Evaluation of Alfalfa Varieties Solid Seeded into Cropland

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An alfalfa variety trial that included both *Medicago sativa* and *Medicago falcata* was conducted to evaluate the performance of hay- and pasture-type alfalfas under the environmental conditions of western North Dakota. The performance of the alfalfa varieties was compared to the performance of Vernal, which was selected as the standard variety because of its long record of high production across the northern United States. The study was conducted at the Dickinson and the Hettinger Research Extension Centers from 1979 through 1985. Results from the study were presented in papers by Manske and Goetz (1984a and 1984b), Manske (1985), and Manske and Conlon (1986), which are summarized in this report.

Procedure

Alfalfa variety plots of 10 X 25 feet were arranged in a randomized block design with four replications at Dickinson and three replications at Hettinger. Alfalfa was solid seeded into cropland that had been previously used for annual cereal production. The Dickinson site was seeded May 1979, and the Hettinger site was seeded May 1981. The alfalfa plots were managed with a simple one-cut system, and the alfalfa was swathed and baled for hay at the full flower stage, usually during late July or early August. Alfalfa variety herbage biomass production data were collected by the clipping method. Five quarter-meter frames per plot were clipped at the early flower stage, during late June or early July. The herbage samples were oven dried at 140°F. Alfalfa plant density was determined by a count of the number of individual plants rooted within each quarter-meter frame before the herbage biomass was clipped. Mean stem weight was determined from the weight of one hundred individual stems selected from the oven-dried herbage material.

Root rot damage was determined from three to six plants excavated from each plot during August of the seventh growing season. The crown and primary root were divided into two pieces by a cut on the center line. The outside diameter of the main root and the diameter of the infected and damaged portions were measured across the root at the base of the crown. The length of the damaged root tissue was determined in one-third-inch increments starting at the point where the root could be identified from the crown. An index scale rating relative severity of damage caused by alfalfa root rot was developed to assist with evaluation of the damage levels observed in alfalfa plants.

Results

Twenty-four varieties of alfalfa were evaluated during this study. Fourteen varieties were developed by university or government plant breeders working at public research facilities, and ten varieties were developed by plant breeders in private industry (table 1). The alfalfa varieties were categorized into types based on the sources of the parent material (table 2). The four alfalfa types were northern pasture types, Ladak hay types, Vernal hay types, and a general group of Mid West hay types.

Precipitation during the study period occurred at the regional extremes from drought to wet conditions (table 3). The spring months, April through June, had rainfall that ranged from 2% to greater than 200% of the long-term mean monthly precipitation. The seeding year at the Dickinson site, 1979, had low rainfall during May. The following year was considered to have a drought growing season with water deficiencies in April and May, and the precipitation was less than half the normal level during April through June. The seeding at the Hettinger site was postponed in 1980 because of the low soil water that spring. Low rainfall occurred in April and May of 1981. High rainfall occurred in April and May of 1982, and greater-than-normal precipitation occurred in June. Very high rainfall occurred in August, September, and October of 1982. In 1983, low rainfall occurred during April and May, and greater-than-normal precipitation occurred in June. April and June of 1984 were wet months, and a water deficiency occurred in May. Low rainfall occurred during April and June of 1985, and May was a wet month.

The precipitation levels during April through June influenced the herbage production of the alfalfa varieties. Herbage production during the drought year of 1980 was very low, with most varieties producing between 200 and 400 pounds per acre. During 1981, a recovery year that had two spring months with low rainfall, alfalfa herbage production was about a third of the potential production. Herbage production was high

during 1982, 1983, and 1984 as a result of favorable conditions, including high precipitation during at least one spring month or high rainfall during the fall of the previous year. In 1985, the herbage production was less than half the potential. Some of this reduction resulted from low rainfall during two spring months, and some of the reduction was caused by other factors.

The annual aboveground herbage biomass production for each variety (table 4) was very similar. No significant differences among the varieties were found at the Hettinger site (Manske and Goetz 1984a) or at the Dickinson site, except that one variety, Kane, had greater herbage biomass than the other varieties in 1982 (Manske and Goetz 1984b).

