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Agricultural Experiment Station

Colorado State University
Knowledge to Go Places

Agricultural Experiment Station

Cooperative Extension

COLORADO FORAGE RESEARCH 2003

Alfalfa, Irrigated Pastures, and Mountain Meadows

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Cover Photos: (top to bottom)

Loading alfalfa hay with a stack wagon in the Grand Valley of western Colorado. Photo by Calvin Pearson.

Baled alfalfa hay in the Grand Valley. Photo by Calvin Pearson.

Great Basin wildrye, the ultimate bunchgrass, is an excellent grass species for stockpiled winter forage. Photo by Joe Brummer.

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PREFACE

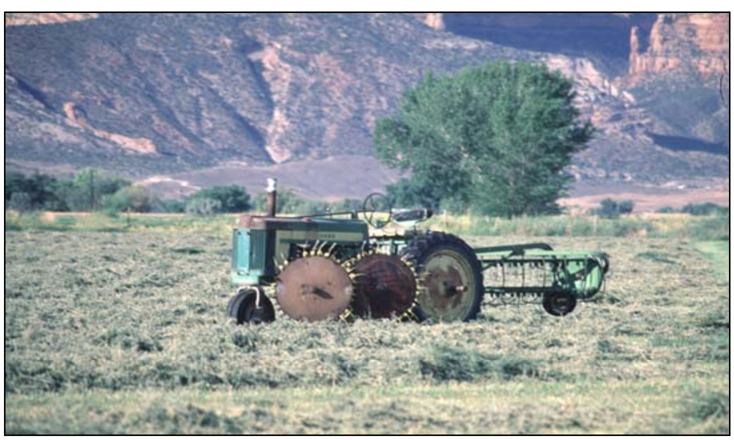
Forages are one of the most important agricultural crops in Colorado, both in terms of their economic value and the land area on which they are produced.

According to the 2003 Colorado Agricultural Statistics, hay crops (alfalfa, grass, and other) in Colorado were valued at more than $480 million in 2001 and $366 million in 2002, making them the state's most valuable crops in these 2 years. It is not unusual for hay to be Colorado's most valuable crop, often being worth substantially more than corn or wheat.

Hay crops in Colorado are produced throughout the state on a large acreage. In 2001, they occupied 1.60 million acres and, in 2002, hay crops were grown on 1.35 million acres. These hay crops account for nearly one-third of the total land area used for producing field crops in Colorado.

A diversity of plant species is used for forage production in Colorado. Plant species used for forage production can be annuals, such as turnips, various small grains, and peas; or they can be perennial, such as alfalfa and a number of grass species. Forage production is accomplished under a wide range of management and production conditions. Such a range of plants, environments, and diverse producer situations used for forage production in Colorado creates a considerable ongoing need to conduct forage research.

This report has been published to provide producers, Cooperative Extension personnel, crop consultants, industry representatives, federal and state agency personnel, and the general public with the latest information obtained from research trials conducted at different locations around the state by Colorado State University researchers.



A wide range of equipment is used in the haymaking process. This tractor has been equipped to re-configure windrows after hay was scattered by high wind. Photo by Calvin Pearson.

ALFALFA VARIETY TRIALS

ARKANSAS VALLEY FORAGE YIELDS OF 24 ALFALFA VARIETIES AT ROCKY FORD 2001-2003

Frank C. Schweissing

The Arkansas Valley, in southeastern Colorado, extends from the mountains on the west to the Kansas border. Alfalfa is the most important irrigated crop in the Valley being produced on 165,000 acres. Furrow or flood irrigation predominates, but about 3,000 acres are produced under sprinklers and there are an additional 5,000 dryland acres. The elevation varies from 3,400 ft. in the east to 4,700 ft. at Pueblo. The average annual precipitation along the Valley is 11 in.

The average frost-free period is 158 days from 1 May to 6 October. This allows for four cuttings per season as a standard practice. Successful varieties need good winter hardiness (temperatures go below 0^0F), but they also must take advantage of a relatively long growing season. The average alfalfa yield in the Valley is 4.40 tons/acre. The most persistent pests are the alfalfa weevil, stem nematode, and tansy mustard/flixweed.

Researcher Comments

The first harvest season for this trial was in 2001. The trial was irrigated three times after planting in the fall, once prior to the first cutting and once after each cutting in 2001. A frost (28^0F) on 25 Sept. 2000 tended to set stand establishment back somewhat. Rainfall from April through 25 Sept. 2001 was 9.5 in. compared to the long-term average of 9 in. Irrigation water was available through the season and all four cuttings were harvested without rain damage. The irrigation prior to the second cutting was inadequately applied and resulted in lower yields. The trial, at the end of the season, appeared to be well established and the earlier problems overcome. The average trial yield was 4.95 tons/acre (Table 1).

In 2002, rainfall from April through September was 2.1 in. compared to a long term average of 9 in. The trial was irrigated prior to the first, second, and third cuttings but not the fourth cutting due to the lack of available irrigation water. It was extremely dry during 2002 but the average yield of 7.26 tons/acre was substantially better than the first year of production in 2001 (Table 2).

In 2003, rainfall from April through September was 7.3 in. compared to the long-term average of 9 in. Growing degree days were above normal in 2003. The trial was irrigated prior to the first cutting and after each of the four cuttings. All four cuttings were harvested without experiencing significant rain damage. Significant differences in yield occurred among varieties for all cuttings and total 2003 yield; however, variability was very high in the trial in 2003 (Table 3).

Researcher

Dr. Frank Schweissing, Superintendent-Entomologist, has conducted alfalfa trials at the Arkansas Valley Research Center (AVRC) for 30 years. He received his B.S. and M.S. in Entomology from Colorado State University and Ph.D. in Entomology from Kansas State University. He began working at the AVRC in 1961 as an Entomologist and became Superintendent in 1980. His major research efforts have been with the insect and mite pests of alfalfa, corn, sorghum, and onions.

Table 1. Forage yields of 24 alfalfa varieties at Rocky Ford[1] in 2001.

Variety	Brand/Source	1st Cut 31 May	2nd Cut 3 July	3rd Cut 9 Aug.	4th Cut 2 Oct.	2001 Total
		-----------------------------tons /acre[2]---------------------------				
Arapaho	Dairyland Research	1.64	1.21	1.24	1.43	5.52
ZX 9450A*	ABI Alfalfa, Inc.	1.47	1.15	1.18	1.40	5.20
Target Plus	Producers Hybrids	1.47	1.15	1.15	1.40	5.17
Arrow Head	Dairyland Research	1.42	1.15	1.26	1.32	5.15
FG 6M71*	Forage Genetics Int'l.	1.32	1.17	1.25	1.36	5.10
Emperor	America's Alfalfas	1.45	1.18	1.14	1.32	5.09
ZG 9650A	ABI Alfalfa, Inc.	1.28	1.12	1.20	1.47	5.07
Winter Crown	Dairyland Research	1.36	1.13	1.22	1.35	5.06
Abilene + Z	America's Alfalfas	1.33	1.16	1.20	1.37	5.06
Dagger + EV	AgriPro Seeds, Inc.	1.33	1.20	1.14	1.36	5.03
53VO8	Pioneer Hi-Bred Int'l.	1.35	1.21	1.16	1.30	5.02
54Q53	Pioneer Hi-Bred Int'l.	1.35	1.09	1.16	1.31	4.91
FG 5M84*	Forage Genetics Int'l.	1.30	1.08	1.19	1.33	4.90
Magnum V-Wet	Dairyland Research	1.22	1.13	1.17	1.38	4.90
Lahontan	USDA - NV	1.30	1.14	1.18	1.25	4.87
Ranger	USDA - NE	1.31	1.14	1.13	1.25	4.83
4200	Arkansas Valley Seed	1.37	1.08	1.10	1.24	4.79
Geneva	Novartis Seeds	1.30	1.10	1.12	1.26	4.78
ZC 9941A*	ABI Alfalfa, Inc.	1.25	1.14	1.11	1.27	4.77
Samurai	America's Alfalfas	1.26	1.12	1.08	1.28	4.74
ZX 9853	ABI Alfalfa, Inc.	1.24	1.03	1.14	1.30	4.71
A30-06	ABI Alfalfa, Inc.	1.25	1.17	1.10	1.18	4.70
Baralfa 42IG	Barenbrug U.S.A.	1.31	1.07	1.09	1.23	4.70
FG 3R139*	Forage Genetics Int'l.	1.26	1.07	1.10	1.24	4.67
Average		1.34	1.13	1.16	1.32	4.95
$LSD_{(0.05)}$		0.13	NS	0.10	0.10	0.33

[1]Trial conducted on the Arkansas Valley Research Center; seeded 1 Sept. 2000.
[2]Yields calculated on oven-dry basis.
*Indicates experimental entry

Site Information

Elevation: 4178 ft. Average annual precipitation 11.86 in. Average frost-free days - 158
Last spring frost – 24 Apr. 2001; First fall frost – 6 Oct. 2001; 2001 frost-free days - 165
Fertilizer: 100 lbs. P_2O_5 + 21 lbs. N/acre prior to planting
Soil Series: Rocky Ford silty clay loam

Table 2. Forage yields of 24 alfalfa varieties at Rocky Ford[1] in 2001-2002.

Variety	Brand/Source	1st Cut 29 May	2nd Cut 2 July	3rd Cut 7 Aug.	4th Cut 1 Oct.	2002 Total	2001 Total	2-Yr Total
		tons/acre[2]						
Arapaho	Dairyland Research	2.85	1.88	2.01	1.54	8.28	5.52	13.80
Arrowhead	Dairyland Research	2.56	1.86	1.73	1.48	7.63	5.15	12.78
ZX 9450A*	ABI Alfalfa, Inc.	2.41	2.03	1.73	1.32	7.49	5.20	12.69
FG 6M71*	Forage Genetics Int'l.	2.30	1.89	1.87	1.42	7.48	5.10	12.58
Emperor	America's Alfalfas	2.58	1.79	1.71	1.34	7.42	5.09	12.51
Dagger + EV	AgriPro	2.53	1.72	1.81	1.37	7.43	5.03	12.46
Ranger	USDA-NE	2.46	1.80	1.81	1.56	7.63	4.83	12.46
ZG 9650A*	ABI Alfalfa, Inc.	2.38	1.83	1.79	1.36	7.36	5.07	12.43
Lahontan	USDA-NV	2.47	1.78	1.87	1.42	7.54	4.87	12.41
Target Plus	Producers Hybrids	2.43	1.69	1.74	1.37	7.23	5.17	12.40
Abilene + Z	America's Alfalfas	2.27	1.84	1.72	1.42	7.25	5.06	12.31
53V08	Pioneer Hi-Bred Int'l.	2.49	1.75	1.74	1.31	7.29	5.02	12.31
Magnum V-Wet	Dairyland Research	2.43	1.69	1.84	1.44	7.40	4.90	12.30
Winter Crown	Dairyland Research	2.46	1.65	1.78	1.30	7.19	5.06	12.25
54Q53	Pioneer Hi-Bred Int'l.	2.36	1.71	1.70	1.36	7.13	4.91	12.04
ZX 9853*	ABI Alfalfa, Inc.	2.47	1.70	1.72	1.33	7.22	4.71	11.93
Geneva	Novartis Seeds	2.33	1.75	1.71	1.36	7.15	4.78	11.93
FG 5M84*	Forage Genetics Int'l.	2.19	1.76	1.75	1.30	7.00	4.90	11.90
ZC9941A*	ABI Alfalfa, Inc.	2.46	1.53	1.69	1.40	7.08	4.77	11.85
4200	Arkansas Valley Seeds	2.18	1.75	1.76	1.36	7.05	4.79	11.84
Samurai	America's Alfalfas	2.36	1.60	1.72	1.24	6.92	4.74	11.66
Baralfa 42IG	Barenbrug U.S.A.	2.45	1.61	1.64	1.24	6.94	4.70	11.64
FG 3R139	Forage Genetics Int'l.	2.18	1.67	1.70	1.29	6.84	4.67	11.51
A30-06	ABI Alfalfa, Inc.	2.15	1.45	1.52	1.22	6.34	4.70	11.04
Average		2.41	1.74	1.75	1.36	7.26	4.95	12.21
$LSD_{(0.05)}$		0.29	0.21	0.20	0.15	0.76	0.33	1.04

[1]Trial conducted on the Arkansas Valley Research Center; seeded on 1 Sept. 2000.
[2]Yields calculated on oven-dry basis.
*Indicates experimental entry

Site Information

Elevation: 4178 ft.
Precipitation: Average Annual - 11.86 in. 2002 April through September - 2.0 in.
Growing Days: Average - 158 1 May – 6 Oct. Frost Free
2002 - 164 23 April - 4 Oct. Frost Free
Fertilizer: 100 lbs. P_2O_5 + 21 lbs. N/acre prior to planting.
Herbicide: Sencor DF .75 + Gramoxone Extra .47 lbs. AI/Acre – 12 Mar. 2002
Insecticide: Warrior T .025 lbs. AI/Acre – 13 May 2002
Soil Series: Rocky Ford Silty Clay Loam

Table 3. Forage yields of 24 alfalfa varieties at Rocky Ford[1] in 2001-2003.

Variety	Brand / Source	1st Cut 4 June	2nd Cut 8 July	3rd Cut 12 Aug.	4th Cut 14 Oct.	2003 Total	2002 Total	2001 Total	3-Yr Total
		---tons/acre[2]---							
Arapaho	Dairyland Research	2.61	1.33	1.15	0.80	5.89	8.28	5.52	19.69
Arrowhead	Dairyland Research	2.30	1.31	1.28	0.83	5.72	7.63	5.15	18.50
Ranger	USDA-Neb	2.50	1.32	1.24	0.78	5.84	7.63	4.83	18.30
53V08	Pioneer Hi-Bred Int'l.	2.69	1.37	1.14	0.79	5.99	7.29	5.02	18.30
Emperor	America's Alfalfa	2.21	1.33	1.16	0.90	5.60	7.42	5.09	18.11
ZG 9650A*	ABI Alfalfa, Inc.	2.43	1.26	1.14	0.82	5.65	7.36	5.07	18.08
ZX 9450A*	ABI Alfalfa, Inc.	2.36	1.20	1.11	0.60	5.27	7.49	5.20	17.96
Abilene + Z	America's Alfalfa	2.45	1.41	1.13	0.62	5.61	7.25	5.06	17.92
54Q53	Pioneer Hi-Bred Int'l.	2.27	1.36	1.25	0.92	5.80	7.13	4.91	17.84
Lahontan	USDA-NV	2.24	1.34	1.23	0.60	5.41	7.54	4.87	17.82
Winter Crown	Dairyland Research	2.14	1.35	1.16	0.85	5.50	7.19	5.06	17.75
Dagger + EV	AgriPro	2.41	1.09	1.10	0.68	5.28	7.43	5.03	17.74
4200	Seed Solutions	2.23	1.49	1.11	0.95	5.78	7.05	4.79	17.62
FG 6M71*	Forage Genetics Int'l.	1.81	1.21	1.16	0.83	5.01	7.48	5.10	17.59
Target Plus	Producers Hybrids	2.07	1.22	1.11	0.72	5.12	7.23	5.17	17.52
MagnumV-Wet	Dairyland Research	1.91	1.18	1.19	0.77	5.05	7.40	4.90	17.35
Geneva	Novartis	2.18	1.26	1.25	0.68	5.37	7.15	4.78	17.30
FG 5M84*	Forage Genetics Int'l.	2.08	1.39	1.16	0.76	5.39	7.00	4.90	17.29
FG 3R139*	Forage Genetics Int'l.	2.41	1.32	1.16	0.77	5.66	6.84	4.67	17.17
ZX 9853*	ABI Alfalfa, Inc.	2.10	1.20	1.18	0.73	5.21	7.22	4.71	17.14
ZC 9941A*	ABI Alfalfa, Inc.	1.98	1.20	1.12	0.80	5.10	7.08	4.77	16.95
Baralfa42IG	Barenburg USA	1.93	1.13	1.10	0.76	4.92	6.94	4.70	16.56
Samurai	America's Alfalfa	1.96	1.06	1.02	0.80	4.84	6.92	4.74	16.50
A30-06	ABI Alfalfa, Inc.	1.82	1.09	1.14	0.74	4.79	6.34	4.70	15.83
Average		2.21	1.27	1.16	0.77	5.41	7.26	4.95	17.62
CV%		15.80	15.11	18.29	24.07	13.98	7.39	4.71	7.02
$LSD_{(0.05)}$		0.49	0.27	0.30	0.26	1.07	0.76	0.33	1.75

[1]Trial conducted at the Arkansas Valley Research Center; seeded 1 Sept. 2000.
[2]Yields calculated on oven-dry basis.
*Indicates experimental entry.

Site Information

Elevation: 4178 ft.
Precipitation: Average annual 11.77 in. 2003 April through September - 7.3 in.
Growing Days: Average - 158 1 May – 6 Oct. Frost Free
2003 - 188 9 April - 14 Oct. Frost Free
Fertilizer: 100 lbs. P_2O_5 + 21 lbs. N/acre prior to planting
156 lbs. P_2O_5 + 33 lbs. N/acre – 28 Nov. 2002.
Herbicide: Sencor DF .75 lbs. + Gramoxone Extra .47 lbs. AI/Acre – 12 Mar. 2002, 13 Mar 2003.
Insecticide: Warrior T .025 lbs. + Lorsban .125 lbs. AI/Acre – 13 May 2002, 14 May 2003.
Soil Series: Rocky Ford Silty Clay Loam.

2000 ARKANSAS VALLEY ALFALFA VARIETY TRIAL AT ROCKY FORD

Frank C. Schweissing

The Arkansas Valley, in southeastern Colorado, extends from the mountains on the west to the Kansas border. Alfalfa is the most important irrigated crop in the Valley being produced on 165,000 acres. Furrow or flood irrigation predominates, but about 3,000 acres are produced under sprinklers and there are an additional 5,000 dryland acres. The elevation varies from 3,400 feet in the east to 4,700 feet at Pueblo. The average annual precipitation along the Valley is 11 inches.

The average frost-free period is 158 days from May 1 to October 6 which results in four cuttings per season as a standard practice. Successful varieties need winter hardiness (temperatures go below 0^oF), but they also must take advantage of a relatively long growing season. The average alfalfa yield in the Valley is 4.35 tons/acre. The most persistent pests are the alfalfa weevil, stem nematode, and tansy mustard/flixweed.

Researcher Comments

This was the third season for a trial established in the fall of 1997. The trial was irrigated prior to the first cutting and after each of the four cuttings. Rainfall from April through September was 5.6 in. compared to the long-term average of 9 in. Irrigation water was adequate and all four cuttings were harvested without rain damage. The average trial yield was 5.84 tons, compared to 6.35 tons in 1999 and 5.36 tons in 1998 (Table 1).

Researcher

Dr. Frank Schweissing, Superintendent-Entomologist, has conducted alfalfa trials at the Arkansas Valley Research Center (AVRC) for 30 years. He received his B.S. and M.S. in Entomology from Colorado State University and Ph.D. in Entomology from Kansas State University. He began working at the AVRC in 1961 as an Entomologist and became Superintendent in 1980. His major research efforts have been with the insect and mite pests of alfalfa, corn, sorghum, and onions.

Site Information

(Elevation 4178 ft.)
Average annual precipitation 11.88 in. Average frost-free days - 158 (32^oF base).
Last spring frost - 25 April 2000: First fall frost - 25 Sept. 2000; 2000 frost free days - 153.
Soil series: Rocky Ford silty clay loam; ca 1.5% o.m.; ca 7.8pH.
Seeding rate: 10.2 lbs. seed/acre
Fertilizer: 150 lbs. P_2O_5 + 31 lbs. N/acre prior to planting and 30 Nov. 1998.
Herbicide: Sencor 75 DF .50 + Gramoxone .31 lbs. AI/Acre - 16 Feb. 1999 and 22 Feb. 2000.
Insecticide: Furadan 4F .75 lbs. AI/Acre - 21 Apr. 1999; Furadan 4F 1.0 lb. AI/Acre – 25 Apr. 2000.

Table 1. Forage yields of 28 alfalfa varieties at Rocky Ford[1] in 1998-2000.

Variety	Brand/Source	1st Cut 30 May	2nd Cut 5 July	3rd Cut 10 Aug	4th Cut 28 Sept	Total 2000	Total 1999	Total 1998	Total 3-Yr
		tons/acre[2]							
WL 334RK	W-L Research	1.87	1.82	1.57	1.39	6.65	7.03	5.86	19.54
3L104*	Novartis	1.95	1.74	1.40	1.34	6.43	6.59	5.57	18.59
DK143	DeKalb	1.88	1.68	1.36	1.42	6.34	6.52	5.67	18.53
Millennia	Union Seed Co	2.02	1.70	1.37	1.27	6.36	6.64	5.48	18.48
Leaf Master	Union Seed Co	1.99	1.72	1.43	1.30	6.44	6.73	5.24	18.41
Cimarron 3i	Great Plains Research	1.90	1.61	1.39	1.34	6.24	6.62	5.54	18.40
Pinnacle	Arkansas Valley Seed	1.98	1.66	1.49	1.23	6.36	6.48	5.35	18.19
Depend + EV	Agripro Seeds Inc	1.56	1.58	1.35	1.25	5.74	6.63	5.60	17.97
TMF Multiplier II	Mycogen Seeds	1.77	1.62	1.28	1.33	6.00	6.40	5.44	17.84
Big Horn	Cargill Hybrid Seeds	1.76	1.56	1.38	1.24	5.94	6.48	5.41	17.83
ZX 9352*	ABI Alfalfa	1.50	1.53	1.38	1.40	5.81	6.55	5.46	17.82
WL 324	Germain's	1.50	1.49	1.34	1.21	5.54	6.52	5.74	17.80
5454	Pioneer Hi-Bred Int'l	1.57	1.62	1.35	1.32	5.86	6.49	5.43	17.78
DK142	DeKalb	1.79	1.57	1.29	1.30	5.95	6.47	5.34	17.76
631	Garst Seed Co	1.61	1.58	1.24	1.26	5.69	6.60	5.38	17.67
ZC 9651*	ABI Alfalfa	1.46	1.57	1.34	1.29	5.66	6.39	5.56	17.61
Archer	America's Alfalfa	1.54	1.64	1.35	1.34	5.87	6.29	5.24	17.40
WL 325HQ	Germain's	1.86	1.62	1.38	1.26	6.12	6.01	5.25	17.38
Innovator + Z	America's Alfalfa	1.62	1.54	1.32	1.20	5.68	6.27	5.43	17.38
Affinity + Z	America's Alfalfa	1.46	1.46	1.25	1.27	5.44	6.44	5.44	17.32
DK127	DeKalb	1.67	1.61	1.30	1.16	5.74	6.29	5.24	17.27
Lahontan	USDA NV-AES	1.77	1.68	1.38	1.25	6.08	6.06	5.13	17.27
630	Garst Seed Co	1.57	1.60	1.28	1.19	5.64	6.19	5.34	17.17
Haygrazer	Great Plains Research	1.61	1.42	1.29	1.14	5.46	6.24	5.29	16.99
6L271*	Arkansas Valley Seed	1.40	1.58	1.32	1.44	5.74	6.11	5.07	16.92
ZC 9650*	ABI Alfalfa	1.42	1.55	1.28	1.21	5.46	6.01	5.30	16.77
Ranger	USDA NE-AES	1.28	1.28	1.17	1.10	4.83	5.25	4.71	14.79
Vernal	USDA WI-AES	1.29	1.25	1.01	0.94	4.49	5.39	4.51	14.39
Average		1.67	1.58	1.33	1.26	5.84	6.35	5.36	17.55
CV%		10.28	5.32	6.82	7.25	5.90	4.72	4.12	3.79
$LSD_{(0.05)}$		0.24	0.12	0.13	0.13	0.48	0.42	0.31	0.94

[1]Trial conducted on the Arkansas Valley Research Center, seeded 29 Aug. 1997.
[2]Yields calculated on oven-dry basis.
*Indicates experimental entry

FORAGE YIELDS OF 20 ALFALFA VARIETIES AT THE SOUTHWESTERN COLORADO RESEARCH CENTER AT YELLOW JACKET 2000-2003

Mark Stack, Abdel Berrada, and Tom Hooten

Summary

This alfalfa variety trial was planted in 2000 and evaluated over a 4-year period. In the establishment year, a planting date of 2 June was too late to allow for more than one cutting. In 2001, the first full year, the alfalfa trial averaged 8.25 tons/acre. This relatively high yield may be attributed to the new stand and harvesting only one cutting the previous year. In 2002, the alfalfa was damaged by unusually cold spring temperatures. The first cutting yield of 1.65 tons/acre was below average. As a result, the total yield for 2002 was only 5.85 tons/acre. In 2003, the alfalfa variety trial averaged 6.14 tons/acre for three cuttings, notwithstanding an army cutworm infestation and a late summer hailstorm. The combined 3-year total yield (2001, 2002, and 2003) for each alfalfa variety shows that the 10 highest yielding varieties were not statistically different. There were significant yield differences for each cutting and for each year, except for the second cutting in 2001. Ranger, the check variety, was the lowest yielding variety in 2001, 2002, and 2003.

Introduction and Objectives

Alfalfa variety performance tests under local conditions provide growers with information to assist them in selecting varieties for their own farm. Variety tests also provide seed companies, seed dealers, and consultants with information to evaluate and recommend varieties.

In southwestern Colorado, alfalfa is the main crop in terms of acreage, production, and cash value. In 2001, a total of 86,000 acres of alfalfa were harvested in the five counties of southwestern Colorado (Archuleta, Dolores, La Plata, Montezuma, and San Miguel). Approximately 85% of this acreage was irrigated. The majority of the irrigated areas are served by older water delivery systems. The Dolores Project, a pressurized irrigation system developed by the Bureau of Reclamation, supplies irrigation water to the Dove Creek/Yellow Jacket area and to the Ute Mountain Indian Reservation. The average growing season is 120 to 160 days with annual precipitation of 16 in. One-half of the precipitation is received as snow with June being the driest month. The major soil series is Wetherill clay loam with a water holding capacity of 1.8 to 2.0 in./foot and soil organic matter content of 1%. The soils are generally low in phosphorus and high in potassium. The elevation where alfalfa is produced ranges from 5,500 ft. to over 7,000 ft.

Average irrigated alfalfa yields in 2001 ranged from 2.60 tons/acre in Archuleta County to 4.35 tons/acre for Montezuma County. Cropland in the Dolores Project in the Dove Creek/Yellow Jacket area averaged 4.20 tons/acre in 2001.

There are usually three cuttings per year: June, late July, and September. Alfalfa varieties recommended have dormancy ratings of 3 to 5 in most areas. The primary insects and diseases in the area are pea aphids, thrips, crown and root rots, and alfalfa weevil in the lower elevation areas. The interaction between stem nematodes and root and crown rots is receiving increased attention in the area.

The winters of 2001-02 and 2002-03 were extremely dry with below average snowpack in the mountains. The record low stream runoffs resulted in limited irrigation water supplies in southwestern Colorado. The dry soil moisture conditions going into the growing season and a shortage of irrigation water made it difficult for area growers to meet the water requirements of the alfalfa crop. Most growers had enough irrigation water for only one or two cuttings each year. The Southwestern Colorado Research

Center was able to reallocate water from other crops to provide adequate water for the alfalfa variety trial during this period.

Alfalfa hay quality in southwestern Colorado is good to excellent due to dry weather and relatively few disease and insect problems. The older irrigated areas of southwestern Colorado produce alfalfa targeted either local livestock operations or for livestock operations in the Four Corners area. A significant market for alfalfa hay has been developed with members of the nearby Indian tribes. A majority of the alfalfa produced under the Dolores Project is marketed to dairies in the southwestern United States.

Materials and Methods

The alfalfa variety trial was planted on 2 June 2000. A randomized complete block design with four replications was used for the trial. The trial was seeded with a Kincaid cone planter at 20 lbs/acre. A Carter Forage Plot Harvester (sickle-bar) was used to harvest the plots. Pursuit herbicide was used in the seeding year to achieve a weed-free stand. A good to excellent alfalfa stand was obtained. Phosphate fertilizer (200 lbs P_2O_5/acre) was broadcast in 2001. Mustang Max insecticide was applied on 11 Apr. 2003 to control a severe army cutworm infestation. A wheel-line irrigation system and sprinklers with a single nozzle (40 ft. spacing) was used to irrigate the variety trial. Wheel-line moves were 60 ft. initially. This spacing was modified in 2002 and a spreader nozzle was added to improve irrigation efficiency. Irrigation water applied per acre in 2001, 2002, and 2003 was 19.5, 30.0, and 34.5 in., respectively.

Results and Discussion

Only one cutting was made in the seeding year due to the late planting date. The results for 2000 are not included in this report due to high variability in the data caused by hot and dry conditions during the summer. The average yield for the initial cutting in 2000 was 1.71 tons/acre.

