	Source	Origin
1. Prairie sandreed	<i>Calamovilfa longifolia</i> (Hook.) Scribn.	native	Kansas
2. Sand dropseed	<i>Sporobolus cryptandrus</i> (Torr.) Gray	native	Kansas
3. Little bluestem	<i>Andropogon scoparius</i> Michx.	native	Nebraska
4. Big bluestem	<i>Andropogon gerardi</i> Vitman	cv. Bonilla	Kansas
5. Big bluestem	<i>Andropogon gerardi</i> Vitman	native	Kansas
6. Indian grass	<i>Sorghastrum nutans</i> (L.) Nash	native	Kansas
7. Blue grama	<i>Bouteloua gracilis</i> (HBK.) Lag.	native	Colorado
8. Indian ricegrass	<i>Oryzopsis hymenoides</i> (R. & S.) Ricker	native	Kansas
9. Indian ricegrass	<i>Oryzopsis hymenoides</i> (R. & S.) Ricker	cv. Paloma	Kansas
10. Western wheatgrass	<i>Agropyron smithii</i> Rydberg	native	Montana
11. Green needlegrass	<i>Stipa viridula</i> Trin.	native	S. Dakota
12. Thickspike wheatgrass	<i>Agropyron dasystachyum</i> (Hook.) Scribn.	native	Kansas
Checks			
13. Siberian wheatgrass	<i>Agropyron fragile</i> (Roth) P. Cand.	introduced	Washington
14. Slender wheatgrass	<i>Agropyron trachycaulum</i> (Link) Malte	commercial	Manitoba, Canada
15. Altai wildrye	<i>Elymus angustus</i> Trin.	cv. Prairieland	Swift Current, Sask.
16. Russian wildrye	<i>Elymus junceus</i> Fisch.	cv. Sawki	Swift Current, Sask.
17. Crested wheatgrass	<i>Agropyron desertorum</i> (Fisch. Schult.)	cv. Summit	Swift Current, Sask.

% Crude Protein and % Phosphorus

In 1979, samples of the grasses were taken on June 20, July 20, and August 15 (Table 4). Crude protein (CP) values were determined from measured % N. On June 20 only Siberian wheatgrass had a CP level less than 11%.

By July 20, 2 more of the native grasses, thickspike wheatgrass and one of the ricegrasses, had fallen in % CP of less than 10%. By mid-August all the grasses as well as slender wheatgrass had fallen to less than 11% CP. By mid-August all of the grasses, with the exception of Russian wildrye, had shown a further rather marked decrease in CP.

By June 20 in 1979, all of the grasses had a % P level at about or lower than NRC minimum level for adequacy which is given as 0.17 to 0.23%. By July 20 they had, of course, declined to an even lower level. By August 15, all grasses were distinctly deficient in level of % P.

In the last 2 years, 1980 and 1981 (Table 5), CP levels were generally lower than those obtained in the June and July cuts in 1979 (Table 4). However, the levels in the two tame *Elymus* species

were again distinctly higher than in most other grasses in the test. Phosphorus values in 1980-81 were similar to those measured in 1979.

Discussion and Other Considerations

This trial was conducted with more than ordinary care and attention. Whereas we often leave our tame perennial experimental seedlings to fare for themselves with respect to weeds, this was not the case with this test. We cultivated between the rows in 1978, hand-hoed weeds adjacent to rows, and hand-weeded within rows. Again, in the 2 succeeding years we did interrow cultivation where needed, supplemented by recommended herbicide spraying of the entire test area. By the third growing year (second sampling year) vigorous stands of Siberian wheatgrass, slender wheatgrass, Russian wildrye, and crested wheatgrass did not allow within-row weed growth. By the fourth growing year (1981), weeds were not a serious problem even between rows of these 4 grasses. Also, by then, weeds did not occur within rows of green needlegrass or Altai

Table 2. Grass description, establishment and survival.