Most alfalfa varieties had mean herbage production greater than 4000 lbs/ac during the three years with favorable precipitation, 1982 to 1984 (table 4). Three varieties produced an average of less than two tons of herbage per acre, Agate, Polar II, and 532. The three-year mean herbage biomass produced by the pasture types, Ladak types, Mid West hay types, and Vernal types were 4569, 4484, 4214, and 4198 pounds per acre, respectively. Vernal produced an annual average of 4190 lbs/ac during 1982 to 1984. The varieties with three-year mean herbage production 105% or greater than that of Vernal (table 5) were Drylander (4800 lbs/ac), Spredor II (4792 lbs/ac), Ladak 65 (4659 lbs/ac), Kane (4634 lbs/ac), Ladak (4576 lbs/ac), Prowler (4545 lbs/ac), Nugget (4541 lbs/ac), Norseman (4488 lbs/ac), 520 (4468 lbs/ac), Rangelander (4466 lbs/ac), Polar I (4461 lbs/ac), and Travois (4440 lbs/ac) (table 4).

Vernal has performed well in western North Dakota. Most of the varieties in the trial performed as well as or better than Vernal (table 5). Only three varieties, Agate, Polar II, and 532, consistently performed more poorly than Vernal. The pasture-type alfalfas and the Ladak-type alfalfas generally performed at levels greater than Vernal under a one-cut system in western North Dakota. Both the pasture- and Ladak-type alfalfas have *M. falcata* as 45% to 100% of their parentage. Vernal has *M. falcata* as about 33% of its parentage.

The amount of herbage biomass produced per acre is determined by the height and weight of each stem and by the density of the alfalfa plants. The mean weight of individual stems did not differ among the alfalfa varieties: the stems of most varieties weighed between 0.25 and 0.50 ounces, with between 64 and 32 stems required to weigh one pound (table 6). The plant density per square foot did not differ among the alfalfa varieties. The density of most alfalfa varieties was between 3.0 and 4.0 plants per square foot (table 7).

The performance of alfalfa varieties can be influenced from attacks by pests. The major pests of alfalfa include fungi, bacteria, viruses, nematodes, and insects. These pests can cause plant diseases and tissue injury that can result in substantial reductions in herbage production and quality. The vulnerability of plants to attacks from pests varies greatly among the different alfalfa varieties, which range from susceptible (S) to resistant (R) to the attack of individual pest types.

Resistance to bacterial wilt was the first physiological trait alfalfa breeders tested and reported as showing variations in response to plant pests among alfalfa varieties. The resistance ratings for the alfalfa varieties in this trial are included in table 8. Most alfalfa varieties grown in the Northern Plains are resistant to bacterial wilt. This disease is generally not a problem for dryland alfalfas in North Dakota because the bacterium requires warm, moist conditions to develop serious infections.

Root rot, a disease caused by soil-borne fungi, is widespread across North America. The disease infects the woody centers of the roots and slowly progresses outward. The extent of root rot damage to the primary root ranged between 35% and 50% of the root diameter at the base of the crown for most alfalfa varieties in this trial (table 8). Travois had the lowest percent damage to the root, 26.8%. The length of the root rot damage ranged between 1.00 and 2.33 inches into the root from the base of the crown. This level of tissue damage from root rot was considered moderate. Every variety in the trial had some root rot damage; however, none of the varieties had severe damage. Moderate levels of root rot damage could cause reductions in herbage production, decreases in tolerance to cold and dry conditions, and diminished resistance to other diseases and pests.

Discussion

The similarity in performance among the varieties in this trial resulted because of the similarities in the sources of parental germplasm. The alfalfa varieties that perform well in Canada and the northern United States have a high proportion of parental material originating from a few accessions, Grimm (*M. media*), Cossack (*M. media*), Don Siberian (*M. falcata*), Orenburg Siberian (*M. falcata* creeper), Semipalatinsk Siberian (*M. falcata* creeper), and Ladak (*M. falcata*).