In 2001, the total average yield for all three cuttings was 8.25 tons/acre. This relatively high yield for the area may be due to the new stand and harvesting only one cutting during the establishment year. The results are shown in Table 1.

In 2002, the variety trial averaged 5.85 tons/acre with a first cutting average of 1.65 tons/acre (Table 2). The alfalfa trial was damaged by cold weather in April and early May. On 21 April, the temperature dropped to 21.9 $^{\circ}$F. The alfalfa never recovered from the freeze damage and the first cutting yields were well below average. The high variability (CV%) for the first and second cuttings may be primarily due to lack of winter moisture, freeze damage, and poor uniformity of irrigation water application. To improve the irrigation water uniformity, the wheel-line moves were shortened to 40 ft. after the first cutting and a spreader nozzle was added for the third cutting. This practice was continued in 2003.

Table 3 shows the 2003 and the 3-year combined yield totals. The varieties are ranked in descending order by total yield. In 2003, the average yield was 6.14 tons/acre. The high variability in the third cutting was due to a severe hailstorm on 9 September. It is estimated that the third cutting yield was reduced by 50% due to leaf loss and broken stems.

The combined 3-year total yield (2001, 2002, and 2003) for each alfalfa variety shows that the 10 highest yielding varieties were not statistically different. There were significant differences for each cutting and total yields for each year, except for the second cutting in 2001. Ranger, the check variety, was the lowest yielding variety in 2001, 2002, and 2003.

Acknowledgments

We thank Jerry Mahaffey, Southwestern Colorado Research Center staff member, for his assistance in planting, irrigating, and harvesting the alfalfa variety trial.

References

Colorado Agricultural Statistics Service. 2003. Colorado agricultural statistics. Nat'l Agric. Statistics Service and Colorado Dep. of Agric., Lakewood, CO.

Table 1. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2001.[1]

Variety	Brand/Source	1st Cut 6 June	2nd Cut 20 July	3rd Cut 5 Sept.	2001 Total
		----------tons/acre[2]----------			
ZG 9650A*	ABI Alfalfa, Inc.	4.41	2.68	1.90	8.98
Focus HSN	Arkansas Valley Seeds	4.64	2.54	1.65	8.83
DK 134	DeKalb	4.11	3.00	1.69	8.79
WL 327	Germain's Seed	3.68	3.09	1.92	8.70
Award	Asgrow Seed Co.	4.24	2.74	1.70	8.67
Magnum V	Dairyland Seed Co.	3.93	2.85	1.79	8.58
DK 142	DeKalb	3.76	2.92	1.83	8.51
Pro Gro	MBS Genetics	3.76	2.70	1.97	8.42
Aspire	Asgrow Seed Co.	4.05	2.62	1.74	8.41
DK 143	DeKalb	3.89	2.67	1.83	8.39
Baralfa 54	Barenbrug USA	3.73	2.63	1.97	8.33
Millennia	IFA	3.75	2.58	1.94	8.26
Forecast 1001	Dairyland Seed Co.	3.59	2.63	1.92	8.14
Archer II	America's Alfalfa	3.78	2.38	1.93	8.09
AmeriGraze 401+Z	America's Alfalfa	3.48	2.60	1.78	7.85
WL 325HQ	Germain's Seed	3.63	2.57	1.55	7.75
Abound	Asgrow Seed Co.	3.59	2.30	1.86	7.74
Geneva	Novartis Seeds	3.27	2.55	1.87	7.69
ZX 9652*	ABI Alfalfa, Inc.	3.46	2.43	1.73	7.61
Ranger	Public	3.42	2.27	1.39	7.07
Average		3.81	2.64	1.80	8.25
CV%		12.98	16.31	14.52	9.52
$LSD_{(0.30)}$		0.37	NS	0.19	0.58

[1]Trial conducted at the Southwestern Colorado Research Center, seeded 2 June 2000.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Table 2. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2002.[1]

Variety	Brand/Source	1st Cut 14 June	2nd Cut 24 July	3rd Cut 25 Sept.	2002 Total	2-Year Total
		----------------------------tons/acre[2]----------------------------				
Magnum V	Dairyland Seed Co.	2.27	1.80	2.44	6.52	15.10
Baralfa 54	Barenbrug USA	1.59	2.22	2.47	6.29	14.62
WL 327	Germain's Seed	1.80	2.00	2.47	6.27	14.97
Millennia	IFA	1.80	1.93	2.50	6.23	14.49
Aspire	Asgrow Seed Co.	2.00	1.61	2.59	6.20	14.61
Geneva	Novartis Seeds	1.60	2.17	2.36	6.13	13.82
ZG 9650A*	ABI Alfalfa, Inc.	1.50	1.92	2.65	6.06	15.04
Pro Gro	MBS Genetics	1.46	2.15	2.38	5.99	14.41
DK 142	DeKalb	1.81	1.68	2.45	5.93	14.44
Forecast 1001	Dairyland Seed Co.	1.61	1.89	2.39	5.89	14.03
Focus HSN	Arkansas Valley Seeds	1.88	1.61	2.40	5.88	14.71
ZX 9652*	ABI Alfalfa, Inc.	1.63	1.91	2.33	5.87	13.48
Archer II	America's Alfalfa	1.47	1.84	2.54	5.85	13.94
DK 134	DeKalb	2.00	1.47	2.34	5.81	14.60
DK 143	DeKalb	1.27	2.12	2.41	5.80	14.19
WL 325HQ	Germain's Seed	1.74	1.79	2.14	5.66	13.41
AmeriGraze 401+Z	America's Alfalfa	1.45	1.89	2.29	5.63	13.48
Award	Asgrow Seed Co.	1.62	1.64	2.33	5.59	14.26
Abound	Asgrow Seed Co.	1.23	2.10	2.21	5.54	13.28
Ranger	Public	1.33	1.28	1.36	3.98	11.05
Average		1.65	1.85	2.35	5.85	14.10
CV%		30.57	24.83	7.96	10.27	7.81
$LSD_{(0.30)}$		0.37	0.34	0.14	0.44	0.81

[1]Trial conducted at the Southwestern Colorado Research Center, seeded 2 June 2000.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
*Indicates experimental entry.

Table 3. Forage yields of 20 alfalfa varieties at Yellow Jacket in 2003.[1]

Variety	Brand/Source	1st Cut 9 June	2nd Cut 5 Aug.	3rd Cut 24 Sept.	2003 Total	3-Year Total
		-------------------	-------------------	tons/acre[2]	-------------------	-------------------
ZG 9650A*	ABI Alfalfa, Inc.	2.99	2.56	0.77	6.32	21.36
Magnum V	Dairyland Seed Co.	3.05	2.28	0.83	6.16	21.26
Baralfa 54	Barenbrug USA	3.08	2.56	0.99	6.63	21.25
Millennia	IFA	3.11	2.71	0.88	6.70	21.19
WL 327	Germain's Seed	2.96	2.44	0.75	6.15	21.12
DK 134	DeKalb	2.93	2.51	0.87	6.31	20.91
Forecast 1001	Dairyland Seed Co.	3.32	2.54	0.98	6.84	20.87
Focus HSN	Arkansas Valley Seeds	2.75	2.60	0.74	6.09	20.80
Pro Gro	MBS Genetics	3.07	2.47	0.83	6.37	20.78
DK 142	DeKalb	2.84	2.62	0.76	6.22	20.66
DK 143	DeKalb	2.87	2.61	0.79	6.27	20.46
Award	Asgrow Seed Co.	2.77	2.49	0.77	6.03	20.29
Aspire	Asgrow Seed Co.	2.48	2.38	0.80	5.66	20.27
Geneva	Novartis Seeds	3.04	2.49	0.87	6.40	20.22
Archer II	America's Alfalfa	2.94	2.49	0.80	6.23	20.17
ZX 9652*	ABI Alfalfa, Inc.	2.85	2.34	0.82	6.01	19.49
AmeriGraze 401+Z	America's Alfalfa	2.79	2.40	0.72	5.91	19.39
WL 325HQ	Germain's Seed	2.89	2.35	0.67	5.91	19.32
Abound	Asgrow Seed Co.	2.81	2.33	0.68	5.82	19.10
Ranger	Public	2.45	1.90	0.42	4.77	15.82
Average		2.90	2.45	0.79	6.14	20.24
CV%		6.04	5.38	14.97	5.27	6.00
$LSD_{(0.30)}$		0.13	0.10	0.09	0.24	0.90

[1]Trial conducted at the Southwestern Colorado Research Center, seeded 2 June 2000.
[2]Yields were calculated on an oven-dry basis and adjusted to 12% moisture.
[*]Indicates experimental entry.

NORTHEASTERN COLORADO ALFALFA VARIETY TRIAL AT WIGGINS

Jerry Johnson and Bruce Bosley

Twenty counties in northeast and east-central Colorado that might draw information from the Wiggins trial produce about half of Colorado's alfalfa hay. This 20-county area has about 260,000 acres of irrigated and about 55,000 acres of dryland alfalfa with annual hay production valued at over $135 million.

Researcher Comments

Most of Colorado's alfalfa variety trials are conducted on research stations due to practical harvest and handling considerations. There are no research stations in the irrigated alfalfa area of northeastern Colorado; therefore, we are grateful for the cooperation of Martin Smits who sacrificed an acre of land and his harvest flexibility to make this trial possible. Alfalfa stands in the plots remained excellent throughout the life of the trial

Researchers

Jerry Johnson is extension specialist for crop production and, since 1995, has been the leader of the Crops Testing program at CSU in the Department of Soil and Crop Sciences. He obtained his M.S. and Ph.D. from Washington State University where he studied crop variety testing.

Bruce Bosley is the Morgan County Cooperative Extension Director/Agronomist. He has worked in Extension for 15 years and served as the education outreach coordinator on the Colorado Hay Days management committee from 1988 through 1991. He was an independent crop consultant for 5 years in the mid 1980's. He obtained his M.S. at Colorado State University.

Site Information

Elevation 4750 ft.
Soil series: Valent loamy sand with some bijou loamy sand characteristics**.**

Table 1. Forage yields of 26 alfalfa varieties at Wiggins[1] 1999-2001.

Variety	Brand/Source	Total Yield			
		2001	2000	1999	3-yr
		tons/acre[2]			
Pioneer brand 5396	Pioneer Hi-Bred Int'l	8.24	8.88	8.05	25.17
Reno	Novartis Seeds	8.04	9.11	8.00	25.16
DEKALB DK142	Monsanto/DEKALB	8.09	9.27	7.78	25.13
Big Horn	Cargill Hybrid Seeds	8.20	9.19	7.66	25.06
Legacy	Grassland West Co.	7.89	9.19	7.92	25.00
DEKALB DK127	Monsanto/DEKALB	8.08	9.26	7.54	24.88
TMF Multi-plier II	Mycogen Seeds	7.94	9.09	7.80	24.83
Pioneer brand 5312	Pioneer Hi-Bred Int'l, Inc.	8.25	9.01	7.56	24.82
Depend+EV	Agripro Seed, Inc.	7.79	9.24	7.77	24.80
Garst Seed 631	Garst Seeds	8.06	8.86	7.84	24.76
Garst Seed 630	Garst Seeds	8.04	8.84	7.78	24.66
WL 325HQ	W-L Research, Inc.	8.01	8.84	7.77	24.62
Magnum III	Dairyland Seed Co.	7.92	8.74	7.80	24.46
Alpha 2001	Great Lakes Hybrids	8.09	8.54	7.77	24.40
Shamrock	Sharp Bros. Seed Co.	7.56	8.88	7.92	24.36
AlfaLeaf II	Sharp Bros. Seed Co.	7.60	8.98	7.76	24.34
Innovator+Z	America's Alfalfa	7.80	8.64	7.81	24.25
Excalibur II	Allied Seed	7.76	8.75	7.74	24.25
AmeriGraze 401 + Z	America's Alfalfa	7.59	8.86	7.59	24.04
Spartan	Allied Seed	7.80	8.57	7.67	24.04
Complete	Arrow Seed Co.	7.54	8.58	7.81	23.93
Tahoe	Novartis Seeds	7.96	8.76	6.98	23.70
Total + Z	America's Alfalfa	7.48	8.43	7.71	23.62
Webfoot MPR	Great Lakes Hybrids	7.60	8.32	7.44	23.37
Focus HSN[3]	Arkansas Valley Seeds	7.68	8.46	7.18	23.32
Evergreen-2	Arkansas Valley Seeds	7.77	8.36	6.87	23.00
Average		7.88	8.83	7.67	24.38
LSD(0.30)		0.18	0.27	0.24	0.13

[1] conducted on the Martin Smits farm, seeded 3 Sept.1997.
[2] Yields calculated on air-dry basis.
[3] Previously named ‘Pinnacle.’

SAN LUIS VALLEY ALFALFA VARIETY TRIAL AT CENTER

Merlin A. Dillon

Introduction

The San Luis Valley (SLV) is a huge, flat valley surrounded by snow-capped mountains. The elevation is 7700 feet. Alfalfa and other crops are grown with irrigation water ultimately obtained from snow melt. The SLV area is comprised of Alamosa, Conejos, Costilla, Rio Grande, and Saguache counties. Alfalfa yield, price, and acreage within the SLV has been increasing in recent years. Alfalfa was produced on 167,000 acres in 2001 and the resulting hay crop was worth $69 million. With acreage in the SLV plus other surrounding high elevation acreage, high valley alfalfa is grown on over 250,000 acres.

Typically, alfalfa is cut three times per year. Except in years with warm summers, the third cutting is usually immature. Alfalfa stands typically last 5 to 7 years; however, warm, dry winters can cause severe winter kill. Winter-hardiness and persistence are important variety selection factors; as well as regrowth, yield, and pest resistance. Given the unique environment of the SLV, it is important to test new alfalfa varieties under local conditions.

Materials and Methods

The experimental was a randomized complete block with four replications. Average annual precipitation is only 7 in. Average frost-free days are 94, typically from 9 June to 9 September. Appreciation is expressed for the cooperation of local grower, Sherrel Mix, a potato/barley/alfalfa producer. The study site is 2.5 miles southwest of the SLV Research Center. The soil is the same as the one on the Research Center, a Norte gravelly sandy loam. This soil is typical for the area west of Highway 285.

The trial was planted as a sole crop in June 2000 and an excellent stand was established. Planter problems resulted in four missing plots in the trial. The trial was harvested three times in each year during 2001, 2002, and 2003 with the exception of the third cutting in 2001, which was lost because of a mishap by a custom swather operator. This trial will be harvested again in 2004 and a new trial will also be planted in 2004.

Spring weather was warm in all 3 years, resulting in early June first cuttings. The growing season in 2002 and 2003 was warm, which promoted increased growth and higher than normal third cutting yields. The second cutting in 2001 was rained on, which damaged hay and created wheel tracks in the third cutting. Both the 2002 and 2003 growing seasons were dry and the hay harvested these 2 years almost entirely escaped rain damage.

Having adequate irrigation water was a problem for many growers beginning in 2002. Ditches ran very little water that year, the lowest year on record. Irrigation ditches with senior rights ran more water in 2003. However, problems were encountered with many wells because they produced less water, had too little pressure, or pumped air compared to other years. Some wells had no water in 2003. Adequate water and good growing conditions produced better than average yields in this test plot for all 3 years of testing. There was a problem with the second harvest in 2003; the alfalfa had taller and shorter rings of plant growth in concentric circles around the irrigation pivot. This problem was corrected by installing new nozzles on the center pivot before third cutting growth started.

Results and Discussion

Results from 2001 are shown in Table 1. The spring weather was exceptionally warm, resulting in an early first cutting. The second cutting experienced some rain. First cutting hay yields averaged across all 24 varieties was 1.64 tons/acre. There were no significant differences in yield among varieties in the first cutting. In the second cutting, the average yield was 2.15 tons/acre. Again, there were no significant differences in yield among the varieties. It was not possible to harvest the third cutting; however, the yield was estimated at 1.75 tons/acre. Total 2001 yield averaged 5.54 tons/acre. There were no significant differences among alfalfa varieties for total 2001 yield.

Results from 2002 are shown in Table 2. Again, warm spring weather resulted in an early first cutting date. The entire summer was very dry because of drought. There was no rain damage to alfalfa in 2002. Variety differences were statistically significant for each cutting in 2002. The first cutting, averaged across all 24 varieties, was 1.60 tons/acre. Columbia 2000 had the highest yield. The second cutting averaged 2.40 tons/acre. All varieties except one produced high yields. The average across all varieties for third cutting was 2.41 tons/acre. Three varieties produced high yields for third cutting. The average total yield for the three cuttings in 2002 was 6.42 tons/acre. Columbia 2000 and WL 327 produced high yields for the total 2002 yield. The 2-year total yield averaged 11.96 tons/acre. For the 2001-2002 total yield, five varieties produced high yields.

Variety trial results for 2003 are shown in Table 3. Differences in yield among the varieties were not significant for any cutting or the total yield in 2003. Hay yields were very good for the year; averaging 6.12 tons/acre. First cutting was early and rainfall was not a problem. The first cutting averaged 2.16 tons/acre, the second averaged 2.21 tons/acre, and the third cutting averaged 1.75 tons/acre.

There were no significant differences among alfalfa varieties for the 3-year total yields. Although there was no statistical significance for the 3-year total, several varieties performed well in this 3-year trial. Vernal and Ranger were at least 0.7 tons/acre below the top yield, which has been the case over the last 20+ years of trials. Newer improved varieties usually cost more initially, but the higher seed cost is returned many times over by the higher forage yields that are produced.

Fig. 2. The John Deere 3430 crimper/swather with electronic weigh box added to weigh individual plots.

Fig. 1. A view of the alfalfa variety trial; some plots harvested, others remain to be harvested.
Plot size = 8 ft. x 16 ft.

Table 1. Forage yields of 24 alfalfa varieties at Center[1], San Luis Valley in 2001.

Variety	Brand/Source	Harvest 1	Harvest 2	Harvest 3	2001 Total
		---------------------tons/acre[2]	-------------------------		
Select	Forage Genetics Int'l	1.75	2.38	1.75[3]	5.88
DK 143	Monsanto/DeKalb	1.74	2.31	1.75	5.80
WL 325 HQ	W-L Research	1.67	2.38	1.75	5.76
DK 142	Monsanto/DeKalb	1.73	2.26	1.75	5.73
WL 327	W-L Research	1.77	2.20	1.75	5.72
Pro Gro	M.B.S. Inc	1.70	2.26	1.75	5.71
WL 232 HQ	W-L Research	1.76	2.20	1.75	5.70
54Q53	Pioneer Hi-Bred Int'l	1.67	2.25	1.75	5.66
Columbia 2000	Public	1.88	2.00	1.75	5.63
AmeriStand 201	ABI Alfalfa	1.71	2.12	1.75	5.58
Baralfa 42IQ	Barenbrug Colorado	1.78	2.01	1.75	5.54
FG 4200	Ark. Valley Seeds	1.52	2.27	1.75	5.54
Magnum V	Dairyland Seed	1.54	2.23	1.75	5.52
Award	Asgrow Seed	1.65	2.08	1.75	5.48
Aspire	Asgrow Seed	1.65	2.08	1.75	5.48
Abound	Asgrow Seed	1.55	2.19	1.75	5.47
Geneva	Novartis Seeds	1.56	2.12	1.75	5.43
53V08	Pioneer Hi-Bred Int'l	1.64	2.02	1.75	5.41
FG 3R139	Forage Genetics Int'l	1.60	2.06	1.75	5.40
Gold Plus	M.B.S. Inc.	1.57	2.07	1.75	5.39
Vernal	USDA WI-AES	1.54	2.06	1.75	5.35
DK 134	Monsanto/DeKalb	1.47	2.12	1.75	5.34
Ranger	USDA NE-AES	1.51	2.04	1.75	5.30
HybriForce™ 400	Dairyland Research Int'l	1.53	2.00	1.75	5.28
Average		1.64	2.15	1.75	5.54
CV (%)		13.2	10.3	---	6.1
LSD (0.10)		NS	NS	---	NS

[1] Trial conducted on the Sherrel Mix farm, Rio Grande County, Roads 8N & 1W; seeded at 16 lbs/acre on 16 June 2000.
[2] Yields calculated on oven-dry basis.
[3] Third cutting 2001 was lost; overall yield was estimated.
Harvest dates were 5 June, 17 July, and 8 September.

Table 2. Forage yields of 24 alfalfa varieties at Center[1], San Luis Valley in 2002.

Variety	Brand/Source	Harvest 1	Harvest 2	Harvest 3	Total 2002	2-Year total
		---------------------------tons/acre[2]				---------------------------
Columbia 2000	Public	1.96	2.52	2.86	7.34	12.92
WL 327	W-L Research	1.73	2.51	2.74	6.97	12.68
Select	Forage Genetics Intl.	1.68	2.30	2.56	6.54	12.43
DK 142	Monsanto/DeKalb	1.69	2.43	2.51	6.63	12.37
DK 143	Monsanto/DeKalb	1.68	2.54	2.34	6.55	12.22
Geneva	Novartis Seeds	1.57	2.52	2.46	6.55	12.09
Magnum V	Dairyland Seed	1.50	2.41	2.55	6.46	12.05
Baralfa 42IQ	Barenbrug Colorado	1.71	2.39	2.34	6.44	12.03
WL 325 HQ	W-L Research	1.56	2.32	2.40	6.28	12.00
Pro Gro	M.B.S. Inc	1.57	2.23	2.68	6.48	11.99
54Q53	Pioneer Hi-Bred Intl.	1.64	2.40	2.22	6.25	11.99
FG 3R139	Forage Genetics Intl.	1.55	2.53	2.47	6.55	11.94
HybriForce ™-400	Dairyland Research Intl	1.52	2.45	2.51	6.48	11.89
Ranger	USDA NE-AES	1.50	2.47	2.38	6.35	11.89
WL 232 HQ	W-L Research	1.69	2.32	2.31	6.32	11.82
Aspire	Asgrow Seed	1.59	2.32	2.38	6.29	11.82
FG 4200	Seed Solutions	1.49	2.38	2.37	6.24	11.78
53V08	Pioneer Hi-Bred Intl.	1.59	2.50	2.38	6.46	11.78
Vernal	USDA WI-AES	1.48	2.33	2.26	6.07	11.73
AmeriStand 201	ABI Alfalfa	1.69	2.35	2.09	6.14	11.72
DK 134	Monsanto/DeKalb	1.47	2.53	2.29	6.29	11.63
Award	Asgrow Seed	1.58	2.30	2.16	6.04	11.52
Abound	Asgrow Seed	1.45	2.34	2.37	6.16	11.48
Gold Plus	M.B.S. Inc.	1.56	2.32	2.21	6.09	11.41
Average		1.60	2.40	2.41	6.42	11.96
CV (%)		11.9	9.1	10.4	6.4	2.30
LSD (0.10)		0.22	0.26	0.29	0.58	1.48

[1] Trial conducted on the Sherrel Mix farm, Rio Grande County, Roads 8N & 1W; seeded at 16 lbs/acre on 16 June 2000.
[2] Yields calculated on oven-dry basis.
Harvest dates were 5 June, 17 July, and 6 September.

Table 3. Yields of 24 alfalfa varieties at Center[1], San Luis Valley in 2003.

Variety	Source	Harvest 1	Harvest 2	Harvest 3	Total 2003	3-Year total
		-----------------------------	tons/acre[2]	-----------------------------		
WL 327	WL Research	2.21	2.30	1.77	6.27	18.95
Select	Forage Genetics	2.07	2.34	1.81	6.22	18.75
Geneva	Novartis	2.32	2.38	1.89	6.59	18.68
DK 143	DeKalb	2.23	2.34	1.76	6.33	18.56
DK 142	DeKalb	2.07	2.40	1.72	6.18	18.55
Magnum V	Dairyland	2.17	2.32	1.79	6.28	18.33
HybriForce TM-400	Dairyland	2.16	2.38	1.89	6.43	18.32
WL 325 HQ	WL Research	2.22	2.13	1.73	6.08	18.14
Ranger	USDA NE-AES	2.30	2.17	1.78	6.24	18.13
Columbia 2000	Public	2.39	2.38	1.86	6.63	18.11
54Q53	Pioneer	2.12	2.27	1.66	6.04	18.03
Pro Gro	M.B.S., Inc.	2.17	2.07	1.80	6.03	18.02
FG 4200	Forage Genetics	2.10	2.28	1.80	6.19	17.96
FG 3R139	Forage Genetics	2.12	2.27	1.81	6.19	17.96
Vernal	USDA WI-AES	2.22	2.37	1.61	6.20	17.93
Baralfa 42IQ	Barenbrug	2.16	2.03	1.70	5.88	17.92
Aspire	Asgrow	2.10	2.11	1.79	5.99	17.81
DK 134	DeKalb	2.10	2.24	1.75	6.09	17.72
WL 232 HQ	WL Research	2.12	2.03	1.68	5.82	17.61
Abound	Asgrow	2.18	2.06	1.73	5.97	17.45
Award	Asgrow	2.00	2.04	1.67	5.70	17.22
Gold Plus	M.B.S., Inc.	2.04	2.05	1.67	5.76	17.12
AmeriStand 201	ABI Alfalfa	2.18	1.91	1.63	5.73	16.85
53V08	Pioneer	2.21	2.07	1.74	6.02	16.30
Average		2.16	2.21	1.75	6.12	17.94
CV (%)		8.6	14.8	8.1	9.4	2.3
LSD (0 .10)		NS	NS	NS	NS	NS

[1] Trial conducted on the Sherrel Mix farm, Rio Grande County Roads 8N & 1W; seeded at 16 lbs/acre on 16 June 2000.
[2] Yields calculated on oven-dry basis.
Harvest dates in 2003 were 12 June, 22 July, and 22 September.

WESTERN COLORADO ALFALFA VARIETY PERFORMANCE TEST AT FRUITA 2002-2003

Calvin H. Pearson

The 2003 results of Colorado State University's alfalfa variety performance test at Fruita are presented in this report. Plots were planted fall 2001 and the 2003 data are for the second of a 3-year testing period. Results for 2002 are in Table 1 and the 2003 results are in Table 2. Alfalfa stands are excellent. Plots are very weed-free. Alfalfa is furrow-irrigated. Haymaking conditions during 2003 were good and alfalfa yields were also good despite a very hot and dry summer. Summer 2003 was the hottest on record at Fruita. There were 26 days during the summer above 100°F with 16 of those days being consecutive. On 14 July 2003, the temperature recorded at the weather station at the Fruita Research Center was 107.3°F.

Table 1. Forage yields of 15 alfalfa varieties at the Western Colorado Research Center at Fruita in 2002.[1]

Variety	Brand/Source	1st Cut 29 May	2nd Cut 2 July	3rd Cut 23 Aug.	4th Cut 8 Oct.	2002 Total
		tons/acre[3]				
Sendero	Allied Seed, L.L.C.	2.38	2.38	2.85	1.56	9.17
FG 3R139	J.R. Simplot Co.	2.45	2.37	2.81	1.54	9.16
Select	IFA	2.28	2.37	2.91	1.54	9.10
DU 201	Great Plains Research Co., Inc.	2.40	2.20	2.77	1.67	9.03
WL 327	W-L Research	2.58	2.37	2.63	1.46	9.03
Goliath	Allied Seed, L.L.C.	2.38	2.34	2.79	1.51	9.01
WL 342	W-L Research	2.55	2.36	2.47	1.53	8.91
Ameristand 403T	America's Alfalfa	2.65	2.19	2.64	1.32	8.80
HybriForce™400	Dairyland Seed	2.46	2.05	2.64	1.50	8.64
Pawnee	Midwest Seed Genetics	2.45	2.27	2.52	1.40	8.64
Dagger+EV	AgriPro	2.26	2.19	2.65	1.52	8.62
Mountaineer	Croplan Genetics	2.21	2.32	2.61	1.45	8.59
Journey Brand 204 Hybrid	Dairyland Seed	2.34	2.06	2.67	1.49	8.56
Enhancer	Sharp Bros. Seed Co.	2.35	1.97	2.63	1.53	8.49
FR 9802	Great Plains Research Co., Inc.	2.33	1.70	2.38	1.54	7.94
Average		2.41	2.21	2.66	1.50	8.78
CV%		7.69	4.88	6.30	5.09	4.32
$LSD_{(0.05)}$		NS	0.16	0.24	0.11	0.54

[1]Seeded 6 Sept. 2001 at 15 lbs/acre.
[2]Table is arranged by decreasing, 2002 total yield.
[3]Yields were calculated on an air-dry basis.