Entry No.	Crop	Lot. No.	PLS ¹	Purity	Germ.	Cost of seed per kg	Adj cost	Establishment %	1978-79 winter survival %
1.	Prairie sandreed	DP-6054	44.6	72%	62%	\$13.97	\$6.23	5	0
2.	Sand dropseed	DS-2126	85.3	99	86	9.46	9.46	6	0
3.	Little bluestem	BL-2280	40.0	90	80	9.46	9.46	3	0
4.	Big bluestem	BBB-76	72.0	90	80	9.24	6.64	4	0
5.	Big bluestem	BB-2247	56.0	70	80	8.80	4.93	7	0
6.	Indian grass	IT-6125	45.9	74	62	8.25	3.78	11	2
7.	Blue grama	CB-2284	32.5	65	50	8.25	2.68	20	2
8.	Indian ricegrass	IR-ER-7	87.3	97	90	23.10	20.17	70	75
9.	Indian ricegrass (Paloma)	IR-752	60.3	90	67	23.10	13.93	69	80
10.	Western wheatgrass	WW-2172	76.5	90	85	9.92	7.59	80	95
11.	Green needlegrass	FG	71.5	98	73	9.02	9.02	90	90
12.	Thickspike wheatgrass	842	86.2	88	98	16.46	14.19	90	100
Checks									
13.	Siberian wheatgrass	39-899	86.4	95	91	6.49	6.49	96	100
14.	Slender wheatgrass	1789	91.2	97	94	1.43	1.43	100	100
15.	Altai wildrye	Local	94.6		94	8.80	8.80	95	100
16.	Russian wildrye	Local	99.2		98	1.30	1.30	100	100
17.	Crested wheatgrass	Local	97.3		97	1.83	1.83	100	100

¹PLS (pure live seed)

Table 3. Seasonal dry matter yield of selected grass species.

Entry No.	Crop	Dry matter yield kg/ha ¹			3-yr mean
		1979	1980	1981	
8	Indian ricegrass	81e	226d	258e	188
9	Indian ricegrass (Paloma)	18f	168d	447d	211
10	Western wheatgrass	175d	192d	904c	424
11	Green needlegrass	195d	442c	1286b	641
12	Thickspike wheatgrass	628c	820b	791c	746
13	Siberian wheatgrass	1175b	1078a	1555a	1269
14	Slender wheatgrass	1328a	1114a	1324b	1255
15	Altai wildrye	702bc	917a	1531a	1050
16	Russian wildrye	823bc	987a	1898a	1236
17	Crested wheatgrass	1097b	709b	1232b	1013
	Year mean	622	665	1123	

¹Within each column, mean values followed by the same letter are not significantly different by Duncan's multiple range test at *P* 0.05.

Table 4. Crude protein (CP) and phosphorus (P) levels of the selected grasses on 3 sampling dates in 1979.

Entry No.	Crop	Crude protein ¹ and phosphorus ¹ levels					
		Percent CP			Percent P		
		6-20	7-20	8-15	6-20	7-20C	8-15
8	Indian ricegrass	13.4ab	11.4a	5.8d	0.18a	0.16a	0.10a
9	Indian ricegrass (Paloma)	14.0a	9.9b	5.1e	0.16b	0.14a	0.10a
10	Western wheatgrass	14.4a	11.9a	8.7b	0.19a	0.15a	0.11a
11	Green needlegrass	14.9a	11.4a	8.4b	0.15b	0.13b	0.11a
12	Thickspike wheatgrass	11.9b	9.5b	6.6d	0.15b	0.10c	0.08b
13	Siberian wheatgrass	8.8c	8.6c	6.1d	0.14c	0.10c	0.08b
14	Slender wheatgrass	11.1b	9.8b	5.1e	0.16b	0.12b	0.09b
15	Altai wildrye	15.7a	11.7a	9.2b	0.18a	0.16a	0.11a
16	Russian wildrye	15.0a	11.7a	0.5a	0.19a	0.13a	0.10a
17	Crested wheatgrass	13.4a	11.8a	8.1b	0.18a	0.11b	0.07c
	Stage Mean	13.2	10.8	7.4c	0.17	0.13	0.10a

¹Within each column, mean values followed by the same letter are not significantly different by Duncan's multiple range test at *P*=0.05.

Table 5. Two-year average of crude protein and phosphorus content (%) of the selected grasses at the 1st and 2nd cuts in 1980 and 1981.

Entry No.	Crop	Crude protein ¹		Phosphorus ¹	
		1st Cut	2nd Cut	1st Cut	2nd Cut
8	Indian ricegrass	11.4b	8.6b	0.16b	0.14b
9	Indian ricegrass (Paloma)	11.4b	8.6b	0.14c	0.14b
10	Western wheatgrass	11.6b	9.1b	0.18a	0.16b
11	Green needlegrass	11.6b	9.2b	0.17a	0.13b
12	Thickspike wheatgrass	10.5b	9.1b	0.15b	0.13b
13	Siberian wheatgrass	10.0b	10.0b	0.16b	0.16b
14	Slender wheatgrass	11.9b	8.1c	0.16b	0.14b
15	Altai wildrye	14.0a	13.7a	0.18a	0.14b
16	Russian wildrye	14.1a	13.6a	0.18a	0.20a
17	Crested wheatgrass			0.18a	0.17b

¹Within each column, mean values followed by the same letter are not significantly different by Duncan's multiple range test at *P* 0.05.