Vernal was developed in Wisconsin from parental material selected from plants that had survived the environmental extremes of the Plains in old fields that had been planted with seed produced from the early accessions of plant material introduced from Siberia and southern Asia into North America during the first decades of the 1900's. Vernal has performed well under a wide range of environmental conditions of the United States and Canada and has become the standard variety to which alfalfa breeders and researchers compare all other varieties.

The improved performance level of the pasture- and Ladak-type alfalfa varieties appeared to be related to the amount of *M. falcata* in their parentage. The two major species of perennial alfalfa grown in North America are *M. sativa*, which has dark blue or purple flowers, and *M. falcata*, which has white or yellow flowers. The natural cross between them is *M. media*, which has variegated flowers. The *M. sativa* alfalfas have large rounded leaves and tend to have one main tap root growing from a narrow raised crown. The *M. falcata* alfalfas (Ladak types) have lanceolate leaves and have numerous branching roots growing from a moderately wide crown. The *M. falcata* alfalfas (pasture types) have smaller narrow lanceolate leaves and an extensive branching root system that grows from a wide crown located mostly below ground level. The pasture types are creeping alfalfas and can reproduce vegetatively from rhizomes, which are horizontal underground stems.

The varieties with high proportions of *M. falcata* perform well when managed with a one- or two-cut system because they recover relatively slowly after cutting and reduce aboveground production during late summer and early fall. The varieties with a high percentage of *M. falcata* parentage have very high tolerance to cold and dry conditions and persist through adverse conditions.

The varieties with high proportions of *M. sativa* tend to produce greater quantities of herbage than *M. falcata* varieties during growing seasons with favorable precipitation because *M. sativa* varieties recover rapidly after cutting and can be harvested several times per year. However, during dry growing seasons, herbage production of *M. sativa* varieties tends to be much lower than that of *M. falcata* varieties. The varieties with a high percentage of *M. sativa* parentage have lower cold tolerance and are susceptible to winterkill in the Northern Plains; these traits result in short stand longevity.

Conclusion

The alfalfa varieties included in this study had been previously tested at other locations in North America and had performed well. The objective of this trial was to determine if these varieties also performed well in western North Dakota. All of the varieties performed as well as or slightly better than Vernal. The parental origins of the varieties in this trial were similar, and the varieties that performed a little better had sources with a higher percentage of *M. falcata*. The traits that predispose plants to tolerance of adverse cold and dry conditions are derived from the *M. falcata* germplasm. The alfalfa varieties that can be successfully grown under the conditions of western North Dakota have high percentages of *M. falcata* in their parentage.

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Table 1. Development of alfalfa varieties.

Alfalfa Variety	Development Agency	Year Available
Northern Pasture Types		
Anik	Agriculture Canada	1975
Drylander	Agriculture Canada	1971
Kane	Agriculture Canada	1971
Prowler	Northrup, King, and Co.	1980
Rangelander	Agriculture Canada	1978
Spredor II	Northrup, King, and Co.	1980
Travois	South Dakota AES	1963
Ladak Hay Types		
Ladak	Introduced from India	1910
Ladak 65	Montana AES	1964
Norseman	Brazen of Minneapolis	1964
Ramsey	Minnesota AES and USDA	1972
Vernal Hay Types		
Vernal	Wisconsin AES and USDA	1953
Agate	USDA and Minnesota AES	1972
Iroquois	Cornell University	1966
Nugget	North American Plant Breeders	1974
Polar I	Northrup, King, and Co.	1974
Polar II	Northrup, King, and Co.	1980
Mid West Hay Types		
Baker	Nebraska AES and USDA	1976
Ranger	USDA and Nebraska AES	1942
Thor	Northrup, King, and Co.	1970
Trek	Agriculture Canada	1975
520	Arnold-Thomas Seed Service	1968
524	Pioneer Hi-Bred International Inc.	1977
532	Pioneer Hi-Bred International Inc.	1979

Table 2. Parental origin of alfalfa varieties.