Table 2. Forage yields of 15 alfalfa varieties at the Western Colorado Research Center at Fruita in 2003.[1]

Variety	Brand/Source	1st Cut 28 May	2nd Cut 8 July	3rd Cut 19 Aug.	4th Cut 7 Oct.	2003[2] Total	2-yr Total
		---------------------------- tons/acre[3] -------------------------					
FG 3R139	J.R. Simplot Co.	3.06	2.17	2.32	1.14	8.70	17.86
Select	IFA	3.02	2.13	2.35	1.14	8.64	17.74
Mountaineer	Croplan Genetics	3.10	2.02	2.20	1.13	8.46	17.04
Goliath	Allied Seed, L.L.C.	3.08	2.00	2.20	1.08	8.36	17.38
WL 327	W-L Research	3.10	2.06	2.14	1.05	8.35	17.38
DU 201	Great Plains Research Co., Inc.	2.92	2.01	2.21	1.15	8.29	17.32
FR 9802	Great Plains Research Co., Inc.	3.19	1.86	2.04	0.97	8.05	15.99
Dagger+EV	AgriPro	2.91	1.94	2.15	1.02	8.01	16.63
WL 342	W-L Research	2.86	1.94	2.14	1.04	7.98	16.89
Pawnee	Midwest Seed Genetics	2.81	1.97	2.13	1.04	7.95	16.59
Ameristand 403T	America's Alfalfa	2.90	1.92	2.07	0.94	7.82	16.62
Journey Brand 204 Hybrid	Dairyland Seed	2.76	1.86	2.10	1.08	7.81	16.37
Enhancer	Sharp Bros. Seed Co.	2.78	1.91	2.08	1.02	7.79	16.28
Sendero	Allied Seed, L.L.C.	2.48	1.94	2.15	1.22	7.78	16.95
HybriForce™400	Dairyland Seed	2.73	1.78	2.04	1.01	7.56	16.21
Average		2.91	1.97	2.16	1.07	8.10	16.88
CV%		8.4	5.9	4.6	7.2	4.2	3.6
$LSD_{(0.05)}$		0.35	0.17	0.14	0.11	0.49	0.88

[1]Seeded 6 Sept. 2001 at 15 lbs/acre.
[2]Table is arranged by decreasing, 2003 total yield.
[3]Yields were calculated on an air-dry basis.

Site Information

Elevation: 4510 ft. Average annual precipitation is 8.4 in. Average frost-free days is 181 days. Last spring frost – 16 April 2003; first fall frost – 15 Oct. 2003. Frost-free days for 2003 - 182 days (28°F base). Fertilizer: 324 lbs P_2O_5/acre and 68 lbs N/acre broadcast as 11-52-0 on 30 Aug. 2001 and plowed down prior to planting. Applied Select at 8 oz/acre on 8 October for weed control in 2001. For weed control in 2003, Sencor 4F was applied at 1 quart/acre in 22 gallons water/acre at 25 psi on 22 Jan. 2003. Soil series: Youngston clay loam.

WESTERN COLORADO ALFALFA VARIETY PERFORMANCE TEST AT FRUITA 1999-2001

Calvin H. Pearson

Summary

Numerous alfalfa varieties are available for planting on farms and ranches. With so many varieties available in the marketplace, selecting a variety to plant can be challenging. Agronomic performance data of alfalfa varieties provides quantitative information to aid people in deciding which varieties to plant. Testing all available alfalfa varieties at one location is not feasible; thus, information obtained in alfalfa variety performance tests can be valuable to those who live in other areas with similar environments and growing conditions. An alfalfa variety performance test is routinely conducted at the Western Colorado Research Center at Fruita in which selected alfalfa varieties are evaluated over a 3-year testing period. The performance of these varieties is evaluated under local field conditions; thus, the results obtained from these tests are relevant to grower production operations. Averaged across the four cuttings and the 20 varieties, alfalfa yields in 1999, 2000, and 2001 were 8.36, 9.55, and 7.55 tons/acre, respectively. The average 3-year total yield was 25.45 tons/acre. Six of the 20 varieties (Focus HSN, Millennia, ZX 9453, WL 232HQ, Baralfa 54, and Reno) had high 3-year total yields.

Growing a well-adapted alfalfa variety is important for producing high yields and good forage quality, along with having adequate resistance to local diseases. Selecting the right variety for your farming or ranching operation should be based on factual information that is site-specific for your area.

Introduction

Evaluating varieties under local production conditions provides site-specific information that is useful to local growers and others in similar environments and growing conditions. Local variety performance information is also valuable to breeding and seed companies to guide them in developing and marketing seed of their varieties. Alfalfa variety performance tests are conducted over a 3-year testing period.

Prior to planting test plots, alfalfa breeding and seed companies are solicited for varieties to enter into the test. Company representatives determine which of their varieties to include in the test. They pay a fee to the University for each entry tested. One or more public check varieties may be included in the test.

This report contains test results for alfalfa variety performance evaluations. The data from 1999-2001 are for a complete 3-year testing period for 20 alfalfa varieties.

Materials and Methods

Alfalfa variety performance tests were located at the Colorado State University Western Colorado Research Center at Fruita. The elevation at Fruita is 4510 feet. Average annual precipitation is 8.4 in. Average frost-free days are 181. The number of frost-free days for each year from 1999 through 2002 ranged from 159 to 194 days at Fruita, Colorado (Table 1). Alfalfa is furrow-irrigated with water from the

Colorado River. Irrigation water is delivered to farms through a canal system.

The alfalfa cultivar performance test from 1999-2001 was a randomized, complete-block design with four replications. The soil was a Billings silty clay loam. Fertilizer applied to plots in this study was 416 lbs P_2O_5/acre and 88 lbs N/acre broadcast as 11-52-0 on 13 Aug. 1998 and plowed down prior to planting. Planting occurred on 27 Aug. 1998 at 13 lbs seed/acre. Pursuit was applied at 1.44 oz/acre on 24 Feb. 1999 and on 3 Mar. 2000 for weed control.

Results and Discussions

Twenty alfalfa varieties were tested for 3 years from 1999 through 2001. Data for each of the four cuttings for each of 3 years are presented in this report.

The 1999 yield data are for the first of a 3-year testing period. There was a small amount of volunteer wheat in the first cutting. The summer of 1999 in western Colorado was quite rainy which made haymaking a challenge during most cuttings. Hay yield in the first cutting in 1999 averaged across all 20 varieties was 2.62 tons/acre (Table 2). Yields ranged from a high of 3.00 tons/acre for WL 232 HQ to a low of 2.07 tons/acre for Ladak. Fourteen of the 20 varieties had high first cutting yields. Hay yield in the second cutting averaged 2.44 tons/acre. Yields ranged from a high of 2.61 tons/acre for DK 142 to a low of 2.09 tons/acre for Ranger. There were also 14 varieties that had high yields in the second cutting. Hay yield in the third cutting averaged 1.99 tons/acre. Yields ranged from a high of 2.14 tons/acre for Baralfa 54 and Focus HSN to a low of 1.80 tons/acre for TMF 421. Thirteen alfalfa varieties had high third cutting yields. Hay yield in the fourth cutting averaged 1.31 tons/acre. Yields ranged from a high of 1.46 tons/acre for DK 142 to a low of 1.08 tons/acre for Ladak. Six varieties (DK 142, ZX 9453, Archer, Garst 6420, DK 140, and ZX 9451) had high fourth cutting yields.

Selecting a well adapted alfalfa cultivar for your area can mean greater yields and increased profits for your farming or ranching operation.

Averaged across the four cuttings and the 20 varieties, the 1999 total alfalfa yield was 8.36 tons/acre (Table 2). Total 1999 yields ranged from a high of 8.74 tons/acre for DK 142 and Focus HSN to a low of 7.20 tons/acre for Ladak. Fourteen of the 20 varieties had high 1999 total yields. Of the 20 varieties, Ranger and Ladak had the lowest 1999 total yields.

Yield data obtained in 2000 were for the second year of the 3-year testing period. Alfalfa stands were excellent. Summer 2000 in western Colorado was typical in many respects. Thundershowers made haymaking a challenge for some of the four cuttings. Hay yield in the first cutting in 2000 averaged across all 20 varieties was 2.97 tons/acre (Table 3). There were no statistically significant differences among the 20 alfalfa varieties for yield in the first cutting. Hay yield in the second cutting averaged 2.85 tons/acre. There were also no statistically significant differences among the varieties for yield in the second cutting. Hay yield in the third cutting averaged 2.65 tons/acre. Yields in the third cutting ranged from a high of 2.84 tons/acre for Focus HSN to a low of 2.48 tons/acre for TMF 421. Nine alfalfa varieties had high third cutting yields. Hay yield in the fourth cutting averaged 1.08 tons/acre. Yields in the fourth cutting ranged from a high of 1.24 tons/acre for ZX 9453 to a low of 0.94 tons/acre for Innovator+Z. Four varieties (ZX 9453, ZX 9451, Millennia, and Garst 6420) had high fourth cutting yields.

Averaged across the four cuttings and the 20 varieties, the 2000 total alfalfa yield was 9.55 tons/acre and the average 2-year total was 17.91 tons/acre (Table 3). Thirteen of the 20 varieties had high 2000 total yields. Thirteen varieties also had high 2-year total yields. Many of these 13 varieties had both high 2000 total yields and high 2-year total yields. Ranger and Ladak had the lowest 2-year total yields.

Yield data obtained in 2001 were for the third year of the 3-year testing period. Summer 2001 in western Colorado was similar to the other testing years in that thundershowers made haymaking a challenge for some of the four cuttings. Hay yield in the first cutting in 2001 averaged across all 20 varieties was 2.15 tons/acre (Table 4). There were no statistically significant differences among the varieties for yield in the first cutting in 2001. Hay yield in the second cutting averaged 1.92 tons/acre. Yields ranged from a high of 2.24 tons/acre for Archer II to a low of 1.53 tons/acre for Garst 6420. Six varieties were high yielding in the second cutting in 2001. Hay yield in the third cutting averaged 2.43 tons/acre. Yields ranged from a high of 2.70 tons/acre for TMF Multiplier II to a low of 2.04 tons/acre for ABT 350. Twelve alfalfa varieties had high third cutting yields. Hay yield in the fourth cutting averaged 1.06 tons/acre. Yields in the fourth cutting ranged from a high of 1.31 tons/acre for Millennia to a low of 0.82 tons/acre for Ladak. Three varieties (Millennia, ZX 9453, and Baralfa 54) had high fourth cutting yields.

The 2001 alfalfa yield, averaged across the four cuttings and the 20 varieties, was 7.55 tons/acre (Table 4). The 2001 total yields ranged from a high of 8.44 tons/acre for Millennia to a low of 6.63 tons/acre for Garst 6420. Nine of the 20 varieties had high 2001 total yields.

The average 3-year total yield was 25.45 tons/acre (Table 4). Three-year total yields ranged from a high of 26.93 tons/acre for Focus HSN to a low of 23.20 tons/acre for Ladak. Six of the 20 varieties (Focus HSN, Millennia, ZX 9453, WL 232HQ, Baralfa 54, and Reno) had high 3-year total yields.

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Table 1. Last spring frost and first fall frost and the number of frost-free days (28°F threshold) for each year of the past 3 years at Fruita, Colorado 1999-2001.

Year	Last spring frost	First fall frost	Number of frost-free days
1999	17 Apr. 1999	17 Oct. 1999	183
2000	4 Apr. 2000	14 Oct. 2000	193
2001	13 Apr. 2001	24 Oct. 2001	194

Table 2. Forage yields of 20 alfalfa varieties at the Western Colorado Research Center at Fruita in 1999.[1]

Variety	Brand/Source	1st Cut 28 May	2nd Cut 7 July	3rd Cut 19 Aug.	4th Cut 12 Oct.	1999 Total[2]
		tons/acre[3]				
DK 142	DEKALB	2.76	2.61	1.92	1.46	8.74
Focus HSN	Arkansas Valley Seeds	2.81	2.46	2.14	1.33	8.74
WL 232HQ	Germains	3.00	2.50	1.99	1.22	8.70
ZX 9451	ABI	2.72	2.51	2.13	1.35	8.70
Garst 6420	Garst	2.83	2.42	2.02	1.41	8.69
Millennia	IFA	2.83	2.53	1.99	1.32	8.68
ZX 9453	ABI	2.47	2.59	2.09	1.45	8.60
Archer	America's Alfalfa	2.60	2.57	1.96	1.42	8.55
Archer II	America's Alfalfa	2.61	2.46	2.10	1.34	8.51
DK 140	DEKALB	2.77	2.41	1.94	1.38	8.51
TMF Multiplier II	Mycogen	2.69	2.46	2.02	1.27	8.44
ABT 350	ABT	2.64	2.50	2.00	1.26	8.40
WL 325 HQ	Germains	2.65	2.58	1.88	1.28	8.39
Baralfa 54	Seekamp Seed	2.51	2.44	2.14	1.31	8.39
Innovator+Z	America's Alfalfa	2.69	2.30	1.90	1.30	8.20
Reno	Novartis Seeds	2.41	2.45	2.01	1.31	8.18
TMF 421	Mycogen	2.67	2.45	1.80	1.16	8.08
DK 134	DEKALB	2.30	2.42	1.98	1.29	7.99
Ranger	public	2.31	2.09	1.87	1.18	7.45
Ladak	public	2.07	2.14	1.90	1.08	7.20
Ave.		2.62	2.44	1.99	1.31	8.36
CV (%)		11.24	5.17	6.80	5.85	4.16
LSD (0.05)		0.42	0.18	0.19	0.11	0.49

[1]Trial conducted at the Western Colorado Research Center at Fruita; seeded 27 Aug. 1998.
[2]Table is arranged by decreasing, 1999 total yield.
[3]Yields were calculated on an air-dry basis.

Table 3. Forage yields of 20 alfalfa varieties at the Western Colorado Research Center at Fruita in 2000 and 2-year total yields.[1]

Variety	Brand/Source	1st Cut 17 May	2nd Cut 7 July	3rd Cut 23 Aug.	4th Cut 2 Oct.	2000 Total[2]	2-yr Total
		--------------------------------tons/acre[3]--------------------------					
ZX 9453	ABI	3.03	2.90	2.76	1.24	9.94	18.54
Garst 6420	Garst	3.16	2.92	2.65	1.14	9.87	18.56
Focus HSN	Arkansas Valley Seeds	2.94	2.96	2.84	1.12	9.85	18.59
DK 142	DEKALB	3.05	2.96	2.73	1.09	9.83	18.57
Millennia	IFA	3.01	2.89	2.67	1.14	9.72	18.40
ZX 9451	ABI	2.96	2.77	2.79	1.14	9.66	18.36
TMF Multiplier	Mycogen	3.07	2.89	2.58	1.11	9.65	18.09
Reno	Novartis Seeds	2.97	2.91	2.66	1.09	9.64	17.82
ABT 350	ABT	3.07	2.95	2.53	1.03	9.57	17.98
WL 232 HQ	Germains	3.00	2.93	2.54	1.05	9.57	18.27
Archer	America's Alfalfa	2.85	2.81	2.80	1.09	9.54	18.09
Baralfa 54	Seekamp Seed	2.92	2.84	2.68	1.08	9.52	17.91
Archer II	America's Alfalfa	2.91	2.90	2.64	1.07	9.52	18.03
DK 134	DEKALB	2.90	2.86	2.64	1.07	9.47	17.45
DK 140	DEKALB	3.07	2.77	2.53	1.06	9.42	17.93
WL 325 HQ	Germains	2.89	2.74	2.61	1.09	9.34	17.73
Ranger	public	2.81	2.82	2.66	1.02	9.31	16.76
Innovator+Z	America's Alfalfa	2.94	2.78	2.63	0.94	9.29	17.49
TMF 421	Mycogen	2.93	2.82	2.48	0.99	9.21	17.29
Ladak	public	2.82	2.64	2.61	1.01	9.09	16.29
Ave.		2.97	2.85	2.65	1.08	9.55	17.91
CV (%)		5.64	4.97	4.96	7.57	3.14	2.87
LSD (0.05)		NS	NS	0.18	0.12	0.42	0.73

[1]Seeded 27 Aug. 1998.
[2]Table is arranged by decreasing, 2000 total yield.
[3]Yields were calculated on an air-dry basis.

Table 4. Forage yields of 20 alfalfa varieties at the Western Colorado Research Center at Fruita 2001[1] and 3-year total yields.[1]

Variety	Brand/Source	1st Cut 21 May	2nd Cut 6 July	3rd Cut 27 Aug.	4th Cut 2 Oct.	2001 Total	3-yr Total[2]
		----------	----------	----------	tons/acre[3]	----------	----------
Focus HSN	Arkansas Valley Seeds	2.47	2.06	2.66	1.15	8.34	26.93
Millennia	IFA	2.37	2.20	2.57	1.31	8.44	26.84
ZX 9453	ABI	2.24	2.12	2.32	1.21	7.88	26.42
Baralfa 54	Seekamp Seed	2.38	1.98	2.55	1.18	8.09	26.00
WL 232 HQ	Germains	2.31	2.01	2.44	0.98	7.73	26.00
Reno	Novartis Seeds	2.34	1.99	2.65	1.15	8.12	25.94
ZX 9451	ABI	2.16	1.95	2.28	1.13	7.52	25.88
Archer	America's Alfalfa	2.08	2.19	2.36	1.16	7.79	25.88
Archer II	America's Alfalfa	2.18	2.24	2.23	1.16	7.81	25.84
DK 142	DEKALB	2.02	1.72	2.50	1.01	7.25	25.82
TMF Multiplier II	Mycogen	2.19	1.75	2.70	1.06	7.69	25.78
WL 325 HQ	Germains	2.16	2.19	2.37	1.10	7.83	25.55
DK 140	DEKALB	2.09	1.93	2.42	1.08	7.51	25.45
Garst 6420	Garst	1.74	1.53	2.32	1.04	6.63	25.19
DK 134	DEKALB	2.09	1.88	2.46	1.02	7.45	24.91
ABT 350	ABT	1.97	1.84	2.04	0.92	6.77	24.75
Innovator+Z	America's Alfalfa	2.02	1.79	2.43	0.90	7.14	24.62
TMF 421	Mycogen	2.14	1.85	2.25	0.93	7.16	24.45
Ranger	public	1.99	1.57	2.43	0.89	6.88	23.64
Ladak	public	2.00	1.58	2.52	0.82	6.91	23.20
Ave.		2.15	1.92	2.43	1.06	7.55	25.45
CV (%)		13.66	8.11	8.73	8.94	6.79	2.84
LSD (0.05)		NS	0.22	0.30	0.13	0.72	1.03

[1]Seeded 27 Aug. 1998.
[2]Table is arranged by decreasing 3-year total yield.
[3]Yields were calculated on an air-dry basis.

SPECIAL TOPICS

MAKING HAY THE RIGHT WAY

Calvin H. Pearson

Introduction

Producing high quality hay should be the goal of every hay grower. High quality hay is a better product, is easier to market, brings a higher selling price, creates a good reputation for the seller, and encourages repeat customers by meeting consumer needs. Most importantly, high quality hay brings increased profits and, as a feed, increases animal performance.

Under favorable conditions and using currently available haymaking technology, it is possible for growers to routinely produce prime alfalfa hay with relative feed values greater than 151, crude protein contents greater than 19%, and digestible dry matter greater than 65%.

Production practices used during haymaking can have a significant effect on hay yield and hay quality. Adopting the most effective and economical haymaking practices available are essential for continued improvement of production practices. All aspects of the haymaking process should be continually scrutinized for improvement.

Fundamental to good haymaking is obtaining maximum plant mass recovery from the field and producing an economically valuable product for use on the farm or that can be sold. What this means is efforts should be directed at keeping leaf loss to a minimum while at the same time producing a profitable crop. Alfalfa leaves dry more quickly than stems, and leaves are more likely to be damaged than stems. Growers should identify how each haymaking practice affects leaf loss and how they can improve their haymaking practices to increase leaf retention while at the same time producing hay that stores well and doesn’t spoil or experience other costly losses while in storage.

The Haymaking Process

Ideal haymaking conditions and, thus, ideal hay are not always attainable; however, having a sound understanding of the haymaking process will increase the ability of growers to manage production more precisely under changing conditions and therefore increase the likelihood of obtaining high quality hay more consistently. The haymaking process can be separated into four general operations: 1) Swathing and cutting, 2) Curing, 3) Packaging, and 4) Hauling and storing. As part of the haymaking process a few topics are relevant across all four categories. These include equipment considerations, weather, and managing harvest losses. Each of the four categories and these additional topics are discussed in this report.

Swathing and Cutting

Swathers are the most widely used piece of equipment for cutting grass and alfalfa hay. Years ago, sickle mowers were used extensively for cutting alfalfa and grass hay, but nowadays, sickle mowers are used very little for alfalf and only occasionally for grass. There are various types of cutting devices used for hay crops. Sickles blades continue to be widely used for cutting hay crops, although disc blades are gaining in popularity.

The hay conditioner, sometimes also referred to as a "crimper," is designed to crush and bend alfalfa in several places along the length of the stem. Hay conditioning bends and crushes the stem which allows internal stem moisture to escape more readily. Proper conditioning speeds plant drying. Hay conditioners should be checked regularly and adjusted for optimum performance. This includes setting the proper tension on the conditioner rollers. Rollers set too tight can cause excessive leaf loss with no improvement in stem conditioning.

Maintaining and operating swathers correctly is important for good haymaking.

The cutting schedule for alfalfa can be based on a fixed interval, stage of maturity, or crown shoot development. With a fixed interval, cutting is done every 28 to 33 days. A fixed interval for cutting alfalfa may be useful for planning, but it is difficult to stay on schedule when adverse weather conditions or other interferences delay harvest.

Forage yield and quality are inversely related, which means harvesting alfalfa at an immature growth state will result in reduced yields and high forage quality. Waiting to harvest at a more mature growth stage will result in high forage yield and reduced forage quality.

At least two schemes have been proposed to address the yield/quality tradeoff in alfalfa production. The first scheme is based on the sequence fields are cut for each cutting (Orloff and Putnam, 1988). A field cut in the middle or end of the field sequence would be cut first in the next cutting. This approach helps ensure that some fields will be cut at immature stages and thus have high forage quality, while fields cut first during one cutting and last during the next cutting will likely have lower hay quality and a higher yield, along with increased root reserve replenishment. This scheme is applicable for production operations that have numerous fields and large acreages.

Another harvest timing scheme is based on the plant growth and development of alfalfa as it is affected by each cutting during the growing season. Balancing between high forage yields and high quality can best be achieved by performing each cutting at different stages of maturity. The first cutting should be at the bud stage. Generally, the first cutting of the growing season is the largest with thick stems. Cutting early will increase quality and slightly lower the size of the cutting. The second cutting should be at midbud, and the third and fourth cuttings should be at 10 to 25% flowering. As with the first cutting, the second cutting is designed to obtain high yields and high quality. Allowing the third and fourth cuttings to flower increases root reserves and promotes increased stand persistence. Stems are smaller in the third and fourth cuttings, thus, the leaf-to-stem ratio is increased and hay quality can be high. The smaller forage yields of late summer cuttings also allows for good drying times under favorable environmental conditions.

Preferred cutting height for alfalfa is 3 to 4 in. A higher cutting height reduces yield while lower cutting heights may reduce the number of sites on the plant that produce new growth for the next cutting. For the last cutting of the growing season ,a cutting height of 6 in. will increase the amount and duration of snow cover; thus, providing plants with better protection against winter injury.

The configuration of the windrow affects drying. Alfalfa in the windrow should lay evenly. “Clumpy” windrows slow drying. Alfalfa should not lay flat in the windrow. Windrows should be shaped so that they are peaked and plants are loosely intertwined. Peaked windrows permit air to circulate more readily through plant material in the windrow, which results in faster drying.

Windrows should be as wide as possible and still allow for unrestricted baling. Alfalfa in wide, fluffy uniform windrows dry faster than narrow, dense uneven windrows; however, keep in mind fluffy windrows may be more susceptible to scattering by wind.

The preferred time of day to cut alfalfa has been the subject of considerable interest. Research has shown that alfalfa cut during late afternoon or early evening contains more accumulated soluble sugars that are retained in cured hay (Mayland et al., 1988). Ruminant animals consumed more and lactating cows produced more milk when fed PM-harvested than when fed AM-harvested hay. Yet, crude protein tended to be higher in AM-harvested alfalfa (Putnam et al., 1988). On the other hand, alfalfa cut in the morning can experience a full day of drying compared to alfalfa cut in the afternoon. Drying alfalfa as fast as possible reduces the possibility of adverse weather conditions and significant yield and quality losses. Deciding which factors are most important may determine whether AM- or PM-harvested hay is preferred. Because of the time needed to harvest a large acreage of alfalfa, it may not be practical to confine harvesting to a specific time of the day. Regardless of the time of day, swathing of alfalfa and grass should not begin until all dew has evaporated from plants.

Curing

The moisture content of alfalfa growing in the field ranges between 75 and 80%. Following cutting, the moisture content of the alfalfa must be reduced to 15 to 20% before baling can begin. Cut alfalfa must lose large quantities of water as rapidly as possible to promote good hay curing. Curing time is affected by humidity, temperature, soil moisture, sunlight, wind speed, swath configuration and size, weeds, and plant-related characteristics such as yield and growth stage that affects stem diameter and leafiness. Alfalfa dries most rapidly under low humidity, high temperatures, dry soil conditions, and moderate winds that do not scatter windrows.

The loss of moisture from alfalfa over a 24-hour period is not constant. The amount of moisture lost from cut alfalfa is highly dependent on environmental conditions. During the day when temperatures are high and air humidity is low and conditions are favorable, moisture loss from plant tissue can be high. At night, temperatures often decrease, air humidity increases, and conditions are not favorable for moisture loss from plant tissue causing moisture loss from plants to be low. In fact, at night it is not uncommon for plant tissue to gain some moisture back. This is evident when dew forms on swathed plants.

Curing of hay can be aided by swathing manipulation such as fluffing, inverting, and tedding.

Sometimes alfalfa is swathed onto wet soil. Longer drying times are needed when windrows are formed on wet soils. If plants are swathed onto wet soil, the field should be monitored and once the hay in the windrow and the soil between the swaths is dry enough, windrows should be moved onto the drier soil.

The moisture content of alfalfa must be actively managed to promote fast drying while at the same time maintaining the highest quality hay possible. To promote fast curing of alfalfa and grass hay, various pieces of equipment can be used, including rakes, tedders, inverters, and fluffers.

Single side delivery rakes were used for several decades, but their use has dwindled over the years in many areas. With the advent of big balers, the use of twin, side delivery rakes has increased. This has allowed hay producers to rake two windrows together and, thus, increase the efficiency of their big balers.

Bales should be packaged at the proper moisture content; have uniform in size, shape, and density; and contain high quality hay.

Leaf loss can be high because PTO-driven side delivery rakes often twist the windrow into a "rope," which does not promote fast drying. Because of a high operating speed and vigorous raking action, PTO-driven side delivery rakes also cause considerable leaf loss. Whatever implement is used to manipulate windrows it must be gentle on the hay to minimize leaf loss.

If plant stem moisture is too low, then dew moisture is needed to increase leaf retention during baling. If baling is performed with too much stem moisture, spoilage can occur. Baling with stem moisture is generally only warranted when humidity is expected to be so low that little or no dew will form. Baling alfalfa hay with stem moisture without causing spoilage in bales can be challenging. Generally, if alfalfa is to be baled with stem moisture, the use of an effective hay preservative is advised.

Hay moisture should be checked at the end of the drying day but before dark and before dew moisture sets in. Late afternoon or early evening is a good time to check hay moisture. In preparation for baling, monitoring hay should begin once plant moisture drops below 30 to 40%. Hay should not be baled when it is too wet. For example, on the night of Day 3 alfalfa may be too wet for baling but during the night of Day 4 alfalfa will become too dry. Growers must wait and bale when the hay is slightly dry during the night of Day 4. It is better to bale hay when it is on the dry side than it is to bale hay when it is too wet for safe storage.

Packaging

Baling is a critical step in good haymaking. Numerous factors that affect haymaking, particularly those related to weather conditions, are mostly beyond human control; however, the baling process is subject to a high degree of management. Using good management during the baling process will increase the likelihood of achieving the highest yields and highest quality hay possible.

The goal of good baling management should be to package hay at moisture contents that will achieve high leaf retention without damaging the product through loss or spoilage.

To accurately determine the optimum time for baling, stem moisture must be quantitatively monitored. A moisture meter must be used to determine stem moisture content as hay dries in the windrow. Determining the moisture content of stems, rather than the leaves, is important because leaves dry quicker than stems; thus, the moisture content of stems, not the leaves, is the limiting factor for baling.

There are several methods for determining hay and stem moisture in the windrow. See the owner's manual of your hay moisture testing meter for the manufacturer's recommended procedure for determining hay moisture in the windrow.

Packaging hay can be accomplished in several forms and sizes. The most common method of packaging hay is baling. Small rectangular balers come in two common sizes– 14 x 18, and 16 x 18-in. and tied with two- or three-tie poly twine strings or wire. Mid-size balers– 3 x 3-ft. sized bales with four strings have also been quite popular in recent years. Big balers have become very popular in recent years. With good equipment, one or two people can bale and haul a considerable amount of hay in one day, that used to take several people several days to haul. Big bales are also convenient to load onto trucks to achieve needed weight and height requirements. Big balers package hay into bale sizes of 3 x 4 and 4 x 4-ft. that have 6 strings per bale and are 8 ft. long.