Table 6. Annual and seasonal precipitation at Swift Current, Sask., during the period 1977-81 (mm).

	1978	1979	1980	1981	96-yr long term
Annual (mm)	297	294	329	315?	361
Percent of long term	(82%)	(81%)	(91%)	(87%)	
Apr.-Aug. incl. (mm)	179	194	192	227	232
Percent of long term	(77%)	(84%)	(83%)	(98%)	

wildrye. However, weeds continued to be a serious problem in plots of the 2 Indian ricegrasses, western wheatgrass and thickspike wheatgrass. We were careful to either hand weed or hand separate weeds from harvested material to gain a true grass yield.

The years 1979-81 inclusive were droughty seasons for perennial grasses, particularly during early spring and through the months of April and May and well into June (Table 6). Drought years, particularly early in the growing season, can be very deleterious to grass establishment and, of course, to subsequent plant development and yields. Be that as it may, these are not uncommon occurrences in a semiarid region. That is precisely what plant breeders consider when they attempt to select and breed for hardy, tolerant tame grasses (Lawrence 1978). They are not opposed to native grasses (after all, that's where their gene base originates) but simply want to improve them for greater success when seeding, reseeding, or revegetating.

There are undoubtedly instances where, because of circumstances, climate or esthetic value, the use of native grass for vegetating would be acceptable or even preferable. In such cases economic considerations, as cost and productivity, are of minor importance, but in range improvement economics play an important role.

However, it is even probable that ecotypic variation in several grass species makes it necessary to use locally harvested seed. McMillan (1956, 1959, 1967) has shown that different species of prairie grasses have different flowering patterns. Clones from different areas transplanted to one location might, therefore, not produce any viable seed. For example, western and northern clones of blue grama, little bluestem, and big bluestem flower earlier than eastern and southern clones.

In several small-scale tests at this Research Station, which included transplanting as well as seeding of various native species, it became apparent that very few of these species are suitable for domestication. Most of the native species appear to be a complex of ecotypes, each adapted to an environmental complex, including moisture conditions, amount and periodicity of precipitation, soils, earliest and latest frost, daylength, and temperature. As a result, each ecotype can survive only in areas with a prevailing environment very similar to that in which it is indigenous.

Even species that do not show ecotypic variation, however, may be of limited use, or are of no economic value. Among the latter are

some of the early bluegrasses (*Poa* spp.) and June grass (*Koeleria gracilis* Pers.). Indian ricegrass and the needlegrasses do not show ecotypic variation, and many wheatgrasses seem to be adapted to a wide variety of environments.

However, Indian ricegrass is best adapted to light soils; western and thickspike wheatgrass sown as dryland pasture are not very tolerant to grazing and are of relatively low palatability. Green needlegrass is slow in establishing, of rather low palatability, and has low tolerance to grazing.

The most important native grasses in western Canadian rangeland, spear grass or needle-and-thread (*Stipa comata* Trin. & Rupr.), and rough fescue [*Festuca campestris* Rydb. and *F. hallii* (Vasey) Piper], are not commercially available. Speargrass is practically impossible to harvest, while seed yields of the rough fescues are very low, and germination is very erratic.

In our case we are concluding that, everything considered, most available native grass species do not have the potential in our region to be competitive with the adapted introduced and domesticated species and cultivars for pasture or hay.

These considerations include: (a) the unavailability of seed of local origin, (b) the variability in germination, (c) the physical difficulty in processing and seeding some native species, (d) unreliable emergence and establishment, (e) susceptibility to winter injury, especially with seed harvested outside the immediate area (f) limited competition with weeds, (g) low yields, and (h) the comparative high cost of the seed.

Literature Cited

- Lawrence, T. 1978. An evaluation of thirty grass populations as forage crops for southwestern Saskatchewan. *Can. J. Plant Sci.* 58:107-115.
- McMillan, C. 1956. Nature of the plant community. I. Uniform garden and light period studies of five grass taxa in Nebraska. *Ecology* 37:330-340.
- McMillan, C. 1959. The role of ecotypic variation in the distribution of the central grassland of North America. *Ecol. Monographs* 29:285-308.
- McMillan, C. 1967. Phenological variation within seven transplanted grassland community fragments from Texas and New Mexico. *Ecology* 48:807-813.
- Valentine, J.F., Ed. 1978. *In: U.S.—Canadian Range Management, 1935-1977: A Selected Bibliography on Ranges, Pastures, Wildlife, Livestock, and Ranching.* p. 130-134. Oryx Press, Phoenix, Ariz.