Alfalfa Variety	Parental Varieties
Northern Pasture Types	
Anik	M. falcata
Drylander	M. falcata, M. media, M. sativa, Rambler
Kane	Beaver, M. falcata, Rambler
Prowler	Spredor I, Travois, Kane, Rambler, M. sativa
Rangelander	Rambler, Roamer, Drylander, M. falcata
Spredor II	Rambler, Travois, Vernal, M. sativa
Travois	Cossack X Semipalatinsk (M. falcata), Rambler
Ladak Hay Types	
Ladak	Ladak
Ladak 65	Ladak
Norseman	Ladak
Ramsey	Cossack, Ladak
Vernal Hay Types	
Vernal	Cossack, M. falcata X Ladak, Kansas Common
Agate	Ramsey, Vernal
Iroquois	Narragansett, Vernal
Nugget	Alfa, Tuna, Vernal
Polar I	Cardinal, Ladak, Lahontan, Meeker Baltic, Narragansett, Vernal
Polar II	Polar I, Iroquois
Mid West Hay Types	
Baker	Atlantic, Baltic, Cossack, Grimm, Kansas Common, Ladak, Nebraska Common, Ranger, Turkistan, Vernal
Ranger	Cossack, Ladak, Turkistan
Thor	Cardinal, Glacier, Saranac
Trek	Beaver, Lahontan
520	Arnim, Culver, Narragansett, Vernal, selection population
524	Saranac, Vernal, 4 experimentals
532	Flemish, fall dormant type

Table 3. Precipitation in inches for growing-season months.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Growing Season
Long-term mean	1.41	2.04	3.36	2.75	1.85	1.39	1.24	14.04
1979	1.28	0.91	3.06	2.22	2.21	1.27	0.17	11.12
% of LTM	90.8	44.6	91.1	80.7	119.5	91.4	13.7	79.2
1980	0.03	0.12	2.67	1.43	3.31	0.76	2.41	10.73
% of LTM	2.1	5.9	79.5	52.0	178.9	54.7	194.4	76.4
1981	0.66	1.30	3.71	1.57	4.05	2.75	0.23	14.27
% of LTM	46.8	63.7	110.4	57.1	218.9	197.8	18.5	101.6
1982	1.85	4.32	3.43	2.02	2.63	1.77	6.51	22.53
% of LTM	131.2	211.8	102.1	73.5	142.2	127.3	525.0	160.5
1983	0.32	1.15	3.43	2.81	1.16	1.06	0.25	10.18
% of LTM	22.7	56.4	102.1	102.2	62.7	76.3	20.2	72.5
1984	2.90	0.05	4.98	0.66	2.92	0.91	1.19	13.61
% of LTM	205.7	2.5	148.2	24.0	157.8	65.5	96.0	96.9
1985	0.87	4.31	2.13	1.91	1.75	1.61	2.05	14.63
% of LTM	61.7	211.3	63.4	69.5	94.6	115.8	165.3	104.2

Table 4. Alfalfa herbage production (lbs/ac) under a one-cut system.

Alfalfa Variety	1980	1981	1982	1983	1984	1985	1982-1984 Mean
Northern Pasture Types							
Anik	171	1978	4563	4459	3892	1606	4305
Drylander			4604	5528	4267		4800
Kane	402	1655	4892	5191	3819	1929	4634
Prowler			5244	5212	3178		4545
Rangelander	400	1642	4583	4692	4122	1585	4466
Spredor II	369	1289	5123	4827	4427	1728	4792
Travois	372	1277	5134	4384	3803	1788	4440
Ladak Hay Types							
Ladak	320	1351	4769	4414	4546	1740	4576
Ladak 65	337	1407	4627	5274	4077	1958	4659
Norseman	445	1556	4808	4282	4374	1628	4488
Ramsey	307	1195	4416	4832	3387	1768	4212
Vernal Hay Types							
Vernal	372	1572	4097	4488	3986	1512	4190
Agate	329	1401	3870	4253	3435	1578	3853
Iroquois	401	1422	4788	4109	3975	1803	4291
Nugget	374	1391	4659	5205	3760	1360	4541
Polar I	244	1519	4649	4862	3881	1606	4464
Polar II			4016	4036	3493		3848
Mid West Hay Types							
Baker	233	1662	4281	4945	3480	1779	4235
Ranger	403	1239	4377	4668	3901	1666	4315
Thor	284	1554	4087	4660	3937	1916	4228
Trek	335	1362	4222	4569	3771	1904	4187
520	180	1485	4393	5275	3736	2059	4468
524	339	1518	4281	5232	3597	1684	4370
532			3832	4165	3095		3697