Baling is widely recognized by growers as an important step in the haymaking process.

Round balers are commonly used and are attractive to producers mainly because they are less expensive than most square balers. Round bales are typically used locally. They are not preferred for the commercial hay market. Because of their size and shape, round bales do not stack well on trucks.

The weight of bales produced is an important aspect of the haymaking process. A bale that is 55 lbs. or less coming directly out of a 14 x 18-in. bale chamber is considered to be light. Acceptable bales should weigh 60 to 70 lbs. from a baler of this size. Bales that weigh more than 70 lbs. from a 14 x 18-in. bale chamber may have moisture contents that could cause hay to spoil. Bales from a baler with a 16 x 18-in. chamber may weigh up to 80 lbs. and not spoil.

Generally, hay moisture contents will be too high if the bales are so tight that the twine breaks. In actuality, hay moisture contents are often too high long before twine breaks.

Ideal hay is bright green in color, has high leaf retention (leaves remain attached to the stem), has a soft texture and flakes separate easily, shows no evidence of heat damage (discoloration, mold, or undesirable odor), and contains no foreign material.

It is difficult to make well-formed, uniform alfalfa bales from dry hay. Hay bales formed with dry hay can be lightweight, difficult to transport, and transportation losses are likely to be higher.

Growers are limited by the amount of time that hay is at the ideal moisture content for baling. Under many conditions it is not possible to bale alfalfa for extended periods and have high quality hay in all bales made during a long baling session.

As previously mentioned, moisture content in the windrow should be monitored regularly. The field should be sampled sufficiently to have a good understanding of the variability of hay moisture content across the field. The size of the bale dictates the moisture content at which hay will be suitable for baling. Hay moisture content of large balers (3 x 3, 3 x 4, 4 x 4) must be lower than small rectangular bales. Growers who switch from small rectangular balers to big balers often have some difficulty adjusting to baling at lower hay moisture contents. The “old” hay buyer saying is, “Never buy hay from a guy the first year he owns a big baler.”

For most situations, baling small rectangular bales should not begin until no single stem is found to have a moisture greater than 16%. Once baling has started and a few well-formed (proper density, shape, and length) bales are made, the moisture content of bales should be checked. Bale moisture must be quantified by probing bales with a hand-held hay moisture probe. Each bale must be probed several times to determine the uniformity

To prevent spoilage big bales must be baled at a lower moisture content than small rectangular bales.

of moisture in the bale. The range of hay moisture content must be determined, paying particular attention to the high moisture content readings.

Average bale moisture should not exceed 15%. Bales should be probed equidistantly along the length of the bale in six places. Any one of the six readings on a bale should not exceed 18% for big bales, and one or more of the six readings in a small bale should not exceed 20% moisture content.

Under many climatic conditions, the amount of baling time is longer when dew is forming than when dew is evaporating. In other words, it takes longer for dew to form to a level that is too high for baling than it takes for dew already formed on the surface of the hay to evaporate and for the hay to become too dry for baling. Changes in hay moisture from evaporating dew can occur rapidly. Within a matter of minutes, hay moisture contents can drop 4 to 5 percentage points.

When balers were first invented, sisal twine (hemp) was used in making bales. Sisal twine rotted readily, would break easily during baling, and was subject to chewing by rodents, particularly mice. Transportation and storage losses were high when sisal twine was used. Fortunately, better materials have been identified for tying bales. Wire is widely used in the sheep industry because the poly twine gets into the wool. Once in the wool, there is no practical way to remove the poly twine; thus, the price of wool contaminated with poly twine is heavily docked by the buyer. Poly twine is widely used in haymaking.

Chemical Hay Conditioning

Chemical conditioning of hay can be classified into two general types: preservatives and drying agents. Both types are intended to minimize the risk of hay experiencing weather damage (rain, wind, sun bleaching, etc.) by reducing the time from swathing to baling. Hay preservatives offer the best advantage of reducing yield losses and maintaining quality because hay is baled at a higher moisture content.

Drying agents are desiccants that are applied during swathing. They are intended to hasten field curing and reduce the chance for hay to experience damage from adverse weather conditions. Drying agent compounds react with the waxy layer on the surface of plant tissues, allowing water to escape more readily from inside the plant. Drying agents are usually potassium carbonate or a mixture of potassium and sodium carbonate. Effective drying agents decrease the time needed to cure hay by a third to half; however, with drying agents, hay is baled at a conventional moisture content.

Preservatives are applied at baling and are designed to permit baling and safe storage of hay at higher moisture contents than usual. Preservatives are intended to reduce harvest losses and increase hay quality by reducing leaf loss. Preservatives also lengthen baling sessions by allowing hay to be baled later into the evening and earlier in the morning when higher amounts of dew can cause higher hay moisture contents.

The moisture content of the hay must be known when using hay preservatives.
Hay with variable moisture contents creates

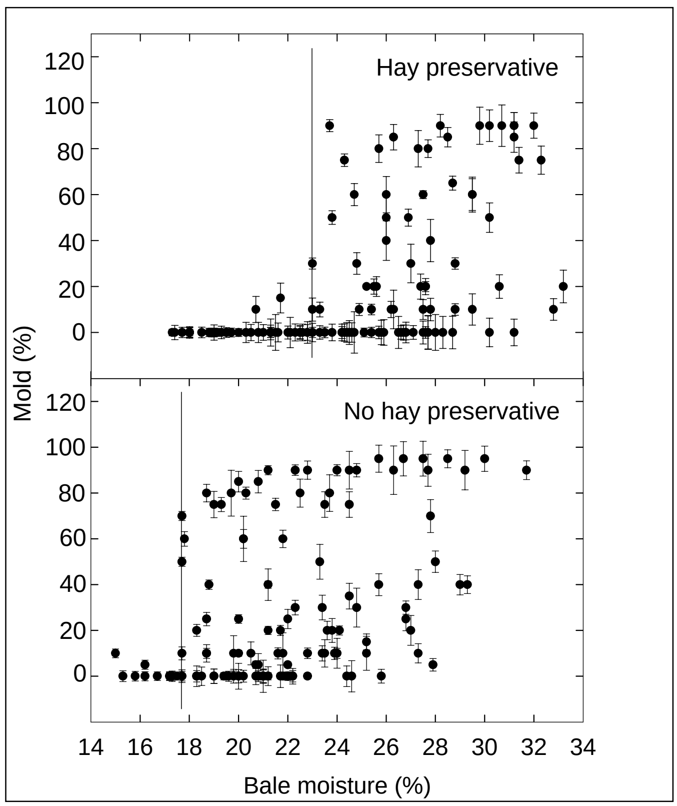


Fig. 1. The effect of hay preservatives on the development of mold as bale moisture content increases. Average bale moisture content was determined by taking the average of six equidistant readings with a hand-held moisture probe along the cut side of the bale. The hay preservative used in this study was Forco.

increased difficulty in achieving uniform results with hay preservatives. Hay preservatives of any kind should not be used on hay with an average bale moisture content high than 25% and no single moisture content reading in the bale should exceed 30%.

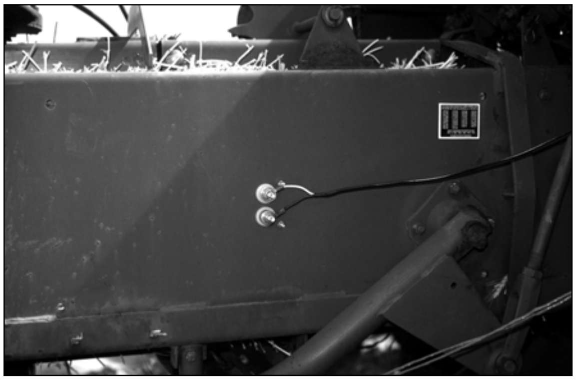
A study with hay preservatives was conducted at Fruita, Colorado in which alfalfa hay was baled with and without hay preservatives over a range of hay moisture contents. After bales were stacked and stored for more than 90 days, bales were checked for spoilage. Data were collected from 126 bales. Bales were obtained from three cuttings – two first cuttings and one third cutting (42 bales per cutting). Mold development did not occur in alfalfa hay baled with the hay preservative (Forco Products, Flagler, Colorado) until the average bale moisture content exceeded 23%, while hay baled without a hay preservative experienced mold development at a bale moisture content of approximately 18% (Fig. 1). Thus, the application of the hay preservative used in this study allowed for safe baling of alfalfa hay at average bale moisture contents that were 5 percentage points higher than when alfalfa was baled without a hay preservative.

The effectiveness of many hay preservatives has not been thoroughly tested to determine the optimum application and performance of these products under different haymaking conditions.

Hauling and Storing

If baling occurs when hay is too wet, reducing excess moisture from bales can be attempted by increasing bale ventilation, by either leaving bales in the field for a few days or by making loose stacks that allow for increased air movement around and through the bales; however, attempting to reduce the content of high moisture hay is often met with varying degrees of success.

Once bales are out of the field and in the stack, it is easy to mistakenly think concerns about further crop losses are over. Hay losses while in storage can be substantial. Hay should be adequately protected during storage. Hay, baled at the proper moisture content, can be covered directly after baling under most conditions. Hay stacks can be covered with a top layer of straw bales, covered with hay tarps, hay roofs, or stored in buildings.



A bale chamber moisture meter provides information to the operator while the baler is operating.

Structures used for storing hay range from sheds with only a roof to those that are fully enclosed. Hay roofs vary considerably in their shapes, pitches, and materials.

Hay tarps are available in various designs, materials, and fabrics; thus, the quality of tarps can vary considerably. Good quality hay tarps made of materials that shed water and do not deteriorate rapidly should be used. Tie hay tarps securely so wind will not damage the tarp or lift the tarp and allow water to enter the stack. Tarps should overlap or fit together so water cannot enter between them.

Inexpensive hay tarps often tear easily and degrade within a short period of time due to ultraviolet light. Poor quality or poorly positioned tarps may allow water to be channeled into a section of the stack, causing considerable stack damage. Good quality hay tarps should not rip or tear, fit tight against the stack, and last for several years. Haystacks should be inspected regularly to make sure hay is adequately protected.

Fully enclosed buildings should be sufficiently ventilated or water can collect inside the building as bales continue to lose moisture. The type of storage facility that is best suited for a particular application is highly dependent on a grower’s situation. The best storage facility for an individual grower depends on several factors, including the objectives of the hay management system, local environmental conditions, and cost of the facility.

Generally, most losses occur on the top and bottom layers of the stack, although interior damage can also occur. Interior damage often results because of a leaky covering that channels water from rain or snow melt across the top of the stack and down through an interior section of the stack.

The moisture content of bales changes during storage. Uniformity of moisture within the bale, environmental conditions, and ventilation of the bale in storage affects how bale moisture content changes. Bale weight loss during storage increases as the moisture content of bales increase when entering storage (Pearson and Rechel, 1999). The amount of moisture loss during storage is affected by the cutting, plant characteristics such as leaf-to-stem ratios, and the environmental conditions under which bales are stored.

Hay should be stored on surfaces and in locations where bottom bales remain dry and where water will not collect or flooding does not occur. Preferred surfaces for stacking hay are coarse rock or river rock. This type rock of material promotes good drainage and helps to keep water from ponding around bottom bales. Coarse surface material also minimizes rocks from "sticking" to bales when they are moved. Top bales should be arranged on the stack to form a peak so water and snow will be readily shed from the hay tarp.

Haymaking Equipment

Equipment is an essential part of modern haymaking. Reliable equipment that is well suited to the task and when properly operated can improve haymaking considerably. Many different types of equipment are available for haymaking including mowers, swathers, inverters, tedders, rakes, fluffers, balers, bale accumulators, stackers, loaders, and haulers. A variety of after-market accessories and supplies are available for many pieces of haymaking equipment. Before making new purchases of haymaking equipment, an assessment must be conducted to determine if the new equipment purchased will be compatible with existing equipment and established haymaking procedures.

A number of specialty devices and supplies have been marketed over the years with the promise of improving various aspects of haymaking. These products are often after-market accessories that attach to a piece of haymaking equipment. Some are supplies that are routinely used during the haymaking process. Sellers of these devices and supplies make various claims regarding the performance of their products including reduced bale moisture content, reduced leaf loss, more uniform bale size, reduced friction and thus reduced wear and tear on the baler, and increased baler performance. Some of these specialty devices and supplies can be expensive. These products must add value in terms of hay yield, hay quality, or reduced equipment repair and maintenance costs, and increase grower profits. Before purchasing specialty devices or supplies, growers should seek to find information regarding independent and thorough testing of these items.

Proper adjustment of equipment during haymaking is important for achieving top haymaking conditions. The operator should monitor equipment performance during the operation, be knowledgeable about each piece of equipment used in haymaking, and be prepared to adjust machinery to improve its performance for the conditions under which it is operating. A good maintenance and repair schedule for haymaking equipment will serve to reduce the number and extent of breakdowns. Equipment breakdowns during haymaking, which may last only a few hours, can still result in crop losses and lower product quality. Not only should operators know how each piece of equipment operates and how to adjust it for optimum performance, but the operator should be familiar with all safety aspects of the equipment and be committed to safe use of all haymaking machinery.

Bales should be hauled from the field as soon as baling is complete so that damage to new growth by wheel traffic is kept to a minimum.

The cost of owning and operating haymaking equipment has a direct effect on profitability for each grower. The cost of equipment, particularly when new, is expensive and should be carefully considered prior to making any purchase. Purchasing hay equipment when it cannot be justified can put an entire grower's farming or ranching operation in jeopardy. Conversely, using haymaking equipment that is well-suited to the operation can increase profits and improve efficiencies.

Because of their particular circumstances, owning their own equipment may not be advisable for some growers. Renting or contracting with custom operators may be more economically worthwhile.

Producers must evaluate several aspects when considering the purchase of haymaking equipment including the value of timeliness by using their own equipment to perform specific operations, machinery purchase and maintenance costs, and the quality of the work or product quality when they perform their own operation compared to what might be expected when performed by a custom operator. The justification for purchasing various types of haymaking equipment or hiring a custom operation to do the work is complex and will vary depending on various objective and subjective considerations that often only a particular grower can answer. Nevertheless, decisions that growers make about purchasing equipment should be based on as much objective information as possible.

To help growers determine the cost of owning and operating various types of farm machinery, including haymaking equipment, a Windows©-based computer software program was developed by Ray L. Huhnke, agricultural engineer, at Oklahoma State University (Huhnke, 2002). This software can help growers determine how farm equipment purchases can affect their net return. The software is free and can be downloaded from www.dasnr.okstate.edu/agmach.

Weather Considerations

Unfavorable weather adversely affects harvest in several ways. Harvest can be delayed while waiting for good weather to return. Harvest delays can also be caused by unfavorable weather that extends hay curing time. Bad weather can also extend the baling period. Hay yield and hay quality can both be reduced to varying degrees by bad weather that occurs during harvest.

Losses in hay quality and yield can be affected by several unfavorable weather conditions. Damaging rains during haymaking are always a concern. Excessive and untimely precipitation can cause a wide range of losses in terms of both hay yield and quality. When and how much precipitation occurs during curing affects how much loss will occur. Light rains just after cutting have little effect on hay yield and quality, yet several days of consistent rain that occurs when hay is ready to bale can cause large hay losses.

Winds can also cause devastating hay losses. In extreme cases, strong winds can blow windrows completely out of the field, resulting in nearly a total crop loss from that cutting. Windrows are most susceptible to blowing when they are dry and ready to bale.

Losses can also be experienced from dew moisture. Hay that is baled with excessive dew can experience losses from spoilage. Excessive dew may also delay baling and increase the risk of exposure of hay to other unfavorable environmental conditions. When no dew develops during baling, leaf losses increase and quality losses can be significant even though yield losses may be relatively small.

Generally, operators with a large acreage of hay cannot afford to delay harvest based on anticipated adverse weather conditions. Delays can create scheduling problems that may carry on through the rest of the growing season.

Hay bales should not have surface moisture on them going into the stack. If bales get rained on, they should not be picked up in the field until they are completely dry. Bales with heavy dew on them should also not be picked up until all of the dew has evaporated off the bales.

Operators with a small acreage may find it to their advantage to monitor weather forecasts and identify a favorable period of time to harvest.

Haymaking operations can be managed in several ways to cope with weather-related concerns. Bales should be removed from the field as soon as possible after hay is baled. Bales should not be left in the field any longer than necessary. This practice will decrease the potential of bales being exposed to adverse weather conditions. Bales should also be stacked and covered to protect hay from exposure to adverse weather conditions.

Managing Harvest Losses

Significant dry matter losses can occur from the numerous field operations used during the haymaking process. Even when losses are minimal, dry matter losses from each operation can accrue to a total that has a significant impact on yield and quality (Table 1). Haymaking losses can have a significant effect on profits (Table 2).

Performing each field operation as precisely as possible will lower losses. For example, swathers should be adjusted, maintained, and operated properly to cut and form windrows. The correct ground speed will allow the swather to cut plants completely. Swath manipulation should be done after the alfalfa has dried considerably but before plants become so dry that disturbing the windrow causes excessive dry matter losses. Baling to obtain the proper bale weight, density, and length can reduce crop loss during handling. Uniform, tight, and well-shaped bales are better suited for making stacks that are even and snug and, thus, the risk of broken bales and stack collapse is reduced.

Conclusion

The moisture content of growing alfalfa is between 75 and 80%. Plant respiration continues until the moisture content of plant tissue drops below 40%. Cut alfalfa must lose large quantities of water as rapidly as possible to promote good hay curing and result in high quality hay. To help ensure high yields and high quality, harvest management practices should be used that reduce the time from cutting to baling (Fig. 2).

Performing operations in a timely manner is critical to good haymaking. Operations, done in a timely manner, does not generally increase production costs, but has a big impact on hay yields and product quality. Using good management and performing haymaking operations on a timely basis can increase profits.

New technology is continually being developed to improve haymaking. Information on the latest developments in haymaking should be sought from reputable sources. Sources of good information on haymaking include high quality trade magazines, grower meetings sponsored by respected companies and organizations, knowledgeable crop consultants and Cooperative Extension personnel, and numerous internet web sites hosted by universities, government agencies, forage organizations, and companies.

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DECREASING THE TIME FROM SWATHING TO BALING

- Harvest at the optimum growth stage. Thick stems and heavy windrows require more drying time.
- Control weeds. Some weeds may cause windrows to dry slowly.
- Make sure the soil is sufficiently dry. Equipment traffic may cause damage in fields with wet soil. Hay also cures more slowly on wet soil.
- Configure windrows correctly. Make the windrow as wide as practical. Hay in windrows should lay as evenly as possible. Avoid making "clumpy" windrows. Adjust the swather for optimum performance.
- Possibly manipulate windrows by spreading, moving, or inverting windrows. This will improve drying on the bottom of the windrow. Use good management to minimize leaf loss when manipulating windrows.
- Use an effective hay conditioner product and apply it according to the manufacturer's recommendations.
- Bale as soon as the hay is dry enough. Over drying hay causes needless delays.

Fig. 2. Management practices that can be used to decrease the time from swathing to baling.

Table 1. Possible crop losses of alfalfa during harvesting and storage.

Field operation	Crop loss (%)
Swather with conditioner	1 to 5
Flail mower	6 to 11
Tedding	1 to 3
Swath inversion	0 to 2
Raking	1 to 20
Baling	2 to 5
Hauling	1 to 5
Storage	5 to 10
Average loss per cutting	24 to 28

Table 2. Monetary losses at various yield levels when hay losses are 10% and 20%.

Yield (tons/acre)	Loss (%)	Monetary loss of hay valued at $80 per ton	Loss (%)	Monetary loss of hay valued at $80 per ton
7.50	10	60	20	120
6.75	10	54	20	108
5.50	10	44	20	88
5.00	10	40	20	80

POTENTIAL FOR SELECTING ALFALFA VARIETIES BASED ON FORAGE QUALITY

Calvin H. Pearson and Joe E. Brummer

Summary

In recent years, producing high quality alfalfa hay has become increasingly more important to many people. High quality alfalfa hay can often be produced with little or no increase in production costs, yet profits from selling high quality hay can be attractive. Farmers and ranchers can also realize increased profits through improved performance when animals are fed high quality hay.

A variety performance test was conducted at the Western Colorado Research Center at Fruita in which 20 alfalfa varieties were evaluated for forage yield during a 3-year testing period from 1999 through 2001. Crude protein and *in vitro* digestibility were determined for all 20 alfalfa varieties in each of the four cuttings during the 3-year testing period. Alfalfa varieties that had high crude protein yield, high *in vitro* digestible dry matter yield, and high forage yield were Focus HSN, Millennia, and WL 232 HQ. Ranger and Ladak had the lowest crude protein yield, *in vitro* digestible dry matter yield, and total forage yield. Alfalfa varieties that consistently produce high yields and high forage quality across cuttings and years of production will be of interest to many people. Alfalfa varieties with low yields and low quality should be avoided unless they have unique, desirable characteristics that fit specific production requirements. The 3-year total forage yield of the top three alfalfa varieties was 14% greater compared to the two low-yielding varieties in the study. The 3-year total crude protein yield of the top three alfalfa varieties was 17% greater compared to the two low quality varieties. The 3-year total digestible dry matter yield of the top three varieties was 13% greater compared to the two low quality varieties. These data provide sound evidence that alfalfa varieties differ significantly in forage quality, and when selecting varieties for planting, the performance of alfalfa varieties for both forage yield and hay quality should be considered.

Using good management, hay growers can produce high quality hay with little or no increase in production costs.

Introduction

Using good management practices has been encouraged by researchers, educators, extension agents, consultants, agribusiness, and others to achieve increased alfalfa hay quality. Examples of management practices that growers have been encouraged to adopt are: i) to increase hay quality by cutting alfalfa at the proper stage of growth and, ii) baling at the proper time of day and at a suitable hay moisture content to minimize leaf loss.

Traditionally, alfalfa variety development has focused on increasing yields and improving plant resistance to disease. Only recently, within approximately the past 10 years, have plant breeders directed their efforts at improving alfalfa quality by attempting to breed alfalfa varieties with increased hay quality. While yield has long been recognized as a key factor to productivity and profitability, hay quality has gained increased importance to people in the hay industry – from grower to end user (Gray, 2001). High quality alfalfa hay can increase profits for both growers and end users.

In recent years, alfalfa varieties have been developed and marketed with the promise of increased hay quality. Limited published information is available on the comparative performance among alfalfa varieties for both hay quality and yield.

Materials and Methods

An alfalfa variety performance test was conducted at the Colorado State University Western Colorado Research Center at Fruita from 1999 through 2001. The experiment was a randomized complete block with four replications. The soil was a Billings silty clay loam. The elevation at Fruita, Colorado is 4510 ft. Average annual precipitation is 8.4 in. Average frost-free days are 181. Details regarding the methods used in this alfalfa variety performance test are presented in the report in this publication entitled, “Western Colorado Alfalfa Variety Performance at Fruita 1999-2002.”

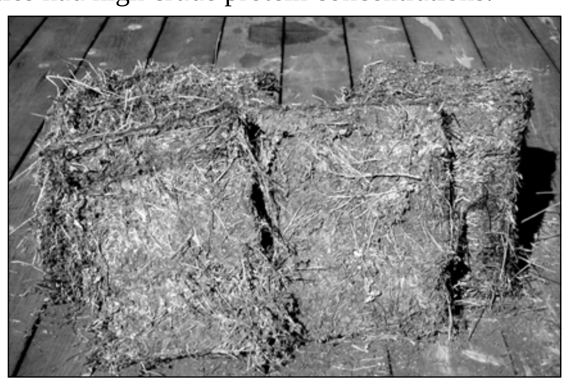
As plots were harvested for yield, a subsample was obtained for moisture determination. After moistures were determined, samples were oven-dried at 60 ºC and then ground in a Wiley Mill. Ground samples were kept frozen until forage quality analyses were conducted. Samples were sent to the Mountain Meadow Research Center at Gunnison, Colorado where they were fine-ground through a 1 mm screen in a Cyclone Mill prior to being analyzed for digestibility and crude protein. Digestibility was determined using standard *in vitro* procedures. Samples were incubated in test tubes for 48 hr with 40 ml of buffer solution and 10 ml of rumen fluid that was collected from a steer being fed a diet of grass and alfalfa hay. Samples were then acidified with 6 ml of hydrochloric acid followed by the addition of 2 ml of pepsin and incubated for an additional 24 hr. Crude protein was determined using the Hach method (sulfuric acid/hydrogen peroxide digest) for total Kjedahl nitrogen x 6.25.

Results and Discussion

Crude protein and *in vitro* digestibility were determined for the 20 alfalfa varieties in each of the four cuttings during the 3-year testing period from 1999 through 2001. The ensuing discussion presents results for crude protein concentration, crude protein yield, digestible dry matter concentration, and digestible dry matter yield for each year from 1999 through 2001.

Crude Protein Concentration

In 1999, there were significant differences among varieties in all four cuttings and for the 1999 average crude protein (Table 1). Average crude protein in the first cutting in 1999 was 22.86%. Crude protein in the first cutting in 1999 ranged from a high of 24.63% for ZX9451 to a low of 21.09% for ABT350. In the first cutting in 1999, 12 of the 20 varieties had high crude protein concentrations. Average crude protein in the second cutting in 1999 was 19.90%. Crude protein in the second cutting in 1999 ranged from a high of 22.13% for Innovator+Z to a low of 17.64% for ABT350. In the second cutting in 1999, 8 of the 20 varieties had high crude proteins. Average crude protein in the third cutting in 1999 was 20.69%. Crude protein in the third cutting in 1999 ranged from a high of 22.16% for TMF421 to a low of 19.34% for ZX9453. In the third cutting in 1999, 7 of the 20 varieties had high crude proteins. Average crude protein in the fourth cutting in 1999 was 24.40%. Crude protein in the fourth cutting in 1999 ranged from a high of 26.49% for WL232HQ and



Forage quality is largely determined once alfalfa hay has been packaged into bales.

TMF421 to a low of 22.17% for ZX9453. In the fourth cutting in 1999, 10 of the 20 varieties had high crude proteins. Average crude protein in 1999 was 21.96%. Average crude protein in 1999 ranged from a high of 23.55% for WL232HQ to a low of 20.59% for ABT350. When averaged across the four cuttings in 1999, 5 of the 20 varieties had high crude proteins.

In 2000, there were significant differences among varieties in the first and fourth cuttings and for the 2000 average crude protein concentration (Table 2). Average crude protein in the first cutting in 2000 was 17.84%. Crude protein in the first cutting in 2000 ranged from a high of 19.58% for WL232HQ to a low of 16.04% for Garst 6420. In the first cutting in 2000, nine of the 20 varieties had high crude proteins. Average crude protein in the second and third cuttings in 2000 was 17.74% and 18.99%, respectively. Average crude protein in the fourth cutting in 2000 was 25.56%. Crude protein in the fourth cutting in 2000 ranged from a high of 27.38% for WL232HQ to a low of 23.96% for Baralfa 54. In the fourth cutting in 2000, 8 of the 20 varieties had high crude proteins. Average crude protein in 2000 was 20.03%. Average crude protein in 2000 ranged from a high of 21.19% for WL325HQ to a low of 18.75% for Baralfa54. When averaged across the four cuttings in 2000, 5 of the 20 varieties had high crude proteins.

In 2001, there were significant differences among varieties in the first and fourth cuttings and for the average 2001 crude protein (Table 3). Average crude protein in the first cutting in 2001 was 19.28%. Crude protein in the first cutting in 2001 ranged from a high of 20.74% for WL232HQ to a low of 18.18% for ZX9453. In the first cutting in 2001, 8 of the 20 varieties had high crude proteins. Average crude protein in the second and third cuttings in 2001 was 19.56% and 18.39%, respectively. Average crude protein in the fourth cutting in 2001 was 25.76%. Crude protein in the fourth cutting in 2001 ranged from a high of 27.27% for TMF 421 to a low of 24.86% for Archer. In the fourth cutting in 2001, 5 of the 20 varieties had high crude proteins. Average crude protein in 2001 was 20.75%. Average crude protein in 2001 ranged from a high of 21.96% for WL232HQ to a low of 19.92% for ZX9453. When averaged across the four cuttings in 2001, 3 of the 20 varieties had high crude proteins. They were WL232HQ, TMF 421, and WL 325HQ.

Crude Protein Yield

In 1999, there were significant differences among varieties in the first and fourth cuttings and for the 1999 total crude protein yield (Table 4). Average crude protein yield in the first cutting in 1999 was 0.60 tons/acre. Crude protein in the first cutting in 1999 ranged from a high of 0.74 tons/acre for WL232HQ to a low of 0.47 tons/acre for Ladak. In the first cutting in 1999, four of the twenty varieties (WL232HQ, ZX9451, WL 325HQ, and DK140) had high crude protein yields. Average crude protein yields in the second and third cuttings in 1999 were 0.49 and 0.41 tons/acre, respectively. Average crude protein yield in the fourth cutting in 1999 was 0.32 tons/acre. Crude protein yield in the fourth cutting in 1999 ranged from a high of 0.36 tons/acre for Archer to a low of 0.28 tons/acre for Ladak. In the fourth cutting in 1999, 12 of the 20 varieties had high crude protein yields. Average total crude protein yield in 1999 was 1.83 tons/acre. Total crude protein yield in 1999 ranged from a high of 2.05 tons/acre for WL232HQ to a low of 1.60 tons/acre for Ladak. When totaled across the four cuttings in 1999, 4 of the 20 varieties (WL232HQ, Millennia, Focus HSN, and WL 325HQ) had high crude proteins.

Producing high quality hay will increase profits for growers.

In 2000, there were significant differences among varieties in the second and fourth cuttings and for the 2000 total crude protein yield (Table 5). Average crude protein yield in the first cutting in 2000 was 0.53 tons/acre. Average crude protein yield in the second cutting in 2000 was 0.50 tons/acre. Crude protein yield in the second cutting in 2000 ranged from a high of 0.54 tons/acre for Focus HSN to a low of 0.44 tons/acre for Ladak. In the second cutting in 2000, 14 of the 20 varieties had high crude protein yields. Average crude protein yield in the third cutting in 2000 was 0.50 tons/acre. Average crude protein yield in the fourth cutting in 2000 was 0.28 tons/acre. In the fourth cutting in 2000, ZX9453 and Millennia had high crude protein yields at 0.30 tons/acre and Innovator+Z had the lowest crude protein yield at 0.25 tons/acre. Average total crude protein yield in 2000 was 1.91 tons/acre. Total crude protein yield in 2000 ranged from a high of 2.04 tons/acre for Focus HSN to a low of 1.76 tons/acre for Ladak. When totaled across the four cuttings in 2000, 8 of the 20 varieties had high crude protein yields.

In 2001, there were significant differences among the varieties in all four cuttings for crude protein yield and for the 2001 total crude protein yield (Table 6). Average crude protein yield in the first cutting in 2001 was 0.41 tons/acre. Crude protein yield in the first cutting in 2001 ranged from a high of 0.48 tons/acre for WL232HQ to a low of 0.32 tons/acre for Garst 6420. In the first cutting in 2001, 13 of the 20 varieties had high crude protein yields. Average crude protein yield in the second cutting in 2001 was 0.38 tons/acre. Crude protein yield in the second cutting in 2001 ranged from a high of 0.45 tons/acre for WL325HQ to a low of 0.29 tons/acre for Garst 6420. In the second cutting in 2001, 5 of the 20 varieties had high crude protein yields. Average crude protein yield in the third cutting in 2001 was 0.45 tons/acre. Crude protein yield in the third cutting in 2001 ranged from a high of 0.50 tons/acre for TMF Multiplier II to a low of 0.38 tons/acre for ABT 350. In the third cutting in 2001, 13 of the 20 varieties had high crude protein yields. Average crude protein yield in the fourth cutting in 2001 was 0.27 tons/acre. Crude protein yield in the fourth cutting in 2001 ranged from a high of 0.33 tons/acre for Millennia to a low of 0.21 tons/acre for Ladak. In the fourth cutting in 2001, 8 of the 20 varieties had high crude protein yields. Total crude protein yield in 2001 averaged 1.57 tons/acre. Total crude protein yield in 2001 ranged from a high of 1.76 tons/acre for Millennia to a low of 1.34 tons/acre for Garst 6420. When totaled across the four cuttings in 2001, five (Millennina, WL232HQ, Focus HSN, WL325HQ, and Reno) of the 20 varieties had high crude protein yields.

Digestible Dry Matter Concentration

In 1999, there were significant differences among the varieties in the first, third, and fourth cuttings for digestible dry matter and for the 1999 total digestible dry matter when averaged across all four cuttings (Table 7). Average digestible dry matter in the first cutting in 1999 was 69.14%. Digestible dry matter in the first cutting in 1999 ranged from a high of 71.73% for DK134 to a low of 67.33% for Archer. In the first cutting in 1999, 4 of the 20 varieties had high digestible dry matter. Average digestible dry matter in the second cutting in 1999 was 61.45%. Average digestible dry matter in the third cutting in 1999 was 63.09%. Digestible dry matter in the third cutting in 1999 ranged from a high of 64.90% for TMF 421 to a low of 61.25% for ZX9453. In the third cutting in 1999, 11 of the 20 varieties had high digestible dry matter. Average digestible dry matter in the fourth cutting in 1999 was 72.49%. Digestible dry matter in the fourth cutting in 1999 ranged from a high of 74.63% for TMF 421 to a low of 69.85% for ZX 9453. In the fourth cutting in 1999, three (TMF 421, WL232HQ, and Ladak) of the 20 varieties had high digestible dry matter. Digestible dry matter in 1999 averaged 66.54%. Average digestible dry matter ranged from a high of 67.78% for DK134 to a low of 64.86% for ZX 9453. When averaged across the four cuttings in 1999, 11 of the 20 varieties had high digestible dry matter.

In 2000, there were significant differences among alfalfa varieties for digestible dry matter in the first, second, and fourth cuttings and also among varieties when averaged across all four cuttings (Table 8).

Selecting the right variety to grow can increase forage yields and forage quality.

Average digestible dry matter in the first cutting in 2000 was 68.40%. Digestible dry matter in the first cutting in 2000 ranged from a high of 70.59% for WL232HQ to a low of 66.68% for Ladak. In the first cutting in 2000, 8 of the 20 varieties had high digestible dry matter. Average digestible dry matter in the second cutting in 2000 was 61.99%. Digestible dry matter in the second cutting in 2000 ranged from a high of 64.19% for Ranger to a low of 60.20% for Archer II. In the second cutting in 2000, 11 of the 20 varieties had high digestible dry matter. Average digestible dry matter in the third cutting in 2000 was 65.31%. Average digestible dry matter in the fourth cutting in 2000 was 72.69%. Digestible dry matter in the fourth cutting in 2000 ranged from a high of 73.85% for TMF421 to a low of 70.68% for Archer. In the fourth cutting in 2000, 15 of the 20 varieties had high digestible dry matter. Digestible dry matter in 2000 averaged 67.10%. Average digestible dry matter in 2000 ranged from a high of 68.21% for TMF421 to a low of 65.83% for Archer. When averaged across all four cuttings in 2000, 11 of the 20 varieties had high digestible dry matter.

In 2001, there were significant differences among alfalfa varieties for digestible dry matter in the third and fourth cuttings and also among varieties when averaged across all four cuttings (Table 9). Average digestible dry matter in the first cutting in 2001 was 67.75%. Average digestible dry matter in the second cutting in 2000 was 64.16%. Average digestible dry matter in the third cutting in 2001 was 64.31%. Digestible dry matter in the third cutting in 2001 ranged from a high of 65.54% for TMF421 to a low of 63.19% for Archer. In the third cutting in 2001, 12 of the 20 varieties had high digestible dry matter. Average digestible dry matter in the fourth cutting in 2001 was 74.06%. Digestible dry matter in the fourth cutting in 2001 ranged from a high of 75.21 % for TMF421 to a low of 72.44% for Archer. In the fourth cutting in 2001, 11 of the 20 varieties had high digestible dry matter. Digestible dry matter in 2001 averaged 67.57%. Average digestible dry matter in 2001 ranged from a high of 68.50% for WL232HQ to a low of 66.27% for Archer. When averaged across all four cuttings in 2001, 14 of the 20 varieties had high digestible dry matter.

Digestible Dry Matter Yield

In 1999, there were significant differences among alfalfa varieties for digestible dry matter yield in the first, second, and fourth cuttings and for the 1999 total digestible dry matter yield (Table 10). Average digestible dry matter yield in the first cutting in 1999 was 1.81 tons/acre. Digestible dry matter yield in the first cutting in 1999 ranged from a high of 2.10 tons/acre for WL232HQ to a low of 1.43 tons/acre for Ladak. In the first cutting in 1999, 11 of the 20 varieties had high digestible dry matter yield. Average digestible dry matter yield in the second cutting in 1999 was 1.50 tons/acre. Digestible dry matter yield in the second cutting in 1999 ranged from a high of 1.62 tons/acre for DK142 to a low of 1.33 tons/acre for Ranger. In the second cutting in 1999, 14 of the 20 varieties had high digestible dry matter yield. Average digestible dry matter yield in the third cutting in 1999 was 1.25 tons/acre. Average digestible dry matter yield in the fourth cutting in 1999 was 0.95 tons/acre. Digestible dry matter yields in the fourth cutting in 1999 ranged from a high of 1.06 tons/acre for DK142 to a low of 0.80 tons/acre for Ladak. In the fourth cutting in 1999, 5 of the 20 varieties had high digestible dry matter yields. Digestible dry matter yields in 1999 averaged 5.56 tons/acre. Average digestible dry matter yields ranged from a high of 5.86 tons/acre for WL232HQ to a low of 4.83 tons/acre for Ladak. When averaged across all four cuttings in 1999, 13 of the 20 varieties had high digestible dry matter yields.

Hay with high forage quality is often easier to sell and promotes repeat business from satisfied customers.

In 2000, there were only significant differences among alfalfa varieties for digestible dry matter yield in the fourth cutting (Table 11). Average digestible dry matter yield in the first, second, and third cuttings in

2000 were 2.03, 1.77, and 1.73 tons/acre, respectively. Average digestible dry matter yield in the fourth cutting in 2000 was 0.78 tons/acre. Digestible dry matter yields in the fourth cutting in 2000 ranged from a high of 0.89 tons/acre for ZX9453 to a low of 0.69 tons/acre for Innovator+Z. In the fourth cutting in 2000, 8 of the 20 varieties had high digestible dry matter yields. Overall, digestible dry matter yields in 2000 averaged 6.41 tons/acre.

In 2001, there were significant differences among alfalfa varieties for digestible dry matter yield in the second, third, and fourth cuttings and for the 2001 total digestible dry matter yield (Table 12). Average digestible dry matter yield in the first cutting in 2001 was 1.45 tons/acre. Average digestible dry matter yield in the second cutting in 2001 was 1.23 tons/acre. Digestible dry matter yields in the second cutting in 2001 ranged from a high of 1.43 tons/acre for WL325HQ to a low of 0.97 tons/acre for Garst 6420. In the second cutting in 2001, 7 of the 20 varieties had high digestible dry matter yields. Average digestible dry matter yield in the third cutting in 2001 was 1.56 tons/acre. Digestible dry matter yields in the third cutting in 2001 ranged from a high of 1.75 tons/acre for TMF Multiplier II to a low of 1.33 tons/acre for ABT350. In the third cutting in 2001, 12 of the 20 varieties had high digestible dry matter yields. Average digestible dry matter yield in the fourth cutting in 2001 was 0.78 tons/acre. Digestible dry matter yields in the fourth cutting in 2001 ranged from a high of 0.97 tons/acre for Millennia to a low of 0.61 tons/acre for Ladak. In the fourth cutting in 2001, two (Millennia and ZX9453) of the 20 varieties had high digestible dry matter yields. Digestible dry matter yields in 2001 averaged 5.10 tons/acre. Average digestible dry matter yields ranged from a high of 5.70 tons/acre for Millennia to a low of 4.46 tons/acre for Garst 6420. When averaged across all four cuttings in 2001, 7 of the 20 varieties had high digestible dry matter yields.

Three-Year Total Yields

Total 3-year crude protein yield was calculated based on crude protein concentration and forage yield. Four varieties had high 3-year total crude protein yields (Table 13). They were WL232HQ at 5.75 tons/acre, Focus HSN at 5.67 tons/acre, Millennia at 5.65 tons/acre, and WL325HQ at 5.59 tons/acre. Conversely, the two varieties with the lowest 3-year crude protein yields were Ranger and Ladak at 4.93 and 4.80 tons/acre, respectively.

Total 3-year *in vitro* digestible dry matter yield was calculated based on *in vitro* digestible dry matter concentration and forage yield. Four varieties had high 3-year total *in vitro* digestible dry matter yields (Table 14). They were Focus HSN at 18.10 tons/acre, Millennia at 17.91 tons/acre, WL232HQ at 17.65 tons/acre, and Reno at 17.45 tons/acre. Conversely, the two varieties with the lowest 3-year *in vitro* digestible dry matter yields again were Ranger at 15.95 tons/acre and Ladak at 15.61 tons/acre.

Five varieties had high 3-year total forage yields (Table 15). They were Focus HSN at 26.93 tons/acre, Millennia at 26.84 tons/acre, ZX9453 at 26.42 tons/acre, WL232HQ at 26.00 tons/acre, and Baralfa 54 at 26.00 tons/acre. The varieties with the lowest 3-year total forage yields were Ranger at 23.64 tons/acre and Ladak at 23.20 tons/acre. Alfalfa varieties that had high crude protein yields, high *in vitro* digestible dry matter yields, and high forage yields were Focus HSN, Millennia, and WL 232 HQ. Ranger and Ladak had the lowest crude protein yields, *in vitro* digestible dry matter yields, and total forage yields.

Alfalfa varieties that consistently produce high yields and high forage quality across cuttings and years of production will be of interest to many people. Alfalfa varieties with low yields and low quality should be avoided unless they have unique, desirable characteristics that fit specific production requirements. Alfalfa hay is an important crop in the U.S., generating millions of dollars each year to the economy. In Colorado alone, the alfalfa hay crop was valued at $361 million in 2001 (Colorado Agricultural Statistics, 2002). Just by selecting the right variety, both forage yield and hay quality can be increased. The 3-year total forage yield of the top three alfalfa varieties was 14% greater compared to the two low-yielding varieties evaluated in the study. The 3-year total crude protein yield of the top three alfalfa varieties was 17% greater compared to the two low quality varieties. The 3-year total digestible dry matter yield of the top three varieties was 13% greater than the two low quality varieties. The data obtained in this study provide sound evidence that alfalfa varieties differ significantly in forage quality, and when selecting varieties for planting, the performance of alfalfa varieties for both forage yield and hay quality should be considered.

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Table 1. Percent crude protein of 20 alfalfa varieties grown at Fruita 1999.

Variety	Brand/Source	1st Cut 28 May	2nd Cut 7 July	3rd Cut 19 Aug.	4th Cut 12 Oct.	1999 Average crude protein
		---------------	---------------	--- % ---	---------------	---------------
WL 232 HQ	Germains	24.55	21.38	21.76	26.49	23.55
TMF 421	Mycogen	23.08	20.41	22.16	26.49	23.03
WL 325 HQ	Germains	24.44	19.74	21.69	25.45	22.83
DK 134	DEKALB	24.36	19.81	20.94	24.95	22.51
Innovator+Z	America's Alfalfa	23.34	22.13	20.19	24.36	22.50
Reno	Novartis Seeds	23.53	21.22	20.43	24.04	22.30
Ladak	public	22.81	19.94	20.68	25.70	22.28
Millennia	IFA	22.12	19.96	20.84	26.08	22.25
Ranger	public	22.39	20.58	20.94	25.03	22.23
DK 140	DEKALB	23.02	21.12	21.33	23.24	22.17
Focus HSN	Arkansas Valley Seeds	21.99	20.44	20.88	25.04	22.09
Archer	America's Alfalfa	22.95	19.27	20.80	25.29	22.08
TMF Multiplier II	Mycogen	22.47	19.67	20.13	25.11	21.84
DK 142	DEKALB	22.35	20.86	21.06	22.89	21.79
ZX 9451	ABI	24.63	19.22	20.39	22.29	21.63
Garst 6420	Garst	21.75	18.89	19.92	24.16	21.18
Baralfa 54	Seekamp Seed	21.98	18.67	19.52	23.32	20.87
ZX 9453	ABI	23.06	18.73	19.34	22.17	20.83
Archer II	America's Alfalfa	21.25	18.45	20.34	22.86	20.73
ABT 350	ABT	21.09	17.64	20.49	23.13	20.59
Ave.		22.86	19.90	20.69	24.40	21.96
CV (%)		6.8	7.6	4.2	5.4	3.5
LSD (0.05)		2.21	2.14	1.22	1.87	1.08

Table 2. Percent crude protein of 20 alfalfa varieties grown at Fruita 2000.

Variety	Brand/Source	1st Cut 17 May	2nd Cut 7 July	3rd Cut 23 Aug.	4th Cut 2 Oct.	2000 Average crude protein
		%				
WL 325 HQ	Germains	19.28	19.81	19.72	25.95	21.19
WL 232 HQ	Germains	19.58	17.98	19.12	27.38	21.01
TMF 421	Mycogen	19.32	17.76	20.33	26.30	20.93
Focus HSN	Arkansas Valley Seeds	18.27	18.39	20.03	26.19	20.72
Innovator+Z	America's Alfalfa	18.94	18.08	18.96	26.11	20.52
Millennia	IFA	17.29	17.94	19.54	26.21	20.24
Reno	Novartis Seeds	17.88	17.64	19.14	26.22	20.22
DK 134	DEKALB	17.72	18.57	18.17	25.79	20.06
ABT 350	ABT	17.84	17.13	19.69	25.43	20.02
Archer	America's Alfalfa	18.65	17.33	19.47	24.60	20.01
DK 140	DEKALB	17.33	17.29	19.29	25.89	19.95
Ranger	public	17.50	17.31	18.79	25.84	19.86
DK 142	DEKALB	17.27	17.65	18.48	26.02	19.86
TMF Multiplier II	Mycogen	18.21	16.98	18.38	25.80	19.84
Archer II	America's Alfalfa	18.07	18.01	18.71	24.21	19.75
ZX 9451	ABI	17.34	18.05	19.19	24.36	19.73
ZX 9453	ABI	16.97	17.80	18.54	24.18	19.37
Ladak	public	16.98	16.92	18.10	25.47	19.37
Garst 6420	Garst	16.04	17.23	18.42	25.31	19.25
Baralfa 54	Seekamp Seed	16.31	17.02	17.72	23.96	18.75
Ave.		17.84	17.74	18.99	25.56	20.03
CV (%)		6.8	6.7	5.8	4.1	3.0
LSD (0.05)		1.71	NS †	NS †	1.49	0.84

† NS, Not significant at the 5% level of probability.

Table 3. Percent crude protein of 20 alfalfa varieties grown at Fruita 2001.

Variety	Brand/Source	1st Cut 21 May	2nd Cut 6 July	3rd Cut 27 Aug.	4th Cut 2 Oct.	2001 Average crude protein
		%				
WL 232 HQ	Germains	20.74	20.24	19.65	27.23	21.96
TMF 421	Mycogen	19.82	20.35	19.36	27.27	21.70
WL 325 HQ	Germains	20.49	20.28	18.62	26.87	21.57
Innovator+Z	America's Alfalfa	19.48	19.68	18.09	26.56	20.95
Millennia	IFA	19.23	19.74	19.11	25.56	20.91
ABT 350	ABT	19.73	19.42	18.51	25.70	20.84
DK 142	DEKALB	18.55	19.99	18.53	26.15	20.80
DK 140	DEKALB	19.35	19.66	18.39	25.73	20.78
ZX 9451	ABI	18.87	19.84	18.74	25.64	20.77
Ladak	public	19.29	19.02	18.83	25.92	20.76
Reno	Novartis Seeds	19.66	18.98	18.14	25.86	20.66
Ranger	public	19.47	20.16	18.02	24.93	20.65
DK 134	DEKALB	19.18	20.45	17.81	25.17	20.65
TMF Multiplier II	Mycogen	18.81	19.19	18.45	25.72	20.54
Archer II	America's Alfalfa	19.78	19.37	17.76	25.06	20.49
Focus HSN	Arkansas Valley Seeds	19.12	19.33	17.58	25.82	20.46
Archer	America's Alfalfa	18.84	19.49	18.56	24.86	20.44
Garst 6420	Garst	18.61	18.76	18.17	25.11	20.16
Baralfa 54	Seekamp Seed	18.40	18.32	17.92	25.14	19.95
ZX 9453	ABI	18.18	19.02	17.54	24.92	19.92
Ave.		19.28	19.56	18.39	25.76	20.75
CV (%)		5.0	5.3	5.4	3.2	3.0
LSD (0.05)		1.37	NS †	NS †	1.18	0.89

†NS, Not significant at the 5% level of probability.

Table 4. Crude protein yield of 20 alfalfa varieties grown at Fruita 1999.

Variety	Brand/Source	1st Cut 28 May	2nd Cut 7 July	3rd Cut 19 Aug.	4th Cut 12 Oct.	1999 Total crude protein yield
		----------------------------	----------	tons/acre[3]	----------	----------------------------
WL 232 HQ	Germains	0.74	0.54	0.43	0.32	2.05
Focus HSN	Arkansas Valley Seeds	0.62	0.50	0.45	0.33	1.93
Millennia	IFA	0.63	0.51	0.42	0.35	1.93
WL 325 HQ	Germains	0.65	0.51	0.41	0.33	1.92
DK 142	DEKALB	0.62	0.55	0.40	0.33	1.90
DK 140	DEKALB	0.64	0.51	0.42	0.32	1.89
ZX 9451	ABI	0.67	0.48	0.43	0.30	1.88
TMF 421	Mycogen	0.62	0.50	0.40	0.31	1.86
Innovator+Z	America’s Alfalfa	0.63	0.51	0.38	0.32	1.85
Garst 6420	Garst	0.61	0.46	0.40	0.34	1.84
TMF Multiplier II	Mycogen	0.61	0.49	0.41	0.32	1.84
Archer	America’s Alfalfa	0.60	0.50	0.35	0.36	1.83
Reno	Novartis Seeds	0.57	0.52	0.41	0.31	1.82
DK 134	DEKALB	0.56	0.48	0.42	0.32	1.80
ZX 9453	ABI	0.57	0.49	0.40	0.32	1.79
Archer II	America’s Alfalfa	0.55	0.45	0.43	0.31	1.76
Baralfa 54	Seekamp Seed	0.55	0.46	0.42	0.31	1.75
ABT 350	ABT	0.56	0.44	0.41	0.29	1.73
Ranger	public	0.52	0.43	0.39	0.30	1.66
Ladak	public	0.47	0.43	0.39	0.28	1.60
Ave.		0.60	0.49	0.41	0.32	1.83
CV (%)		12.9	10.4	9.2	7.8	5.5
LSD (0.05)		0.11	NS†	NS†	0.04	0.14

†NS, Not significant at the 5% level of probability.

Table 5. Crude protein yield of 20 alfalfa varieties grown at Fruita 2000.

Variety	Brand/Source	1st Cut 17 May	2nd Cut 7 July	3rd Cut 23 Aug.	4th Cut 2 Oct.	2000 Total crude protein yield
		tons/acre[3]				
Focus HSN	Arkansas Valley Seeds	0.54	0.54	0.57	0.29	2.04
WL 232 HQ	Germains	0.59	0.53	0.49	0.29	2.00
WL 325 HQ	Germains	0.56	0.54	0.51	0.28	1.98
Millennia	IFA	0.52	0.52	0.52	0.30	1.96
Reno	Novartis Seeds	0.53	0.51	0.51	0.29	1.95
DK 142	DEKALB	0.53	0.52	0.50	0.28	1.95
ZX 9453	ABI	0.51	0.52	0.51	0.30	1.93
TMF 421	Mycogen	0.57	0.50	0.50	0.26	1.93
TMF Multiplier II	Mycogen	0.56	0.49	0.47	0.29	1.92
ZX 9451	ABI	0.51	0.50	0.54	0.28	1.91
ABT 350	ABT	0.55	0.50	0.50	0.26	1.91
Archer	America's Alfalfa	0.53	0.48	0.55	0.27	1.91
Innovator+Z	America's Alfalfa	0.56	0.50	0.50	0.25	1.91
DK 134	DEKALB	0.51	0.53	0.48	0.27	1.90
Garst 6420	Garst	0.51	0.50	0.49	0.29	1.90
Archer II	America's Alfalfa	0.53	0.52	0.49	0.26	1.88
DK 140	DEKALB	0.53	0.48	0.49	0.28	1.88
Ranger	public	0.49	0.49	0.50	0.26	1.85
Baralfa 54	Seekamp Seed	0.48	0.48	0.48	0.26	1.78
Ladak	public	0.48	0.44	0.47	0.26	1.76
Ave.		0.53	0.50	0.50	0.28	1.91
CV (%)		9.0	6.9	8.6	8.1	4.4
LSD (0.05)		NS†	0.05	NS†	0.04	0.12

†NS, Not significant at the 5% level of probability.

Table 6. Crude protein yield of 20 alfalfa varieties grown at Fruita 2001.

Variety	Brand/Source	1st Cut 21 May	2nd Cut 6 July	3rd Cut 27 Aug.	4th Cut 2 Oct.	2001 Total crude protein yield
		----------	----------	tons/acre[3]	----------	----------
Millennia	IFA	0.45	0.43	0.49	0.33	1.76
Focus HSN	Arkansas Valley Seeds	0.47	0.40	0.47	0.29	1.70
WL 232 HQ	Germains	0.48	0.40	0.49	0.26	1.70
WL 325 HQ	Germains	0.44	0.45	0.44	0.30	1.69
Reno	Novartis Seeds	0.46	0.38	0.48	0.30	1.68
Baralfa 54	Seekamp Seed	0.44	0.36	0.46	0.30	1.61
Archer II	America's Alfalfa	0.43	0.43	0.40	0.30	1.61
Archer	America's Alfalfa	0.39	0.43	0.44	0.29	1.59
TMF Multiplier II	Mycogen	0.41	0.34	0.50	0.28	1.59
DK 140	DEKALB	0.41	0.38	0.45	0.28	1.57
ZX 9453	ABI	0.40	0.40	0.41	0.30	1.57
TMF 421	Mycogen	0.42	0.38	0.43	0.26	1.56
ZX 9451	ABI	0.41	0.39	0.43	0.30	1.56
DK 134	DEKALB	0.40	0.38	0.44	0.26	1.54
DK 142	DEKALB	0.37	0.34	0.47	0.27	1.52
Innovator+Z	America's Alfalfa	0.39	0.35	0.44	0.24	1.50
Ladak	public	0.38	0.30	0.47	0.21	1.44
Ranger	public	0.39	0.32	0.44	0.22	1.42
ABT 350	ABT	0.39	0.36	0.38	0.24	1.41
Garst 6420	Garst	0.32	0.29	0.42	0.26	1.34
Ave.		0.41	0.38	0.45	0.27	1.57
CV (%)		12.4	8.1	8.8	10.1	6.1
LSD (0.05)		0.08	0.04	0.06	0.04	0.13

Table 7. Percent *in vitro* digestible dry matter of 20 alfalfa varieties grown at Fruita 1999.

Variety	Brand/Source	1st Cut 28 May	2nd Cut 7 July	3rd Cut 19 Aug.	4th Cut 12 Oct.	1999 Ave. dry matter
		----------	----------	%	----------	----------
DK 134	DEKALB	71.73	62.08	63.83	73.48	67.78
TMF 421	Mycogen	69.60	61.85	64.90	74.63	67.74
WL 325 HQ	Germains	69.95	61.90	64.85	73.50	67.55
Ranger	public	69.35	63.70	63.58	73.20	67.46
WL 232 HQ	Germains	70.15	60.98	64.38	73.88	67.34
Ladak	public	68.95	62.35	63.25	73.70	67.06
DK 140	DEKALB	69.55	62.98	63.53	72.13	67.04
Reno	Novartis Seeds	71.00	62.20	62.15	72.73	67.02
Innovator+Z	America's Alfalfa	69.28	62.38	63.20	73.05	66.98
DK 142	DEKALB	69.68	61.85	63.70	72.55	66.94
TMF Multiplier II	Mycogen	69.23	61.18	63.85	73.30	66.89
Focus HSN	Arkansas Valley Seeds	68.70	61.50	62.50	72.80	66.38
ABT 350	ABT	68.35	61.20	63.00	72.83	66.34
Garst 6420	Garst	68.48	60.93	62.70	72.75	66.21
Millennia	IFA	68.18	60.10	62.28	73.00	65.89
ZX 9451	ABI	68.60	61.70	62.45	70.23	65.74
Archer II	America's Alfalfa	68.35	59.85	62.60	70.75	65.39
Baralfa 54	Seekamp Seed	67.55	60.65	61.70	70.78	65.17
Archer	America's Alfalfa	67.33	60.15	62.03	70.65	65.04
ZX 9453	ABI	68.75	59.58	61.25	69.85	64.86
Ave.		69.14	61.45	63.09	72.49	66.54
CV (%)		1.9	2.9	2.3	0.9	1.0
LSD (0.05)		1.87	NS	2.03	0.97	0.98

Table 8. Percent *in vitro* digestible dry matter of 20 alfalfa varieties grown at Fruita 2000.