Table 5. Alfalfa herbage production as a percentage of the standard, Vernal.

Alfalfa Variety	1980	1981	1982	1983	1984	1985	1982-1984 Mean
Northern Pasture Types							
Anik	46	126	111	99	98	106	103
Drylander			112	123	107		115
Kane	108	105	119	116	96	128	111
Prowler			128	116	80		108
Rangelander	108	104	112	105	103	105	107
Spredor II	99	82	125	108	111	114	114
Travois	100	81	125	98	95	118	106
Ladak Hay Types							
Ladak	86	86	116	98	114	115	109
Ladak 65	91	90	113	118	102	129	111
Norseman	120	99	117	95	110	108	107
Ramsey	83	76	108	108	82	117	101
Vernal Hay Types							
Vernal	100	100	100	100	100	100	100
Agate	88	89	94	95	86	104	92
Iroquois	108	90	117	92	100	119	102
Nugget	101	88	114	116	94	90	108
Polar I	66	97	113	108	97	106	107
Polar II			98	90	88		92
Mid West Hay Types							
Baker	63	106	104	110	87	118	101
Ranger	108	79	107	104	98	110	103
Thor	76	99	100	104	99	127	101
Trek	90	87	103	102	95	126	100
520	48	94	107	118	94	136	107
524	91	97	104	117	90	111	104
532			94	93	78		88

Table 6. Alfalfa stem dry weight (ounces) and the number of stems per pound.

Alfalfa Variety	1983		1984		1985		1983-1985	
	stem weight (oz)	number of stems per lb	stem weight (oz)	number of stems per lb	stem weight (oz)	number of stems per lb	Mean stem weight (oz)	Mean number of stems per lb
Northern Pasture Types								
Anik	0.41	39.0	0.48	33.3	0.32	50.0	0.45	35.6
Drylander	0.75	21.3	0.55	29.1			0.65	24.6
Kane	0.49	32.7	0.42	38.1	0.26	61.5	0.46	34.8
Prowler	0.46	34.8	0.34	47.1			0.40	40.0
Rangelander	0.40	40.0	0.48	33.3	0.26	61.5	0.44	36.4
Spredor II	0.48	33.3	0.48	33.3	0.21	76.2	0.48	33.3
Travois	0.41	39.0	0.45	35.6	0.33	48.5	0.43	37.2
Ladak Hay Types								
Ladak	0.57	28.1	0.62	25.8	0.29	55.2	0.60	26.7
Ladak 65	0.47	34.0	0.44	36.4	0.32	50.0	0.46	34.8
Norseman	0.45	35.6	0.51	31.4	0.25	64.0	0.48	33.3
Ramsey	0.45	35.6	0.38	42.1	0.26	61.5	0.42	38.1
Vernal Hay Types								
Vernal	0.52	30.8	0.44	36.4	0.22	72.7	0.48	33.3
Agate	0.44	36.4	0.43	37.2	0.29	55.2	0.44	36.4
Iroquois	0.49	32.7	0.47	34.0	0.28	57.1	0.48	33.3
Nugget	0.51	31.4	0.45	35.6	0.30	53.3	0.48	33.3
Polar I	0.61	26.2	0.58	27.6	0.38	42.1	0.60	26.7
Polar II	0.38	42.1	0.34	47.1			0.36	44.4
Mid West Hay Types								
Baker	0.49	32.7	0.42	38.1	0.26	61.5	0.46	34.8
Ranger	0.45	35.6	0.42	38.1	0.28	57.1	0.44	36.4
Thor	0.50	32.0	0.58	27.6	0.34	47.1	0.54	29.6
Trek	0.57	28.1	0.44	36.4	0.40	40.0	0.51	31.4
520	0.57	28.1	0.43	37.2	0.34	47.1	0.50	32.0
524	0.52	30.8	0.44	36.4	0.31	51.6	0.48	33.3
532	0.34	47.1	0.28	57.1			0.31	51.6

Table 7. Alfalfa plant density per square foot.