Variety	Brand/Source	1st Cut 17 May	2nd Cut 7 July	3rd Cut 23 Aug.	4th Cut 2 Oct.	2000 Ave. dry matter
		%				
TMF 421	Mycogen	69.97	62.50	66.54	73.85	68.21
WL 232 HQ	Germains	70.59	62.25	66.48	73.18	68.12
WL 325 HQ	Germains	69.70	62.94	65.88	73.13	67.91
Innovator+Z	America's Alfalfa	68.73	63.92	65.87	73.15	67.91
DK 140	DEKALB	68.90	63.49	65.51	73.19	67.77
Ranger	public	68.25	64.19	64.67	73.00	67.53
Focus HSN	Arkansas Valley Seeds	68.58	62.26	65.80	73.24	67.47
TMF Multiplier II	Mycogen	68.51	62.02	65.77	73.43	67.43
Reno	Novartis Seeds	68.87	61.47	65.82	73.46	67.40
ABT 350	ABT	69.17	61.48	65.63	72.90	67.29
Ladak	public	66.68	63.50	65.42	73.27	67.22
DK 134	DEKALB	69.00	60.78	64.82	73.21	66.95
Millennia	IFA	67.07	61.85	65.92	72.59	66.86
Baralfa 54	Seekamp Seed	67.67	61.74	64.88	72.09	66.60
DK 142	DEKALB	67.81	61.53	64.09	72.75	66.54
Garst 6420	Garst	67.21	61.24	65.06	72.61	66.53
ZX 9451	ABI	67.92	61.60	65.08	70.90	66.37
ZX 9453	ABI	67.69	60.53	64.53	71.63	66.10
Archer II	America's Alfalfa	67.46	60.20	64.35	71.50	65.88
Archer	America's Alfalfa	68.25	60.33	64.08	70.68	65.83
Ave.		68.40	61.99	65.31	72.69	67.10
CV (%)		2.1	2.8	2.1	1.2	1.1
LSD (0.05)		2.00	2.46	NS†	1.27	1.00

†NS, Not significant at the 5% level of probability.

Table 9. Percent *in vitro* digestible dry matter of 20 alfalfa varieties grown at Fruita 2001.

Variety	Brand/Source	1st Cut 21 May	2nd Cut 6 July	3rd Cut 27 Aug.	4th Cut 2 Oct.	2001 Ave. dry matter
		----------	----------	%	----------	----------
WL 232 HQ	Germains	68.65	65.12	65.48	74.76	68.50
TMF 421	Mycogen	67.53	65.47	65.54	75.21	68.44
WL 325 HQ	Germains	68.68	65.03	65.49	74.50	68.42
ABT 350	ABT	68.83	63.47	65.10	74.94	68.08
DK 140	DEKALB	68.88	65.13	63.80	74.27	68.02
Innovator+Z	America's Alfalfa	68.57	63.98	64.23	74.86	67.91
DK 134	DEKALB	67.79	64.95	64.69	74.19	67.90
Focus HSN	Arkansas Valley Seeds	67.56	64.26	65.03	74.44	67.82
TMF Multiplier II	Mycogen	67.61	64.21	64.67	74.64	67.78
DK 142	DEKALB	68.10	64.90	63.42	74.63	67.76
Ladak	public	67.32	64.49	64.36	74.61	67.69
Millennia	IFA	67.62	64.07	64.62	74.11	67.61
Ranger	public	68.74	65.14	63.21	73.16	67.56
Reno	Novartis Seeds	67.89	63.89	64.22	73.97	67.49
Garst 6420	Garst	66.69	63.43	64.73	74.28	67.28
ZX 9451	ABI	67.69	64.36	63.77	72.88	67.18
ZX 9453	ABI	67.13	63.56	63.37	72.67	66.68
Archer II	America's Alfalfa	66.93	62.90	63.26	73.56	66.66
Baralfa 54	Seekamp Seed	66.30	62.08	63.95	73.08	66.35
Archer	America's Alfalfa	66.59	62.86	63.19	72.44	66.27
Ave.		67.75	64.16	64.31	74.06	67.57
CV (%)		2.5	2.2	1.6	1.0	1.2
LSD (0.05)		NS†	NS†	1.45	1.00	1.11

†NS, Not significant at the 5% level of probability.

Table 10. *In vitro* digestible dry matter yield of 20 alfalfa varieties grown at Fruita 1999.

Variety	Brand/Source	1st Cut 28 May	2nd Cut 7 July	3rd Cut 19 Aug.	4th Cut 12 Oct.	1999 Total dry matter yield
		tons/acre[3]				
WL 232 HQ	Germains	2.10	1.53	1.28	0.90	5.86
DK 142	DEKALB	1.92	1.62	1.22	1.06	5.85
Focus HSN	Arkansas Valley Seeds	1.93	1.51	1.33	0.97	5.80
Garst 6420	Garst	1.94	1.48	1.27	1.03	5.75
Millennia	IFA	1.93	1.52	1.24	0.97	5.72
ZX 9451	ABI	1.86	1.55	1.33	0.95	5.72
DK 140	DEKALB	1.93	1.52	1.24	1.00	5.70
WL 325 HQ	Germains	1.86	1.60	1.21	0.94	5.67
TMF Multiplier II	Mycogen	1.87	1.51	1.29	0.93	5.65
ZX 9453	ABI	1.70	1.55	1.28	1.01	5.58
ABT 350	ABT	1.81	1.53	1.26	0.92	5.57
Archer	America's Alfalfa	1.75	1.54	1.21	1.00	5.56
Archer II	America's Alfalfa	1.77	1.47	1.32	0.95	5.56
Innovator+Z	America's Alfalfa	1.87	1.44	1.21	0.95	5.49
Reno	Novartis Seeds	1.71	1.53	1.25	0.95	5.48
Baralfa 54	Seekamp Seed	1.69	1.48	1.32	0.93	5.47
TMF 421	Mycogen	1.85	1.52	1.16	0.87	5.47
DK 134	DEKALB	1.65	1.50	1.27	0.95	5.42
Ranger	public	1.60	1.33	1.19	0.86	5.03
Ladak	public	1.43	1.34	1.20	0.80	4.83
Ave.		1.81	1.50	1.25	0.95	5.56
CV (%)		10.7	6.3	6.8	5.9	4.1
LSD (0.05)		0.28	0.13	NS[†]	0.08	0.32

[†]NS, Not significant at the 5% level of probability.

Table 11. *In vitro* digestible dry matter yield of 20 alfalfa varieties grown at Fruita 2000.

Variety	Brand/Source	1st Cut 17 May	2nd Cut 7 July	3rd Cut 23 Aug.	4th Cut 2 Oct.	2000 Total dry matter yield
		-------------------------------tons/acre[3]				---------------------------
Focus HSN	Arkansas Valley Seeds	2.01	1.84	1.87	0.82	6.65
Garst 6420	Garst	2.12	1.79	1.72	0.83	6.57
ZX 9453	ABI	2.05	1.76	1.78	0.89	6.57
DK 142	DEKALB	2.07	1.82	1.75	0.79	6.54
TMF Multiplier II	Mycogen	2.10	1.80	1.69	0.82	6.51
Millennia	IFA	2.02	1.79	1.76	0.83	6.50
WL 232 HQ	Germains	2.12	1.83	1.69	0.77	6.49
Reno	Novartis Seeds	2.05	1.78	1.75	0.80	6.49
ABT 350	ABT	2.12	1.81	1.66	0.75	6.44
ZX 9451	ABI	2.01	1.71	1.82	0.81	6.41
DK 140	DEKALB	2.11	1.76	1.66	0.78	6.39
WL 325 HQ	Germains	2.02	1.73	1.72	0.80	6.34
DK 134	DEKALB	2.00	1.73	1.71	0.78	6.34
Baralfa 54	Seekamp Seed	1.98	1.75	1.74	0.78	6.34
Innovator+Z	America's Alfalfa	2.02	1.78	1.73	0.69	6.31
TMF 421	Mycogen	2.05	1.76	1.65	0.73	6.28
Archer	America's Alfalfa	1.94	1.69	1.80	0.77	6.28
Ranger	public	1.92	1.81	1.72	0.75	6.28
Archer II	America's Alfalfa	1.96	1.75	1.70	0.77	6.27
Ladak	public	1.88	1.68	1.71	0.74	6.11
Ave.		2.03	1.77	1.73	0.78	6.41
CV (%)		5.9	6.1	5.9	7.6	3.5
LSD (0.05)		NS†	NS†	NS†	0.09	NS†

†NS, Not significant at the 5% level of probability.

Table 12. *In vitro* digestible dry matter yield of 20 alfalfa varieties grown at Fruita 2001.

Variety	Brand/Source	1st Cut 21 May	2nd Cut 6 July	3rd Cut 27 Aug.	4th Cut 2 Oct.	2001 Total dry matter yield
		---------------------------------tons/acre[3]-------------------------				
Millennia	IFA	1.60	1.41	1.66	0.97	5.70
Focus HSN	Arkansas Valley Seeds	1.67	1.32	1.73	0.85	5.65
Reno	Novartis Seeds	1.59	1.27	1.70	0.85	5.48
Baralfa 54	Seekamp Seed	1.58	1.23	1.63	0.87	5.37
WL 325 HQ	Germains	1.48	1.43	1.55	0.82	5.35
WL 232 HQ	Germains	1.58	1.31	1.60	0.73	5.30
ZX 9453	ABI	1.50	1.34	1.47	0.88	5.25
TMF Multiplier II	Mycogen	1.48	1.12	1.75	0.79	5.21
Archer II	America's Alfalfa	1.46	1.41	1.41	0.85	5.20
Archer	America's Alfalfa	1.38	1.38	1.49	0.84	5.16
DK 140	DEKALB	1.44	1.25	1.55	0.80	5.11
DK 134	DEKALB	1.42	1.22	1.59	0.76	5.06
ZX 9451	ABI	1.46	1.26	1.46	0.82	5.05
DK 142	DEKALB	1.37	1.12	1.59	0.75	4.91
TMF 421	Mycogen	1.44	1.21	1.47	0.70	4.90
Innovator+Z	America's Alfalfa	1.39	1.14	1.56	0.67	4.85
Ladak	public	1.34	1.02	1.62	0.61	4.68
Ranger	public	1.36	1.02	1.54	0.65	4.64
ABT 350	ABT	1.36	1.16	1.33	0.69	4.61
Garst 6420	Garst	1.16	0.97	1.50	0.78	4.46
Ave.		1.45	1.23	1.56	0.78	5.10
CV (%)		13.0	7.5	9.3	8.9	6.5
LSD (0.05)		NS†	0.13	0.21	0.10	0.47

†NS, Not significant at the 5% level of probability.

Table 13. Three-year total crude protein of 20 alfalfa varieties grown at Fruita 1999-2001.

Variety	Crude protein 3-year yield
	tons/acre
WL 232 HQ	5.75
Focus HSN	5.67
Millennia	5.65
WL 325 HQ	5.59
Reno	5.45
DK 142	5.37
TMF 421	5.35
ZX 9451	5.35
TMF Multiplier II	5.35
Archer	5.34
DK 140	5.34
ZX 9453	5.29
Archer II	5.25
Innovator+Z	5.25
DK 134	5.23
Baralfa 54	5.14
Garst 6420	5.07
ABT 350	5.06
Ranger	4.93
Ladak	4.80
Ave.	5.31
CV (%)	3.26
LSD (0.05)	0.25

Table 14. Three-year total digestible dry matter production of 20 alfalfa varieties grown at Fruita 1999-2001.

Variety	*In vitro* digestible dry matter yield
	tons/acre
Focus HSN	18.10
Millennia	17.91
WL 232 HQ	17.65
Reno	17.45
ZX 9453	17.40
TMF Multiplier II	17.36
WL 325 HQ	17.36
DK 142	17.30
DK 140	17.20
ZX 9451	17.19
Baralfa 54	17.18
Archer II	17.04
Archer	17.00
DK 134	16.81
Garst 6420	16.77
TMF 421	16.66
Innovator+Z	16.65
ABT 350	16.63
Ranger	15.95
Ladak	15.61
Ave.	17.06
CV (%)	2.80
LSD (0.05)	0.68

Table 15. Forage yields of 20 alfalfa varieties at Fruita, 1999-2001[1].

Variety	Brand/Source	2001 Total	2000 Total	1999 Total	3-yr Total[2]
		----------tons/acre[3]----------			
Focus HSN	Arkansas Valley Seeds	8.34	9.85	8.74	26.93
Millennia	IFA	8.44	9.72	8.68	26.84
ZX 9453	ABI	7.88	9.94	8.60	26.42
WL 232 HQ	Germains	7.73	9.57	8.70	26.00
Baralfa 54	Seekamp Seed	8.09	9.52	8.39	26.00
Reno	Novartis Seeds	8.12	9.64	8.18	25.94
Archer	America's Alfalfa	7.79	9.54	8.55	25.88
ZX 9451	ABI	7.52	9.66	8.70	25.88
Archer II	America's Alfalfa	7.81	9.52	8.51	25.84
DK 142	DEKALB	7.25	9.83	8.74	25.82
TMF Multiplier II	Mycogen	7.69	9.65	8.44	25.78
WL 325 HQ	Germains	7.83	9.34	8.39	25.55
DK 140	DEKALB	7.51	9.42	8.51	25.45
Garst 6420	Garst	6.63	9.87	8.69	25.19
DK 134	DEKALB	7.45	9.47	7.99	24.91
ABT 350	ABT	6.77	9.57	8.40	24.75
Innovator+Z	America's Alfalfa	7.14	9.29	8.20	24.62
TMF 421	Mycogen	7.16	9.21	8.08	24.45
Ranger	public	6.88	9.31	7.45	23.64
Ladak	public	6.91	9.09	7.20	23.20
Ave.		7.55	9.55	8.36	25.45
CV (%)		6.79	3.14	4.16	2.84
LSD (0.05)		0.72	0.42	0.49	1.03

[1]Seeded 27 Aug. 1998.
[2]Table is arranged by decreasing 3-year total yield.
[3]Yields were calculated on an air-dry basis.

IRRIGATED PASTURES AND OTHER FORAGES

FORAGE PEA STUDY

Ron F. Meyer

Introduction

Irrigated forage production in the Colorado High Plains has been increasing. Producers are looking for flexible forage production options that fit into High Plains cropping systems. In addition, irrigation wells within the High Plains region have been losing capacity. Many of these wells are strained to pump enough water just to meet the evapotranspiration demands of some summer crops.

Materials and Methods

During the 2003 growing season, forage peas were planted in combination with triticale and oats (Table 1). Three pea varieties (Arvika, Forager, and Salute) were investigated along with two oat varieties (114 and 126) and one triticale variety (Lazer). Data were obtained for yield, crude protein, acid detergent fiber (ADF), total digestible nutrients (TDN), Ca, P, and nitrate-nitrogen. All data are reported on a dry matter basis. Plots were 5 ft. wide by 33 ft. long. The experiment was a randomized complete block design with three replications. Plots were planted on 25 March 2003 and harvested on 16 June 2003. Harvested area was 3 ft. wide by 30 ft. long. No herbicides or fertilizers were applied. The study was sprinkler-irrigated with a center pivot system and 4 in. of irrigation water were applied during the growing season. The study was located at the Glenn Adolf farm near Burlington, Colorado (elevation 4,220 ft. above sea level).

Results and Discussion

Yield and forage quality of the triticale, oat, and pea varieties are presented in Table 2. Lazer triticale, planted as a sole crop, was one of the highest yielding entries while Arvika and Salute peas as a sole crop yielded the lowest. Planting Lazer triticale with Arvika and Forager peas increased yields over planting the peas alone, but Lazer did not increase yield when planted with Salute peas. Oats (126) planted with Forager peas did not yield as well as the Forager pea/Lazer triticale mix. Oats (114) planted alone was the fourth highest yielding entry.

Crude protein was highest in the Arvika pea, Salute pea, Forager pea/oat, and oat (114) entries. The addition of Lazer triticale to forage peas decreased protein levels, but yields were increased. Further, the oat entries studied appeared to have the potential to increase protein levels similar to levels expressed by peas alone.

The addition of forage peas to Lazer triticale did not affect levels of ADF, TDN, Ca, P, or nitrate-nitrogen. Oats, however, had higher protein, TDN, and nitrate-nitrogen than triticale, but lower levels of ADF. Calcium levels between oats and triticale were similar.

TDN levels were highest in oats (114) and the Arvika and Salute peas and lowest in entries that contained Lazer triticale.

Legumes tend to have higher levels of Ca compared to grasses. The highest levels of Ca in this study were found in the Arvika and Salute peas planted as a sole crop.

Nitrate-nitrogen levels were highest in the Forager pea/oat and oat (114) entries, but were below toxic levels.

Summary

Producers concerned with only yield should consider planting triticale alone. Planting oats alone will provide a balance between yield and forage quality. The yield for oats was acceptable at 3.2 tons/acre, but the oats had significantly higher crude protein and TDN levels compared to the triticale. Planting forage peas with triticale has the potential to improve forage quality, but only marginally. In order to make a difference in forage quality, peas should contribute a larger percentage to total yield. Keep in mind these data are for one year only. Often data obtained in field studies must be collected over 2 or more years in order to draw meaningful conclusions.

Table 1. Seeding rates of various triticale, oat, and pea varieties grown under irrigation on the Glenn Adolf farm near Burlington, Colorado in 2003.

Forage Species/Variety	Seeding Rate lbs/acre
Arvika Pea/Lazer Triticale	70/70
Lazer Triticale	140
Forager Pea/Lazer Triticale	70/70
Oats (114)	100
Forager Pea/Oats (126)	70/140
Salute Pea/Lazer Triticale	100/30
Salute Pea	110
Arvika Pea	110

Table 2. Yield and forage quality of various triticale, oat, and pea varieties grown under irrigation on the Glenn Adolf farm near Burlington, Colorado in 2003.

Forage Species/Variety	Yield tons/acre	Protein %	ADF %	TDN %	Ca %	P %	NO_3-N ppm
Arvika Pea/Lazer Triticale	4.00a	13.5b	43.7abc	53.6cde	0.41b	0.35bc	1147d
Lazer Triticale	3.97a	12.6b	45.4a	51.7e	0.39b	0.33c	1488cd
Forager Pea/Lazer Triticale	3.67abc	14.4b	42.0bcd	55.5bcd	0.42b	0.33c	1315cd
Oats (114)	3.20abcd	19.5a	36.0e	62.2a	0.59b	0.39abc	2400b
Forager Pea/Oats (126)	3.00bcd	18.1a	40.9cd	56.8bc	0.63b	0.45ab	4087a
Salute Pea/Lazer Triticale	2.70cd	16.0ab	44.8ab	52.4de	0.52b	0.37abc	1698c
Salute Pea	2.30de	18.1a	39.7d	58.2b	1.03a	0.38abc	421e
Arvika Pea	1.56e	19.3a	39.9d	57.9b	0.99a	0.48a	387e

Means within a column followed by the same letter are not different from one another. Data are reported on a dry matter basis.

PASTURE GRASS SPECIES EVALUATION AT FRUITA 1995-2001

Calvin H. Pearson

Summary

A pasture grass species study was conducted at the Western Colorado Research Center at Fruita in which forage yields of 16 grass entries were determined for 7 years from 1995 through 2001. Yield, averaged across all varieties, for the 7-year total was 28.25 tons/acre. Hay yields totaled across the 7 years of this study ranged from a high of 43.88 tons/acre for 'Blackwell' switchgrass to a low of 21.34 tons/acre for 'Palaton' reed canarygrass. High-yielding entries over the testing period were 'Blackwell' switchgrass and 'Fawn' tall fescue, the same ones as in many individual years. Other entries that were good forage producers for the testing period were Economy pasture mix, 'Regar' meadow brome, and 'Newhy' hybrid wheatgrass. Total annual yield, averaged across all entries, was 6.47 tons/acre in 1995, 3.58 tons/acre in 1996, 5.02 tons/acre in 1997, 3.17 tons/acre in 1998, 3.83 tons/acre in 1999, 3.18 tons/acre in 2000, and 2.99 tons/acre in 2001.

Introduction

Grass hay, an important feed for livestock throughout Colorado, is produced in pastures, meadows, and other grasslands. Many farmers and ranchers depend on these grasses, not only for hay production, but also for grazing, wildlife habitat, and ecological services such as erosion control and streambank stabilization. They also serve in crop rotations and cropping system needs.

Fig. 1. Pasture plots at the Western Colorado Research Center at Fruita in 1995. Photo by Calvin Pearson. 31 May 1995.

Evaluation and performance studies of pasture grass and forage legume species have been conducted in past years in Colorado; however, with the release of new cultivars and other technological advances in forages, additional studies are warranted. The objectives of this research were to identify grass species/mixtures that produce high yields and high forage quality, and to assess weed competition and stand persistence among the 16 entries included in the study. Forage quality of these grass entries was determined in 1996, 1997, and 1999 and the results were presented in an earlier report (Pearson, 2000).

Materials and Methods

The study was conducted at the Colorado State University Western Colorado Research Center at Fruita (Fig. 1). The experiment was a randomized, complete block with four replications. The soil was a Glenton very fine sandy loam. The elevation at Fruita is 4510 ft. The average annual precipitation is 8.4 in. and the average frost-free days are 181. The length of the growing season, based on the number of frost-free days, was calculated for each year of the testing period using a 28°F base (Table 1).

Plots were planted on 22 Apr. 1994. Fertilizer applications for each year are shown in Table 2. Split applications of nitrogen were used and typically applied after a cutting just prior to irrigation. The use of herbicides in this study was avoided in an attempt to determine which grass entries were most competitive against weeds without requiring additional production inputs. Plots were harvested with an automated, forage plot harvester that was designed and built at the Fruita Research Center (Pearson and Robinson, 1994). The forage plot harvester has been used in our forage plot research for many years and has been an efficient and reliable piece of research equipment. During harvest, a small forage sample was obtained from each plot for moisture determination. Yields were calculated based on the moisture content of air-dried samples.

Results and Discussions

Three cuttings were done each year. Dates for each cutting for the 7-year testing period are shown in Table 3. The first cutting was typically done from early May to early June. The second cutting was usually done in July or August and the third cutting was usually done sometime in late September or October.

Plots were evaluated for weed infestation at the conclusion of the study in fall 2001. Notes and observations from this evaluation are shown in Table 4. Dandelion was the predominant weed species in the plots. Other weeds that occurred from time to time were buckhorn plaintain, foxtails, and purslane. 'Fawn' tall fescue and Economy pasture mix were very weed-free. These same two entries, along with Premium pasture mix, had very good to excellent stands.

Forage yields for the pasture grass species are presented in Table 5. Average total hay yield in 1995 was 6.47 tons/acre. Hay yields in 1995 ranged from a high of 8.63 tons/acre for 'Blackwell' switchgrass to a low of 4.57 tons/acre for 'Bozoisky-Select' Russian wildrye.

Average total hay yield in 1996 was 3.58 tons/acre. Hay yields in 1996 ranged from a high of 5.51 tons/acre for 'Blackwell' switchgrass to a low of 2.70 tons/acre for 'Palaton' reed canarygrass.

Average total hay yield in 1997 was 5.02 tons/acre, ranging from a high of 6.92 tons/acre for 'Fawn' tall fescue to a low of 3.88 tons/acre for 'Oahe' intermediate wheatgrass. Average total hay yield in 1998 was 3.17 tons/acre, ranging from a high of 6.48 tons/acre for 'Blackwell' switchgrass to a low of 2.26 tons/acre for 'Palaton' reed canarygrass.

Total hay yield in 1999 averaged 3.83 tons/acre, ranging from a high of 5.88 tons/acre for 'Blackwell' switchgrass to a low of 2.54 tons/acre for 'Palaton' reed canarygrass.

Total hay yield in 2000 averaged 3.18 tons/acre, ranging from a high of 5.16 tons/acre for 'Blackwell' switchgrass to a low of 2.22 tons/acre for 'Palaton' reed canarygrass.

Average hay yield in the first cutting in 2001 was 0.86 tons/acre, ranging from a high of 1.50 tons/acre for 'Fawn' tall fescue to a low of 0.37 tons/acre for 'Latar' orchardgrass. 'Fawn' tall fescue outyielded other entries in the first cutting in 2001. Figures 2 and 3 show the plots in July and October 2001.

Average hay yield in the second cutting in 2001 was 0.98 tons/acre, ranging from a high of 3.03 tons/acre for 'Blackwell' switchgrass to a low of 0.72 tons/acre for 'Potomac' orchardgrass.

Average hay yield in the third cutting in 2001 was 1.15 tons/acre, ranging from a high of 1.99 tons/acre for 'Blackwell' switchgrass to a low of 0.95 tons/acre for 'Manchar' smooth brome. All but three entries yielded less than 1.20 tons/acre in the third cutting in 2001 and these 13 entries did not have significantly different yields.

Average total hay yield in 2001 was 2.99 tons/acre, ranging from a high of 6.02 tons/acre for 'Blackwell' switchgrass to a low of 2.27 tons/acre for 'Palaton' reed canarygrass. High-yielding entries in 2001 were 'Blackwell' switchgrass, 'Fawn' tall fescue, and

Fig. 2. Pasture plots at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson. 18 July 2001.

Economy pasture mix.

Average yield across all 16 entries for the 7-year total was 28.25 tons/acre. Hay yields, totaled across the 7 years of this study, ranged from a high of 43.88 tons/acre for ‘Blackwell’ switchgrass to a low of 21.34 tons/acre for ‘Palaton’ reed canarygrass. High-yielding entries over this seven-year testing period were ‘Blackwell’switchgrass and ‘Fawn’ tall fescue, the same ones as in most individual years. Other entries that were good forage producers were Economy pasture mix, ‘Regar’ meadow brome, ‘Newhy’ hybrid wheatgrass, and ‘Luna’ pubescent wheatgrass.

This research showed that switchgrass can be highly productive as a pasture grass in western Colorado. Historically, cool-season grasses have been used almost exclusively in western Colorado. This research also shows that warm-season grasses can be produced in the warm, valley areas of western Colorado; however, the management of warm-season grasses would be different from that of cool-season grass pastures. For example, weed control in a warm-season grass pasture would be different than in a cool-season grass pasture. Winter annual weeds and early spring weeds would be much more likely to cause problems in warm-season pastures than cool-season pastures and this difference would necessitate weed management strategies for a warm-season pasture. Another difference between warm- and cool-season pastures is the ontogeny of their forage production. While cool-season grass pastures are most productive in the spring and fall, warm-season grass pastures in western Colorado would be more productive in the summer and early fall. This choice would affect how a warm-season grass pasture is managed for optimum grazing. Additionally, the quantities of hay available for feeding or marketing after each cutting would be different for warm-season grass pastures than for cool-season grass pastures.

Fig. 3. Pasture plots at the Western Colorado Research Center at Fruita. Photo by Calvin Pearson. 16 October 2001.

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Table 1. Last spring frost and first fall frost and the number of frost-free days (28°F threshold) for each year in the pasture grass species evaluation study conducted at Fruita 1995-2001.

Year	Last spring frost	First fall frost	Number of frost-free days
1995	24 Apr. 1995	14 Oct. 1995	173
1996	29 Apr. 1996	27 Sept. 1996	151
1997	2 May 1997	13 Oct. 1997	164
1998	19 Apr. 1998	18 Oct. 1998	182
1999	17 Apr. 1999	17 Oct. 1999	183
2000	4 Apr. 2000	14 Oct. 2000	193
2001	13 Apr. 2001	24 Oct. 2001	194

Table 2. Fertilizer applied each year in the pasture grass species evaluation study conducted at Fruita 1995-2001.

Year	Fertilizer Application
1995	36 lbs N/acre and 92 lbs P_2O_5/acre using 18-46-0 on 28 Sept. 1994. 120 lbs N/acre as ammonium nitrate on 27 Feb. 1995. 40 lbs N/acre as ammonium nitrate on 15 Aug. 1995. 36 lbs N/acre and 92 lbs P_2O_5/acre using 18-46-0 on 13 Oct. 1995.
1996	50 lbs N/acre as ammonium nitrate on 14 May 1996. 75 lbs N/acre as ammonium nitrate on 19 June 1996. 22 lbs N/acre and 110 lbs P_2O_5/acre using 11-52-0 on 23 Sept. 1996.
1997	100 lbs N/acre as ammonium nitrate on 10 Mar. 1997. 60 lbs N/acre as ammonium nitrate on 2 June 1997. 75 lbs N/acre as ammonium nitrate on 24 July 1997.
1998	22 lbs N/acre and 104 lbs P_2O_5/acre using 11-52-0 on 16 Mar. 1998. 75 lbs N/acre as ammonium nitrate on 1 June 1998. 76 lbs N/acre as ammonium nitrate on 31 July 1998. 36 lbs N/acre and 92 lbs P_2O_5/acre using 18-46-0 on 9 Oct. 1998.
1999	50 lbs N/acre as ammonium nitrate on 2 Mar. 1999. 73 lbs N/acre as ammonium nitrate on 11 June 1999. 55 lbs N/acre as ammonium nitrate on 31 Aug. 1999.
2000	50 lbs N/acre as ammonium nitrate on 29 Feb. 2000. 70 lbs N/acre as ammonium nitrate on 24 May 2000. 50 lbs N/acre as ammonium nitrate on 24 July 2000. 22 lbs N/acre and 104 lbs P_2O_5/acre using 11-52-0 on 30 Oct. 2000.
2001	50 lbs N/acre as ammonium nitrate on 29 Feb. 2001. 75 lbs N/acre as ammonium nitrate on 29 May 2001. 65 lbs N/acre as ammonium nitrate on 30 July 2001.

Table 3. Harvest dates for each cutting of the pasture grass species evaluation conducted at Fruita, 1995-2001.

Year	Cutting 1	Cutting 2	Cutting 3
1995	12 June	7 August	10 October
1996	9 May	17 June	13 August
1997	23 May	18 July	1 October
1998	27 May	21 July	29 September
1999	3 June	19 August	12 October
2000	19 May	19 July	17 October
2001	23 May	25 July	1 October

Table 4. Visual evaluation of pasture grass plots on 18 Nov. 2001.

	Notes/observations		
Pasture Grass	Weeds	Other grasses	Stand
‘RS-H’ experimental	some to considerable	increasing	thinning
‘Newhy’ hybrid wheatgrass	considerable	some	thinning
‘Regar’ meadow brome	some	some	variable
‘Lincoln’ smooth brome	some	some to considerable	good
‘Manchar’smooth brome	variable	some	variable
‘Potomac’ orchardgrass	some	none to some	very good to thinning
‘Latar’ orchardgrass	some	none to some	thinning
‘Luna’ pubescent wheatgrass	considerable	some to considerable	thinning
‘Climax’ timothy	some to considerable	some to considerable	variable
‘Bozoisky-Select’ Russian wildrye	some to considerable	some to considerable	quite thin
‘Fawn’ tall fescue	none	none	excellent
‘Palaton’ reed canarygrass	some to considerable	some to considerable	considerable thinning
‘Blackwell’ switchgrass	some	some	good
‘Oahe’ intermediate wheatgrass	considerable	some to considerable	thinning
Economy pasture mix	none	none	very good
Premium pasture mix	few	none	very good

Table 5. Hay yields[1] of irrigated pasture grasses at the Western Colorado Research Center at Fruita, 1995-2001.

Pasture Grass	1995 Total	1996 Total	1997 Total	1998 Total	1999 Total	2000 Total	1st cutting 23 May	2nd cutting 25 July	3rd cutting 1 Oct.	2001 Total	7-year Total
	-tons/acre-										
‘Blackwell’ switchgrass	8.63	5.51	6.21	6.48	5.88	5.16	1.00	3.03	1.99	6.02	43.88
‘Fawn’ tall fescue	8.40	4.64	6.92	5.05	5.36	4.58	1.50	1.00	1.35	3.85	38.81
Economy pasture mix[2]	6.21	3.58	6.22	3.81	5.19	4.30	1.12	0.92	1.38	3.41	32.73
‘Regar’ meadow brome	7.19	4.26	5.20	3.48	4.36	2.94	1.02	1.04	1.08	3.14	30.56
‘Newhy’ hybrid wheatgrass	7.37	3.77	4.69	3.11	3.79	3.22	1.07	0.79	1.03	2.88	28.83
‘Luna’ pubescent wheatgrass	7.36	3.92	4.94	2.95	3.39	2.89	0.99	0.80	0.96	2.75	28.19
Premium pasture mix[3]	6.08	3.10	5.48	2.82	3.98	3.14	0.67	0.84	1.16	2.66	27.26
‘Potomac’ orchardgrass	6.13	3.51	5.48	2.63	3.82	2.78	0.68	0.72	1.14	2.54	26.89
‘Climax’ timothy	5.74	3.39	4.82	2.97	3.72	3.09	0.91	1.10	0.98	2.98	26.72
‘RS-H’ experimental	6.89	3.45	4.09	2.62	3.18	2.90	0.89	0.74	1.08	2.71	25.83
‘Manchar’smooth brome	5.62	3.27	4.90	2.38	3.14	2.70	0.70	0.87	0.95	2.51	24.52
‘Lincoln’ smooth brome	5.75	2.86	4.56	2.48	3.38	2.75	0.83	0.80	1.08	2.71	24.49
‘Oahe’ intermediate wheatgrass	6.48	3.45	3.88	2.42	3.12	2.59	0.79	0.75	0.98	2.52	24.45
‘Latar’ orchardgrass	5.91	3.16	4.59	2.49	3.30	2.63	0.37	0.87	1.07	2.31	24.38
‘Bozoisky-Select’ Russian Wildrye	4.57	2.79	4.19	2.82	3.11	2.92	0.78	0.76	1.13	2.66	23.07
‘Palaton’ reed canarygrass	5.24	2.70	4.12	2.26	2.54	2.22	0.48	0.76	1.04	2.27	21.34
Average	6.47	3.58	5.02	3.17	3.83	3.18	0.86	0.98	1.15	2.99	28.25
LSD (0.05)	1.50	0.91	0.98	0.90	0.64	0.67	0.25	0.26	0.28	0.63	5.31
CV (%)	16.30	17.90	13.80	19.90	11.90	14.90	20.20	18.60	17.20	14.70	13.20

[1]Yields were calculated on an air-dry basis.
[2]Economy pasture mix consisted of 35% ‘Potomac’ orchardgrass, 25% ‘Fawn’ tall fescue, 20% ‘Lincoln’ smooth brome, and 20% tetraploid perennial ryegrass.
[3]Premium pasture mix consisted of 30% ‘Regar’ meadowbrome, 25% ‘Dawn’ orchardgrass, 25% ‘Potomac’ orchardgrass, and 20% tetraploid perennial ryegrass.

PASTURE GRASS, FORAGE LEGUME, AND MIXED SPECIES EVALUATION AT MEEKER 1997-2001

Calvin H. Pearson

Summary

Fifty combinations of single and mixed grass and forage legume species were evaluated for forage yield at Meeker, Colorado for five years from 1997 through 2001. A similar study was conducted at Hotchkiss, Colorado. Averaged across all 50 entries, forage yields at Meeker were 1.72 tons/acre in 1997, 2.89 tons/acre in 1998, 3.20 tons/acre in 1999, 2.20 tons/acre in 2000, and 2.73 tons/acre in 2001. The 5-year total forage yield, averaged across all 50 entries, was 12.73 tons/acres. Seven entries had high 5-year total yields. They were smooth brome+orchardgrass+meadow brome+alfalfa; smooth brome+alfalfa as a mixture, smooth brome+alfalfa in alternate seed rows, 'Newhy'+alfalfa in alternate seed rows, 'AV120' alfalfa, 'AV120' alfalfa+'Norcen' birdsfoot trefoil, and smooth brome+orchardgrass+intermediate wheatgrass+alfalfa. Low yielding entries were 'Climax' timothy, 'Kaw' big bluestem, 'Praireland' Altai wildrye, 'Will' Ladino clover, redtop, and 'Garrison' creeping foxtail. This study provides empirical information on the performance of single and mixed species of grasses and legumes for forage production. Producers, crop consultants, seedsman, and others can use the results of this research project to aid them in selecting plant species and managing forages to fit farming and ranching operations.

Introduction

In 2001, alfalfa and grass hay was produced on 1.6 million acres and was valued at $472 million in Colorado (Colorado Agricultural Statistics, 2002). Alfalfa and grass hay is clearly an important agricultural product in Colorado. Irrigated and rainfed pastures and meadows, along with ranges are found throughout the mountain and valley areas of western Colorado. These crop and rangelands produce forage for grazing animals and hay for livestock. Forages are essential to support the large livestock industry of western Colorado.

Pastures, meadows, and ranges in western Colorado contain a diversity of forage plant species, some of which are native while others are introduced. Proper selection and management of grass and legume species for pastures, meadows, and ranges will affect the productivity of these forage lands during establishment and throughout the life of the field or range. The objectives of this research were to: 1) Identify grass and forage legume species and mixtures that produce high yields, 2) Determine the performance of cool- and warm-season grasses when planted in mixtures or in alternate seed rows, 3) Determine the performance of forage legumes when planted in mixtures or in alternate seed rows with a grass species, and 4) Assess grass and forage legume species for stand establishment, weed competition, and stand persistence. Fifty entries of single grass and forage legume species and mixed grass and legume species were evaluated at Meeker, Colorado for 5 years from 1997 through 2001.

Fig. 1. Forage plots at Meeker. 28 June 1998. Photo by Calvin Pearson.

Materials and Methods

The study was conducted at the Upper Colorado Environmental Plant Materials Center at Meeker, Colorado. The experiment was a randomized complete block design with four replications. Plot size was 10-ft. wide by 15-ft. long. The elevation at Meeker is 6240 ft. The mean maximum annual temperature is 60.4°F and the mean minimum annual temperature is 26.8°F. The length of the growing season, based on the number of frost-free days, was calculated for each year of the testing period using a 32°F base (Table 1).

The experiment was planted on 9 Aug. 1996. Most entries established well. Warm-season grasses did not establish by planting in late summer. All plots were replanted on 25 June 1997. This was done to thicken the stand in some plots and to attempt to establish the warm-season grasses. It was more convenient to replant all plots rather than selected ones.

Fertilizer applications for each year are presented in Table 2. No herbicides were applied at any time to the plots during the study.

The experiment was sprinkler-irrigated each year, generally four times or less, once or twice before the first cutting and once or twice before the second cutting. Plots were often not irrigated after the second cutting for the remainder of the year.

Fig. 2. Birdsfoot trefoil is a long-lived, non-bloating perennial legume.

Plots were harvested with an automated, forage plot harvester that was designed and constructed at the Fruita Research Center (Pearson and Robinson, 1994). This automated, forage plot harvesting system has been used for many years and has performed extremely well. During harvest, a small forage sample was obtained from each plot for moisture determination. Yields were calculated based on the moisture content of air-dried samples.

Results and Discussion

Plots were planted in late summer 1996. Two cuttings were obtained each year. The first cutting was typically done in late May to mid-June and the second cutting was done in early September with the exception of an 11 August second cutting harvest in 2000. Dates for each cutting are shown in Table 3.

The data for the 1997 cutting reflect stand establishment and productivity of a new stand (Table 4). Total 1997 forage yield averaged 1.72 tons/acre, ranging from a high of 2.78 tons/acre for Entry 21 (‘Bromar’ mountain brome) to a low of 0.20 tons/acre for Entry 13 (‘Praireland’ altai wildrye). Fifteen entries had forage yields greater than 2.15 tons/acre in this first cutting. They were Entries 21, 46, 9, 48, 8, 50, 17, 47, 41, 7, 1, 49, 43, 20, and 37. Entries with high yields established more readily and were more productive than those entries with low yields.

Total 1998 forage yield averaged 2.89 tons/acre, ranging from a high of 4.75 tons/acre for Entry 33 (smooth brome+alfalfa planted in alternate seed rows) to a low of 0.81 tons/acre for Entry 1 (‘Matua’ bromegrass). Eight entries had high 1998 total yields. They were Entries 33, 37, 41, 46, 19, 26, 48, and 22.

Total 1999 forage yield averaged 3.20 tons/acre, ranging from a high of 5.27 tons/acre for Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+alfalfa) to a low of 0.11 tons/acre for Entry 18 (‘Kaw’ big bluestem). Eight entries had high 1999 total yields. They were Entries 48, 37, 33, 46, 22, 19, 41, and 26.

Total 2000 forage yield averaged 2.20 tons/acre, ranging from a high of 4.76 tons/acre for Entry 33 (smooth brome+alfalfa in alternate seed rows) and Entry 19 ('AV120' alfalfa) to a low of 0.49 tons/acre for Entry 2 ('Garrison' creeping foxtail) and Entry 14 ('Dacotah' switchgrass). Nine entries had high 2000 total yields. They were Entries 33, 19, 48, 37, 22, 46, 26, 27, and 41.

Total 2001 forage yield averaged 2.73 tons/acre, ranging from a high of 4.80 tons/acre for Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+ alfalfa) to a low of 0.97 tons/acre for Entry 14 ('Dacotah' switchgrass). Eleven entries had high 2001 total yields. They were Entries 48, 37, 33, 35, 41, 26, 27, 22, 46, 19, and 39.

Averaged across all 50 entries, forage yields in the first cutting in 2001 were 1.95 tons/acre, ranging from a high of 3.08 tons/acre for Entry 34 (smooth brome+birdsfoot trefoil) to a low of 0.74 tons/acre for Entry 3 ('Venture' reed canarygrass). Fourteen entries were high yielding in the first cutting in 2001.

Forage yields in the second cutting in 2001 averaged 0.78 tons/acre, ranging from a high of 1.84 tons/acre for Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+alfalfa) to a low of 0.18 tons/acre for Entry 18 ('Garnet' mountain brome). Nine entries were high yielding in the second cutting in 2001. They were Entries 48, 37, 41, 26, 33, 35, 27, 19, and 22. The data for these two cuttings in 2001 are similar to those of other years in that the yields of the first cutting were higher than the yields of the second cutting.

The 5-year total yield averaged 12.73 tons/acre, ranging from a high of 21.89 tons/acre for Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+alfalfa) to a low of 2.89 tons/acre for Entry 14 ('Dakotah' switchgrass). Eight entries produced high yields over the five-year testing period. They were Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+alfalfa), Entry 37 (smooth brome+ alfalfa planted as a seed mixture), Entry 33 (smooth brome+alfalfa in alternate seed rows), Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa), Entry 41 ('Newhy'+alfalfa in alternate seed rows), Entry 19 ('AV120' alfalfa), Entry 26 (alfalfa+birdsfoot trefoil), and Entry 22 ('Spredor III' alfalfa).

It has been suggested that improved forage production could be achieved by planting mixtures in separate seed rows rather than planting different plant species as a seed mixture. We tested this idea by planting several plant species (two-specie mixes) with each of the two plant species planted in their own seed row versus planting the two species as a typical seed mixture. Data for smooth brome+alfalfa, smooth brome+birdsfoot trefoil, smooth brome+cicer milkvetch, and smooth brome+sainfoin planted in alternate seed rows and as a seed mixture were analyzed statistically. Forage yields of planting in alternate seed rows or as a seed mixture were not significantly different for any of these entries in any of the testing years or in the 5-year total forage yield. These results indicate there is no advantage to planting a plant specie in its own seed row. These results also indicate that the traditional method of combining seeds of different compatible plant species and then planting them as a homogenous seed mixture continues to be an acceptable practice for forage production.

At the conclusion of the study, plots were evaluated visually and observations regarding plant stand, weeds, and plant growth were noted (Table 5). Considerable differences existed among the entries for weeds, stand, and growth. A number of the entries had excellent stands, were very weed-free, although some alfalfa invasion was common in many plots.

References

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Acknowledgments

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Fig. 3. Forage plots at Meeker. 31 July 2000. Photo by Calvin Pearson.

Table 1. Last spring frost and first fall frost and the number of frost-free days (32°F threshold) for each year in the pasture grass species evaluation study conducted at Meeker 1997-2001.[1]

Year	Last spring frost	First fall frost	Number of frost-free days
1997	27 May	8 October	132
1998	18 June	5 October	106
1999	7 June	21 September	103
2000	19 May	25 September	125
2001	15 June	7 September	83

[1]Data were provided courtesy of Dr. Gary Noller of the Meeker Plant Materials Center.

Table 2. Fertilizer applied each year in the pasture grass species evaluation study conducted at Meeker 1997-2001.

Year	Fertilizer Application
1997	50 lbs N/acre as ammonium nitrate on 14 May 1997. 73 lbs N/acre and 104 lbs P_2O_5/acre as 11-52-0 and ammonium nitrate on 25 Aug. 1997.
1998	46 lbs N/acre as ammonium nitrate on 7 July 1998.
1999	46 lbs N/acre as ammonium nitrate on 6 July 1999. 15 lbs N/acre and 70 lbs P_2O_5/acre as 11-52-0 on 15 Sept. 1999.
2000	46 lbs N/acre as ammonium nitrate on 27 June 2000. 46 lbs N/acre as ammonium nitrate on 22Aug. 2000. 15 lbs N/acre and 70 lbs P_2O_5/acre using 11-52-0 on 3 Oct. 2000.
2001	46 lbs N/acre as ammonium nitrate on 3 July 2001.

Table 3. Harvest dates for each cutting of the pasture grass species evaluation conducted at Meeker 1997-2001.

Year	Cutting 1	Cutting 2
1997	18 June	8 September
1998	29 June	2 September
1999	1 July	9 September
2000	21 June	11 August
2001	21 June	11 September

Table 4. Forage yields of 50 single and mixed species of pasture grasses and forage legumes at Meeker, 1997-2001.

Entry	1997 Total	1998 Total	1999 Total	2000 Total	2001 Total	Cut 1 21 June 2001	Cut 2 11 Sept. 2001	5-Yr Total
	tons/acre[1]							
1. Smooth brome ‘Liso’[†]	2.27	0.81	0.21	1.08	1.82	1.57	0.24	6.18
2. Creeping foxtail ‘Garrison’	0.82	1.56	1.93	0.49	1.68	1.46	0.23	6.48
3. Reed canarygrass ‘Venture’	1.04	1.92	2.08	0.75	1.18	0.74	0.45	6.97
4. Tall fescue ‘Advance’	1.76	2.38	2.36	0.73	1.86	1.22	0.64	9.10
5. Orchardgrass ‘Duke’	2.00	2.24	2.73	1.03	1.87	1.23	0.64	9.86
6. Orchardgrass ‘Tekapo’	1.45	1.62	2.26	0.80	1.72	0.87	0.84	7.85
7. Meadowbrome ‘Fleet’	2.27	2.91	3.47	1.57	2.84	2.38	0.46	13.06
8. Intermediate wheatgrass ‘Oahe’	2.66	3.09	3.08	1.56	2.06	1.67	0.39	12.45
9. Pubescent wheatgrass ‘Luna’	2.77	3.15	3.39	1.70	2.11	1.80	0.31	13.11
10. Slender wheatgrass ‘San Luis’	1.37	1.84	1.99	0.99	1.66	1.31	0.35	7.86
11. Hybrid wheatgrass ‘Newhy’	1.87	2.85	3.60	1.98	3.05	2.04	1.01	13.35
12. Beardless wildrye ‘Shoshone’	0.49	1.42	2.09	1.20	1.97	1.54	0.43	7.15
13. Big bluestem ‘Bison’[†]	0.20	1.36	0.14	0.52	0.99	0.77	0.22	3.20
14. Switchgrass ‘Dacotah’[†]	0.21	1.01	0.22	0.49	0.97	0.79	0.18	2.89
15. Timothy ‘Climax’	1.39	1.85	1.90	0.65	1.57	1.06	0.52	7.37
16. Tall fescue ‘Enforcer’	1.67	2.57	2.94	1.05	2.10	1.41	0.70	10.33
17. Intermediate wheatgrass ‘Rush’	2.58	3.12	3.21	1.73	2.67	2.12	0.55	13.31
18. Mountain brome ‘Garnet’[†]	0.63	1.99	0.11	0.80	1.66	1.48	0.18	5.18
19. Alfalfa ‘AV120'	2.01	4.39	4.72	4.76	4.04	2.55	1.49	19.92
20. Forage chicory ‘LaCerta’	2.22	2.00	2.21	1.26	1.53	1.17	0.36	9.21
21. Mountain brome ‘Bromar’	2.78	1.72	2.06	0.83	1.39	0.90	0.49	8.79
22. Alfalfa ‘Spredor III’	1.89	4.06	4.81	4.61	4.15	2.67	1.48	19.51
23. Birdsfoot trefoil ‘ARS2620'	0.34	3.14	3.95	3.46	3.49	2.43	1.06	14.38
24. Ladino clover ‘Will’	0.38	1.44	1.34	1.47	1.90	1.55	0.35	6.52
25. Redtop	0.98	1.45	2.03	1.15	1.52	1.07	0.45	7.12
26. Alfalfa ‘AV120' + Birdsfoot trefoil ‘Norcen’	1.88	4.35	4.66	4.60	4.26	2.62	1.64	19.74
27. Cicer milkvetch ‘Windsor’	0.95	3.74	4.15	4.50	4.21	2.64	1.57	17.55
28. Sainfoin ‘Remont’	0.87	3.31	4.50	3.61	2.73	2.38	0.35	15.01
29. Switchgrass + Newhy (alternate seed rows)	1.50	2.58	2.81	1.45	2.33	1.63	0.70	10.66
30. Switchgrass + tall fescue (alternate seed row)	1.59	2.85	2.79	1.31	2.23	1.61	0.62	10.77

Table 4 (continued). Forage yields of 50 single and mixed species of pasture grasses and forage legumes at Meeker, 1997-2001.

Entry	1997 Total	1998 Total	1999 Total	2000 Total	2001 Total	Cut 1 21 June 2001	Cut 2 11 Sept. 2001	5-Yr Total
	tons/acre[1]							
31. Switchgrass + Newhy (mixed)	2.07	2.62	2.78	1.09	2.48	1.80	0.68	11.03
32. Switchgrass + tall fescue (mixed)	1.63	2.52	2.47	0.95	1.86	1.29	0.57	9.42
33. Smooth brome + alfalfa (alternate seed rows)	2.05	4.75	5.24	4.76	4.68	3.07	1.61	21.49
34. Smooth brome + birdsfoot trefoil (alternate seed rows)	1.82	3.77	4.20	2.67	3.88	3.08	0.80	19.33
35. Smooth brome + cicer milkvetch (alternate seed rows)	1.93	3.76	4.55	3.64	4.39	2.80	1.60	18.27
36. Smooth brome + sainfoin (alternate seed rows)	1.44	3.64	4.11	2.51	3.33	2.61	0.73	15.02
37. Smooth brome + alfalfa (mixed)	2.15	4.69	5.26	4.63	4.78	3.01	1.77	21.50
38. Smooth brome + birdsfoot trefoil (mixed)	1.81	3.22	3.68	2.54	3.75	2.78	0.97	14.99
39. Smooth brome + cicer milkvetch (mixed)	1.84	3.80	4.61	3.43	4.03	2.75	1.27	17.71
40. Smooth brome + sainfoin (mixed)	1.50	3.38	4.53	2.99	3.03	2.42	0.61	15.43
41. Newhy + alfalfa (alternate seed rows)	2.40	4.59	4.68	4.47	4.39	2.66	1.73	20.53
42. Newhy + birdsfoot trefoil (alternate seed rows)	1.67	3.55	4.16	2.93	3.30	2.22	1.08	15.61
43. Newhy + cicer milkvetch (alternate seed rows)	2.23	3.66	4.26	3.63	3.28	2.24	1.05	17.06
44. Newhy + sainfoin (alternate seed rows)	1.78	3.25	4.03	2.49	2.79	2.15	0.64	14.33
45. Smooth brome + orchardgrass + meadow brome	1.88	2.63	3.24	1.66	3.05	2.44	0.61	12.45
46. Smooth brome + orchardgrass + meadow brome + alfalfa	2.77	4.51	4.86	4.61	4.09	2.96	1.13	20.83
47. Smooth brome + orchardgrass + intermediate wheatgrass	2.51	3.01	3.53	1.63	2.50	1.90	0.60	13.17
48. Smooth brome + orchardgrass + intermediate wheatgrass + alfalfa	2.76	4.33	5.27	4.73	4.80	2.96	1.84	21.89
49. Smooth brome +orchardgrass + meadow brome + creeping foxtail	2.26	2.90	3.07	1.18	1.97	1.53	0.44	11.37
50. Smooth brome 'Bounty'	2.63	3.51	3.57	1.28	2.56	2.31	0.25	13.54
Average	1.72	2.89	3.20	2.20	2.73	1.95	0.78	12.73
CV (%)	27.40	17.50	14.40	20.20	21.30	20.30	34.80	13.60
LSD (0.05)	0.66	0.71	0.64	0.62	0.81	0.55	0.38	2.42

In entries 29-49 we used 'Blackwell' switchgrass, 'Fawn' tall fescue, 'Manchar' smooth brome, 'AV120' alfalfa, 'Norcen' birdsfoot trefoil, 'Remont' sainfoin, 'Windsor' cicer milkvetch, 'Tekapo' orchardgrass, 'Regar' meadow brome, 'Oahe' intermediate wheatgrass, and 'Garrison' creeping foxtail

[1]Yields were calculated on an air-dry basis.

[†]'Liso' smooth brome, 'Dacotah' switchgrass, 'Bison' big bluestem, and 'Garnet' mountain brome were planted July 6, 1999 to replace 'Matua' bromegrass, 'Blackwell' switchgrass, 'Praireland' altai wildrye, and 'Kaw' big bluestem, respectively, that did not establish at Meeker.

Table 5. Notes and observations of 50 grass and mixed plant species at Meeker 7 May 2002.

Entry	Notes and Observations
1. Smooth brome ‘Liso’†	Stand is variable - weak to quite good; some dandelions present; some alfalfa has invaded.
2. Creeping foxtail ‘Garrison	Stand is good; some dandelions present; some alfalfa has invaded.
3. Reed canarygrass ‘Venture’	Stand is variable - thin to good; many dandelions present; some alfalfa and other grasses have invaded.
4. Tall fescue ‘Advance’	Stand is excellent; a few dandelions present; some alfalfa has invaded.
5. Orchardgrass ‘Duke’	Stand is good; mostly weed-free, a few dandelions present in one plot.
6. Orchardgrass ‘Tekapo’	Stand is good; one plot weed-free, a few dandelions and some alfalfa invading in one plot.
7. Meadowbrome ‘Fleet’	Stand is excellent; weed-free entry, some alfalfa invading in one plot.
8. Intermediate wheatgrass ‘Oahe’	Stand is excellent; a few dandelions, some alfalfa invading in one plot.
9. Pubescent wheatgrass ‘Luna’	Stand is very good; some dandelions present, some alfalfa invading in one plot.
10. Slender wheatgrass ‘San Luis’	Stand is variable - weak to okay; some dandelions present, some alfalfa and other grasses have invaded in one plot.
11. Hybrid wheatgrass ‘Newhy’	Stand is good to very good; some dandelions present, some alfalfa has invaded in one plot.
12. Beardless wildrye ‘Shoshone’	Stand is variable - poor to acceptable; considerable dandelions present, some grasses in one plot and alfalfa in another plot.
13. Big bluestem ‘Bison’†	Stand is poor to very poor; many dandelions present, other grasses in one plot and alfalfa in another plot.
14. Switchgrass ‘Dacotah’†	Stand is poor to very poor; many dandelions present.
15. Timothy ‘Climax’	Stand is good; a few dandelions are present, some alfalfa in one plot, some other grass in another plot.
16. Tall fescue ‘Enforcer’	Stand is excellent; two plots weed-free, some alfalfa in one plot, some other grass in another plot.
17. Intermediate wheatgrass ‘Rush’	Stand is good to excellent; some dandelions are present, some alfalfa in one plot.
18. Mountain brome ‘Garnet’†	Stand is variable - okay to very poor; considerable dandelions are present; other grasses and alfalfa.
19. Alfalfa ‘AV120'	Stand is very good to excellent; weed-free in two plots, some grass in two plots.
20. Forage chicory ‘LaCerta’	Stand is very poor; considerable dandelions are present; grasses and alfalfa have invaded some plots.
21. Mountain brome ‘Bromar’	Stand is poor; considerable dandelions are present; other grasses and alfalfa have invaded some plots.
22. Alfalfa ‘Spredor III’	Stand is excellent; weed-free.
23. Birdsfoot trefoil ‘ARS2620'	Stand is variable - good to poor; some scattered dandelions are present; other grasses have invaded.
24. Ladino clover ‘Will’	Stand is weak to poor; some dandelions are present; other grasses and some alfalfa have invaded.
25. Redtop	Stand is good; some dandelions are present; other grasses and some alfalfa have invaded.
26. Alfalfa ‘AV120' + Birdsfoot trefoil ‘Norcen’	Stand is good; some dandelions are present; other grasses have invaded in some plots; very little trefoil has persisted.
27. Cicer milkvetch ‘Windsor’	Stand is poor to very poor; some dandelions are present; alfalfa and grasses have become established; little cicer milkvetch has persisted.
28. Sainfoin ‘Remont’	Stand is variable - poor to good; weed-free; some dandelions and grasses have become established.
29. Switchgrass + Newhy (alternate seed rows)	Stand is variable - okay to very good; some dandelions are present; some alfalfa has invaded.

Table 5 (continued). Notes and observations of 50 grass and mixed plant species at Meeker 7 May 2002.