Alfalfa Variety	1983 plants per ft^2	1984 plants per ft^2	1985 plants per ft^2	1983-1984 Mean plants per ft^2
Northern Pasture Types				
Anik	4.90	2.93	1.88	3.92
Drylander	3.16	3.60		3.38
Kane	3.72	3.43	2.46	3.58
Prowler	4.16	3.41		3.79
Rangelander	4.28	3.13	2.23	3.71
Spredor II	3.97	3.40	3.07	3.69
Travois	4.25	3.27	1.95	3.76
Ladak Hay Types				
Ladak	3.26	2.70	2.19	2.98
Ladak 65	4.08	3.67	2.21	3.88
Norseman	2.08	3.34	2.37	2.71
Ramsey	3.94	3.41	2.46	3.68
Vernal Hay Types				
Vernal	3.32	3.40	2.53	3.36
Agate	3.92	2.97	1.95	3.45
Iroquois	3.72	3.20	2.37	3.46
Nugget	3.92	3.09	1.67	3.51
Polar I	2.99	2.65	1.53	2.82
Polar II	4.09	3.78		3.94
Mid West Hay Types				
Baker	3.80	3.28	2.51	3.54
Ranger	3.91	3.49	2.19	3.70
Thor	3.64	2.83	2.04	3.24
Trek	3.06	2.98	1.72	3.02
520	3.85	3.33	2.19	3.59
524	3.58	3.09	2.00	3.34
532	4.46	4.03		4.25

Table 8. Root rot damage to the primary root and level of resistance to bacterial wilt.

Alfalfa Variety	Resistance to Bacterial Wilt	Diameters of root at base of crown		Percent of root diameter infected (%)	Length of root damage (in)
		Total root (in)	Infected portion (in)		
Northern Pasture Types					
Anik	S	0.54	0.34	63.2	2.33
Drylander	R				
Kane	R	0.41	0.17	42.3	1.00
Prowler	R				
Rangelander	S	0.40	0.20	49.5	1.00
Spredor II	R	0.46	0.22	50.0	2.33
Travois	R	0.32	0.09	26.8	1.00
Ladak Hay Types					
Ladak	MR	0.45	0.18	40.4	1.66
Ladak 65	R	0.41	0.15	36.4	1.33
Norseman	R	0.43	0.17	40.7	1.66
Ramsey	R	0.40	0.19	46.5	2.00
Vernal Hay Types					
Vernal	R	0.43	0.19	42.7	1.66
Agate	R	0.50	0.26	52.3	2.00
Iroquois	R	0.44	0.20	45.1	1.66
Nugget	R	0.47	0.19	40.3	1.66
Polar I		0.50	0.23	45.3	2.00
Polar II	R				
Mid West Hay Types					
Baker	R	0.48	0.22	45.1	2.00
Ranger	R	0.42	0.17	39.6	1.66
Thor	R	0.41	0.22	54.4	1.66
Trek	R	0.55	0.22	40.3	2.00
520	R	0.50	0.19	37.5	1.33
524	MR	0.52	0.25	48.9	2.00
532	R				

Index of Alfalfa Root Rot Damage

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Root Rot
Damage Index

None	0	no injury
Light	1-3	less than 1 inch injured
Moderate	4-6	1 to 2 inches injured
Severe	7-9	more than 2 inches injured
Dead	10	plant is dead

Root
Rot
Damage
Index
0

Root
Rot
Damage
Index
1

Root
Rot
Damage
Index
2

Root
Rot
Damage
Index
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Root
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Root
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