Entry	Notes and Observations
30. Switchgrass + tall fescue (alternate seed row)	Stand is good to excellent; weed-free; no switchgrass is present, some alfalfa has become established.
31. Switchgrass + Newhy (mixed)	Stand is okay to good; some dandelions are present; no switchgrass present.
32. Switchgrass + tall fescue (mixed)	Stand is very good to excellent; weed-free; no switchgrass is present; some alfalfa has become established.
33. Smooth brome + alfalfa (alternate seed rows)	Stand is excellent; weed-free; excellent entry.
34. Smooth brome + birdsfoot trefoil (alternate seed rows)	Stand is excellent; weed-free; birdsfoot trefoil stand is good; excellent entry.
35. Smooth brome + cicer milkvetch (alternate seed rows)	Stand is very good; weed-free; alfalfa has become established; little cicer milkvetch is present.
36. Smooth brome + sainfoin (alternate seed rows)	Stand is okay to good; weed-free; some alfalfa has invaded; sainfoin stand is good.
37. Smooth brome + alfalfa (mixed)	Stand is excellent; weed-free; excellent entry.
38. Smooth brome + birdsfoot trefoil (mixed)	Stand is excellent; weed-free; some alfalfa has become established; birdsfoot trefoil stand is improving in some plots and weak in others.
39. Smooth brome + cicer milkvetch (mixed)	Stand is very good; weed-free; some alfalfa has become established; no cicer milkvetch has persisted.
40. Smooth brome + sainfoin (mixed)	Stand is excellent; weed-free; sainfoin stand is good in some plots.
41. Newhy + alfalfa (alternate seed rows)	Stand is very good; weed-free; Newhy stand is weak.
42. Newhy + birdsfoot trefoil (alternate seed rows)	Stand is good to very good; some dandelions are present; birdsfoot trefoil stand is okay.
43. Newhy + cicer milkvetch (alternate seed rows)	Stand is variable - weak to good; some dandelions present; little cicer milkvetch remains; some alfalfa present.
44. Newhy + sainfoin (alternate seed rows)	Stand is variable - okay to good; some dandelions are present; sainfoin stand is good.
45. Smooth brome + orchardgrass + meadow brome	Stand is excellent; weed-free; excellent entry.
46. Smooth brome + orchardgrass + meadow brome + alfalfa	Stand is excellent; weed-free; excellent entry.
47. Smooth brome + orchardgrass + intermediate wheatgrass	Stand is excellent; weed-free; some alfalfa in one plot; excellent entry.
48. Smooth brome + orchardgrass + intermediate wheatgrass + alfalfa	Stand is excellent; weed-free; excellent entry.
49. Smooth brome +orchardgrass + meadow brome + creeping foxtail	Stand is excellent; weed-free; some alfalfa has invaded.
50. Smooth brome 'Bounty'	Stand is excellent; weed-free; some alfalfa has invaded.

PASTURE GRASS, FORAGE LEGUME, AND MIXED SPECIES EVALUATION AT HOTCHKISS 1998-2001

Calvin H. Pearson

Summary

Fifty single and mixed grass and forage legume species were evaluated for forage yield at the Western Colorado Research Center at Rogers Mesa, Hotchkiss, Colorado. A similar study was conducted at Meeker, Colorado. Data at Hotchkiss were collected for 4 years from 1998 through 2001. The 4-year total forage yield, averaged across all 50 entries, was 13.75 tons/acre and ranged from a high of 22.79 tons/acre for Entry 46 (a seed mixture of smooth brome+orchardgrass+meadow brome+alfalfa) to a low of 8.65 tons/acre for Entry 2 (‘Garrrison’ creeping foxtail). Seven entries had high 4-year total yields, all but one was a seed mixture. They were: Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa), Entry 33 (smooth brome+alfalfa in alternate seed rows), Entry 37 (smooth brome+alfalfa as a seed mixture), Entry 41 (Newhy+alfalfa in alternate seed rows), Entry 19 (‘AV120' alfalfa), Entry 26 (‘AV120' alfalfa+‘Norcen’ birdsfoot trefoil), and Entry 48 (smooth brome+orchardgrass+intermediate wheatgrass+alfalfa). Low-yielding entries, all of which were planted as single species, were ‘Climax’ timothy, ‘Kaw’ big bluestem, ‘Praireland’ Altai wildrye, ‘Will’ Ladino clover, redtop, and ‘Garrison’ creeping foxtail. This study provides empirical information on the performance of single and mixed species of grasses and legume for forage production. The results obtained from this study can be used by producers and others in selecting and managing forages to fit their farming and ranching operations.

Introduction and Objectives

Both irrigated and non-irrigated pastures, meadows, and rangelands are found throughout the mountain and valley areas of western Colorado. These crop and range lands produce forages for grazing and hay for feed. The forages produced on these acreages are essential to support the large livestock industry in western Colorado.

Pastures, meadows, and ranges in western Colorado contain a diversity of forage plant species, some of which are native while others have been introduced. Proper selection and management of grass and legume species for pastures, meadows, and rangelands affect the productivity of these forage lands during establishment and throughout the life of fields and ranges. The objectives of this research were to: 1) Identify grass and forage legume species and mixtures that produce high yields and high quality, 2) Determine the performance of cool- and-warm season grasses when planted in mixtures or in alternate seed rows, 3) Determine the performance of forage legumes when planted in mixtures or in alternate seed rows with a grass species, and 4) Assess grass and forage legume species for stand establishment, weed competition, and stand persistence. Fifty entries of single grass and forage legume species and mixed grass and legume species were evaluated at the Western Colorado Research Center, Rogers Mesa near Hotchkiss, Colorado from 1998 through 2001.

Fig. 1. Harvesting forage plots at the Western Colorado Research Center at Rogers Mesa, Hotchkiss. 10 Sept. 2001. Photo by Calvin Pearson.

Materials and Methods

This study was conducted at the Colorado State University, Western Colorado Research Center, Rogers Mesa, at Hotchkiss, Colorado. The elevation at Hotchkiss is 5,800 ft. The length of the growing season for each of the 4 years of the study are presented in Table 1. The experiment was a randomized complete block with four replications. Plot size was 10-ft. wide by 15-ft. long (Fig. 2). Plots were planted on 28 Apr. 1998. The plot area was flailed on 16 July 1998 to control weeds, particularly sweetclover and annual weeds. Fertilizer applications for each year are listed in Table 2. No herbicides were applied for weed control in the plots at any time during the study period. The experiment was furrow-irrigated.

Fig. 2. Forage plots at the Western Colorado Research Center at Rogers Mesa, Hotchkisss. 24 Sept. 1998. Photo by Calvin Pearson

Plots were harvested with a John Deere 2280 commercial swather equipped with a weigh bin and an electronic weighing system (Pearson and Robinson, 1994; Figs. 1 and 3). The weigh bin was fitted underneath the swather to catch the forage as it was discharged from the conditioner. This automated, forage plot harvesting system has been used for many years and has performed extremely well. During harvest, a small forage sample was obtained from each plot for moisture determination. Harvest dates for each cutting in each year of the study are presented in Table 3.

Results and Discussion

Plots were planted in spring 1998 and one cutting was obtained that year. The data for the 1998 cutting reflect stand establishment and the productivity of a new stand. Entries with high yields established more readily and were more productive than those entries with low yields. The 1998 total yields for the 50 entries are presented in Table 4. Eight entries had high 1998 total yields. They were Entries 46, 26, 33, 37, 19, 20, 41, and 48.

The data for 1999 were for the first full year of production. Two cuttings were obtained (Table 4). Total 1999 forage yield averaged 5.68 tons/acre, ranging from a high of 7.67 tons/acre for Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa) to a low of 4.22 tons/acre for Entry 2 (‘Garrison’ creeping foxtail). Eight entries had high 1999 total yields. They were Entries 46, 37, 26, 19, 33, 41, 48, and 20.

Three cuttings were obtained in 2000 (Table 4). Total 2000 forage yield averaged 4.17 tons/acre, ranging from a high of 7.34 tons/acre for Entry 46 (smooth brome+orchardgrass+ meadow brome+alfalfa) to a low of 2.13 tons/acre for Entry 24 (Ladino clover). As in 1998 and 1999, eight entries had high 2000 total yields. They were Entries 46, 41, 33, 37, 19, 48, 26, and 22.

Three cuttings were obtained in 2001 (Table 4). Averaged across all 50 entries, forage yield in the first cutting was 0.99 tons/acre, ranging from a high of 2.08 tons/acre for Entry 22 (‘Spredor III’ alfalfa) to a low of 0.28 tons/acre for Entry 1 (‘Matua’ bromegrass). Six entries were high yielding in the first cutting in 2001. They were Entries 22, 33, 37, 41, 48, and 26.

Forage yield in the second cutting averaged 0.76 tons/acre, ranging from a high of 2.43 tons/acre for Entry 33 (smooth brome+alfalfa in alternate rows) to a low of 0.19 tons/acre for Entry 8 (‘Oahe’ intermediate wheatgrass). Six entries were high yielding in the second cutting. They were Entries 33, 41, 37, 22, 19, and 46.

Forage yield in the third cutting averaged 0.91 tons/acre, ranging from a high of 1.89 tons/acre for Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa) to a low of 0.49 tons/acre for Entry 34 (smooth brome+birdsfoot trefoil in alternate rows). Seven entries were high yielding in the third cutting. They were Entries 46, 41, 33, 37, 19, 26, and 48.

Total 2001 forage yield averaged 2.65 tons/acre, ranging from a high of 6.18 tons/acre for Entry 33 (smooth brome+alfalfa in alternate seed rows) to a low of 1.25 tons/acre for Entry 2 (‘Garrison’ creeping foxtail). Six entries had high 2001 total yields. They were Entries 33, 41, 37, 22, 46, and 48.

The 4-year total yield averaged 13.75 tons/acre, ranging from a high of 22.79 tons/acre for Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa) to a low of 8.65 tons/acre for Entry 2 (‘Garrison’ creeping foxtail). Seven entries produced high yields over the 4-year testing period. They were Entry 46 (smooth brome+orchardgrass+meadow brome+alfalfa), Entry 33 (smooth brome+alfalfa in alternate rows), Entry 37 (smooth brome+alfalfa planted as a mixture), Entry 41 (Newhy+alfalfa in alternate rows), Entry 19 (‘AV120' alfalfa), Entry 26 (‘AV120' alfalfa+birdsfoot trefoil), and Entry 48 (smooth brome+orchardgrass +intermediate wheatgrass+alfalfa).

It has been suggested that improved forage production could be achieved by planting mixtures in separate seed rows rather than planting different plant species as a seed mixture. We tested this idea by planting several plant species (two-specie mixes) with each of the two plant species planted in their own seed row versus planting the two species as a seed mixture. Data for smooth brome+alfalfa, smooth brome+birdsfoot trefoil, smooth brome+cicer milkvetch, and smooth brome+sainfoin planted in alternate seed rows and as a seed mixture were analyzed statistically. Forage yields of entries planted in alternate seed rows or as a seed mixture were not significantly affected in any of the testing years or in the 4-year total forage yield. These results indicate there is no advantage to planting a given plant species of a seed mixture in its own seed row. The results of this study indicate that the traditional method of mixing seeds of different plant species and then planting them as a homogenous seed product continues to be an acceptable management practice for forage production.

Generally seed mixtures were more productive than single species in this study. Warm-season grasses did not establish well and had poor stands with low yields; much of the plot yields were observed to consist of weeds. Including alfalfa in a seed mixture generally increased forage yields. Plots were evaluated visually and observations regarding plant stand, weeds, and plant growth were noted (Table 5). Alfalfa invaded many plots when plant stands began to thin.

Fig. 3. Harvesting forage plots at Hotchkiss 10 Sept. 2001. Photo by Daniel Dawson.

References

Pearson, C.H., and L. Robinson. 1994. Automating a commercial swather for harvesting forage plots. Agron. J. 86:1131-1133.

Acknowledgments

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Table 1. Last spring frost and first fall frost and the number of frost-free days (28°F threshold) for each year in the pasture grass species evaluation study conducted at Hotchkiss 1998-2001.

Year	Last spring frost	First fall frost	Number of frost-free days
1998	—	4 Nov. 1999	—
1999	6 May 1999	29 Sept. 1999	146
2000	3 Apr. 2000	4 Oct. 2000	215
2001	13 Apr. 2001	24 Oct. 2001	194

Table 2. Fertilizer applied each year in the pasture grass species evaluation study conducted at Hotchkiss 1998-2001.

Year	Fertilizer Application
1998	39 lbs N/acre and 44.8 lbs P_2O_5/acre on 21 July 1998.
1999	42 lbs N/acre and 16 lbs P_2O_5/acre on 29 Apr. 1999. 74 lbs N/acre as ammonium nitrate on 26 June 1999.
2000	17 lbs N/acre and 78 lbs P_2O_5/acre on 19 Mar. 2000. 51 lbs N/acre as ammonium nitrate on 16 Aug. 2000. 17 lbs N/acre and 78 lbs P_2O_5/acre on 12 Dec. 2000.
2001	51 lbs N/acre as ammonium nitrate on 30 July 2001.

Table 3. Harvest dates for each cutting of the pasture grass species evaluation conducted at Hotchkiss 1998-2001.

Year	Cutting 1	Cutting 2	Cutting 3
1998	5 October	—	—
1999	16 June	31 August	—
2000	5 June	4 August	19 September
2001	31 May	20 July	10 September

Table 4. Forage yields of 50 single and mixed species of pasture grasses and forage legumes at Hotchkiss 1998-2001.

Entry	1998 Total	1999 Total	2000 Total	Cut 1 5 June	Cut 2 4 Aug	Cut 3 19 Sept.	2001 Total	4-Yr Total
	-----------	-----------	-----------	-----tons/acre[1]	-----------	-----------	-----------	-----------
1. Bromegrass ‘Matua’	1.59	6.38	3.32	0.28	0.50	0.81	1.59	12.87
2. Creeping foxtail ‘Garrison’	0.90	4.22	2.29	0.42	0.30	0.53	1.25	8.65
3. Reed canarygrass ‘Venture’	1.25	5.25	3.49	0.29	0.48	0.86	1.63	11.61
4. Tall fescue ‘Advance’	1.43	5.15	3.93	0.60	0.38	0.71	1.69	12.19
5. Orchardgrass ‘Duke’	1.40	5.11	3.10	0.40	0.37	0.67	1.44	11.04
6. Orchardgrass ‘Tekapo’	1.41	5.05	3.04	0.35	0.42	0.67	1.44	10.94
7. Meadowbrome ‘Fleet’	1.16	5.87	3.64	1.21	0.39	0.70	2.29	12.95
8. Intermediate wheatgrass ‘Oahe’	1.31	5.91	4.03	1.00	0.19	0.69	1.89	13.13
9. Pubescent wheatgrass ‘Luna’	1.34	6.50	4.74	1.38	0.57	0.70	2.65	15.23
10. Slender wheatgrass ‘San Luis’	0.74	5.14	3.26	0.73	0.37	0.88	1.98	11.12
11. Hybrid wheatgrass ‘Newhy’	1.21	5.36	3.84	0.90	0.34	0.78	2.02	12.43
12. Beardless wildrye ‘Shoshone’	0.63	4.94	3.81	0.67	0.75	0.92	2.34	11.72
13. Switchgrass ‘Blackwell’	0.98	5.97	3.27	0.81	0.65	1.09	2.54	12.76
14. Big bluestem ‘Kaw’	0.60	4.92	3.10	0.76	0.61	0.96	2.34	10.95
15. Timothy ‘Climax’	0.73	5.09	3.28	0.77	0.52	0.76	2.05	11.15
16. Tall fescue ‘Enforcer’	1.42	5.61	3.94	0.87	0.27	0.57	1.72	12.68
17. Intermediate wheatgrass ‘Rush’	1.28	5.75	3.89	0.98	0.31	0.54	1.83	12.75
18. Altai wildrye ‘Praireland’	0.65	4.47	3.39	0.99	0.56	0.86	2.41	10.91
19. Alfalfa ‘AV120'	1.87	7.19	6.99	1.66	2.21	1.58	5.46	21.50
20. Forage chicory ‘LaCerta’	1.84	6.86	2.71	0.88	0.58	0.93	2.39	13.79
21. Mountain brome ‘Bromar’	1.35	6.18	2.80	0.57	0.49	0.75	1.81	12.13
22. Alfalfa ‘Spredor III’	1.51	6.66	6.60	2.08	2.31	1.48	5.86	20.63
23. Birdsfoot trefoil ‘ARS2620'	0.78	4.58	4.11	1.01	0.94	0.85	2.80	12.27
24. Ladino clover ‘Will’	1.31	4.28	2.13	0.48	0.63	1.07	2.18	9.91
25. Redtop	0.70	4.41	2.60	0.50	0.45	0.58	1.53	9.25
26. Alfalfa ‘AV120' + Birdsfoot trefoil ‘Norcen’	1.90	7.28	6.68	1.81	2.04	1.58	5.43	21.29
27. Cicer milkvetch ‘Windsor’	0.77	4.96	3.86	1.16	1.01	1.19	3.35	12.94
28. Sainfoin ‘Remont’	0.93	5.18	3.29	0.70	0.53	0.80	2.02	11.42
29. Switchgrass + Newhy (alternate seed rows)	1.16	6.45	4.55	0.98	0.61	0.81	2.39	14.56
30. Switchgrass + tall fescue (alternate seed row)	1.30	5.25	4.04	1.16	0.49	0.87	2.51	13.09

Table 4 (continued). Forage yields of 50 single and mixed species of pasture grasses and forage legumes at Hotchkiss 2001.

Entry	1998 Total	1999 Total	2000 Total	Cut 1 5 June	Cut 2 4 Aug.	Cut 3 19 Sept.	2001 Total	4-Yr Total
	-------------	-------------	-------------	-----tons/acre[1]-----	-------------	-------------	-------------	-------------
31. Switchgrass + Newhy (mixed)	1.18	5.10	3.08	0.78	0.40	0.64	1.82	11.18
32. Switchgrass + tall fescue (mixed)	1.28	5.39	5.03	1.18	0.53	0.74	2.44	14.14
33. Smooth brome + alfalfa (alternate seed rows)	1.90	7.14	7.29	1.97	2.43	1.79	6.18	22.52
34. Smooth brome + birdsfoot trefoil (alternate seed rows)	1.04	5.26	3.56	0.84	0.38	0.49	1.71	11.57
35. Smooth brome + cicer milkvetch (alternate seed rows)	0.99	5.40	3.65	0.71	0.44	0.65	1.80	11.83
36. Smooth brome + sainfoin (alternate seed rows)	1.27	5.66	3.65	0.83	0.37	0.66	1.86	12.43
37. Smooth brome + alfalfa (mixed)	1.88	7.42	7.19	1.92	2.31	1.71	5.94	22.43
38. Smooth brome + birdsfoot trefoil (mixed)	1.09	5.85	4.12	0.72	0.51	0.69	1.92	12.97
39. Smooth brome + cicer milkvetch (mixed)	1.11	6.16	4.06	0.78	0.43	0.77	1.98	13.30
40. Smooth brome + sainfoin (mixed)	1.09	5.71	3.50	0.73	0.28	0.54	1.55	11.86
41. Newhy + alfalfa (alternate seed rows)	1.78	6.96	7.32	1.88	2.39	1.84	6.11	22.17
42. Newhy + birdsfoot trefoil (alternate seed rows)	1.15	5.52	4.57	1.28	0.75	0.91	2.94	14.18
43. Newhy + cicer milkvetch (alternate seed rows)	1.21	5.52	4.76	1.35	0.81	0.97	3.13	14.61
44. Newhy + sainfoin (alternate seed rows)	1.15	5.61	4.38	1.00	0.31	0.65	1.96	13.10
45. Smooth brome + orchardgrass + meadow brome	1.10	4.86	3.16	0.72	0.38	0.61	1.71	10.82
46. Smooth brome + orchardgrass + meadow brome + alfalfa	1.96	7.67	7.34	1.76	2.17	1.89	5.82	22.79
47. Smooth brome + orchardgrass + intermediate wheatgrass	1.39	5.43	3.79	0.86	0.36	0.72	1.94	12.55
48. Smooth brome + orchardgrass + intermediate wheatgrass + alfalfa	1.76	6.90	6.91	1.83	2.09	1.58	5.49	21.06
49. Smooth brome +orchardgrass + meadow brome + creeping foxtail	1.25	5.15	3.74	0.83	0.35	0.73	1.90	12.03
50. Smooth brome ‘Bounty’	1.07	5.54	3.78	0.97	0.21	0.55	1.73	12.11
Average	1.24	5.68	4.17	0.99	0.76	0.91	2.65	13.75
CV (%)	14.70	10.80	15.60	21.50	26.30	24.90	19.20	11.21
LSD (0.05)	0.25	0.85	0.91	0.30	0.28	0.32	0.71	2.15

In entries 29-49, we used ‘Blackwell’ switchgrass, ‘Fawn’ tall fescue, ‘Manchar’ smooth brome, ‘AV120' alfalfa, ‘Norcen’ birdsfoot trefoil, ‘Remont’ sainfoin, ‘Windsor’ cicer milkvetch, ‘Tekapo’ orchardgrass, ‘Regar’ meadow brome, ‘Oahe’ intermediate wheatgrass, and ‘Garrison’ creeping foxtail

[1]Yields were calculated on an air-dry basis.

Table 5. Visual observations of plots for plant stand, weeds, and plant growth at Hotchkiss, 19 July 2002.

Entry	Notes and Observations
1. Bromegrass ‘Matua’	Stand is thin to very thin; weedy; plant growth is poor; alfalfa has invaded; very poor entry.
2. Creeping foxtail ‘Garrison	Stand is thin to very thin; weedy; plot is contaminated with sweetclover and alfalfa; plant growth is poor; poor entry.
3. Reed canarygrass ‘Venture’	Stand is thin; alfalfa has become established in the plot; sweetclover has invaded; some weeds; plant growth is poor.
4. Tall fescue ‘Advance’	Stand is very good to excellent; alfalfa is invading; weed-free; plant growth is poor.
5. Orchardgrass ‘Duke’	Stand is excellent; sweetclover and medic has established in the plot; plant growth is acceptable.
6. Orchardgrass ‘Tekapo’	Stand is good to excellent; sweetclover and medic has established in one plot; some weeds in one plot; some weed-free plots; plant growth is poor.
7. Meadowbrome ‘Fleet’	Stand is good to excellent; sweetclover and young alfalfa have invaded the plot; growth is slow to poor.
8. Intermediate wheatgrass ‘Oahe’	Stand is excellent; some alfalfa has invaded plots; two plots weed-free; one somewhat weedy; plant growth is slow.
9. Pubescent wheatgrass ‘Luna’	Stand is variable - poor to excellent; some alfalfa has invaded plots; two plots weed-free; two plots with some weeds; plant growth is slow to poor.
10. Slender wheatgrass ‘San Luis’	Stand is very poor; plots are weedy; other grass species have invaded; poor entry.
11. Hybrid wheatgrass ‘Newhy’	Stand is good; alfalfa is invading plot; some weeds in two plots; plant growth is poor.
12. Beardless wildrye ‘Shoshone’	Stand is weak; alfalfa and other grass species are invading plots; some weeds are present.
13. Switchgrass ‘Blackwell’	Stand is poor to marginal; some weeds present such as clover; poor entry.
14. Big bluestem ‘Kaw’	Stand is poor to very poor; quite weedy; other grass species have invaded; poor entry.
15. Timothy ‘Climax’	Stand is poor; plot is weedy; some alfalfa has invaded; poor entry.
16. Tall fescue ‘Enforcer’	Stand is excellent; growth is poor; weed-free; alfalfa is starting to invade.
17. Intermediate wheatgrass ‘Rush’	Stand is excellent; growth is poor; alfalfa is starting to invade; some plots are weed-free; some have a few weeds.
18. Altai wildrye ‘Praireland’	Stand is variable- mostly very poor; weedy, primarily field bindweed and sweetclover; other grasses; very poor entry.
19. Alfalfa ‘AV120'	Stand is excellent; weed-free; excellent growth.
20. Forage chicory ‘LaCerta’	Stand is very poor; very little chicory remaining; weedy; grasses have invaded; very poor entry.
21. Mountain brome ‘Bromar’	Stand is marginal; alfalfa is starting to invade; some weeds; other grasses; poor plant growth.
22. Alfalfa ‘Spredor III’	Stand is very excellent; weed-free; good plant growth.

Table 5 (continued). Visual observations of plots for plant stand, weeds, and plant growth at Hotchkiss, 19 July 2002.

Entry	Notes and Observations
23. Birdsfoot trefoil ‘ARS2620'	Stand is good, thinning in one plot; some other grasses have invaded; some weeds; good growth; nice plot.
24. Ladino clover ‘Will’	Stand is good; other grasses have invaded; some field bindweed; only a few weeds; plants are drought stressed.
25. Redtop	Stand is okay; field bindweed; some alfalfa has invaded; poor plant growth; some plots quite weed-free; poor entry.
26. Alfalfa ‘AV120' + Birdsfoot trefoil ‘Norcen’	Stand is excellent; no trefoil; weed-free; excellent growth.
27. Cicer milkvetch ‘Windsor’	Stand is variable - weak to good; some alfalfa, sweetclover, and grass species have invaded; some weeds.
28. Sainfoin ‘Remont’	Stand is very poor; no sainfoin has survived; very weedy- field bindweed, alfalfa, salsify, sweetclover; poor entry.
29. Switchgrass + Newhy (alternate seed rows)	Stand is good; mostly Newhy, little switchgrass; considerable alfalfa has invaded; weed-free; plant growth is weak to okay.
30. Switchgrass + tall fescue (alternate seed row)	Tall fescue stand is good; no switchgrass; some alfalfa has invaded; mostly weed-free; plant growth is okay to poor.
31. Switchgrass + Newhy (mixed)	Stand is good to very good; no switchgrass; some sweetclover and alfalfa; some field bindweed and salsify; one plot weed-free; poor plant growth.
32. Switchgrass + tall fescue (mixed)	Tall fescue stand is good; no switchgrass; some alfalfa has invaded; weed-free.
33. Smooth brome + alfalfa (alternate seed rows)	Stand is very good to excellent; mostly alfalfa, little smooth brome; weed-free; excellent growth.
34. Smooth brome + birdsfoot trefoil (alternate seed rows)	Smooth brome stand is good; trefoil stand is variable- poor to good; some weeds; poor plant growth.
35. Smooth brome + cicer milkvetch (alternate seed rows)	Smooth brome and milkvetch stand is okay; some alfalfa has invaded; poor plant growth.
36. Smooth brome + sainfoin (alternate seed rows)	Smooth brome stand is good; no sainfoin remaining; some alfalfa has invaded; weed-free.
37. Smooth brome + alfalfa (mixed)	Stand is excellent; mostly alfalfa; weed-free; excellent plant growth.
38. Smooth brome + birdsfoot trefoil (mixed)	Stand is excellent; good mixed stand; weed-free; plant growth is variable- poor to good.
39. Smooth brome + cicer milkvetch (mixed)	Stand is excellent, mostly smooth brome; good mixed stand in one plot; no cicer mikvetch in one plot; some alfalfa has invaded; weed-free; okay plant growth.
40. Smooth brome + sainfoin (mixed)	Brome stand is excellent; no sainfoin remaining; weed-free; alfalfa has invaded; okay plant growth.
41. Newhy + alfalfa (alternate seed rows)	Stand is excellent; mostly alfalfa - little Newhy; weed-free; excellent plant growth.
42. Newhy + birdsfoot trefoil (alternate seed rows)	Newhy stand is okay, trefoil stand is more variable; some alfalfa, most plots are weed-free; plant growth is okay.

Table 5 (continued) Visual observations of plots regarding plant stand, weeds, and plant growth at Hotchkiss, 19 July 2002.

Entry	Notes and Observations
43. Newhy + cicer milkvetch (alternate seed rows)	Stand is okay to good; milkvetch stand is poor; some alfalfa has invaded; one had few weeds; another plot had many weeds; poor plant growth.
44. Newhy + sainfoin (alternate seed rows)	No sainfoin remaining; alfalfa is invading; some field bindweed; poor plant growth.
45. Smooth brome + orchardgrass + meadow brome	Stand is excellent; a few weeds present; some alfalfa in two plots; plant growth is poor.
46. Smooth brome + orchardgrass + meadow brome + alfalfa	Stand is excellent; mostly alfalfa; weed-free; excellent plant growth; very nice entry.
47. Smooth brome + orchardgrass + intermediate wheatgrass	Stand is variable - okay to excellent; some alfalfa is invading; a few weeds invading; poor growth.
48. Smooth brome + orchardgrass + intermediate wheatgrass + alfalfa	Stand is excellent; mostly alfalfa; mostly weed-free; weak plant growth.
49. Smooth brome +orchardgrass + meadow brome + creeping foxtail	Stand is good; some alfalfa is invading; mostly weed-free.
50. Smooth brome ‘Bounty’	Stand is good; some alfalfa has invaded; some weeds present; poor plant growth.

2002 IRRIGATED FORAGES TRIAL AT AKRON

D. Bruce Bosley and Joel P. Schneekloth

Introduction

High Plains producers have become more interested in raising irrigated perennial and annual forages. Forages are considered a potential alternative to raising cash grain crops under irrigation. Furthermore, they can be put up as hay or directly grazed by livestock. Perennial forages have relatively low input costs after they have been established: these being primarily related to water, fertilizer, and harvesting costs. Annual forages offer producers flexibility in their cropping systems. Research and information regarding currently available grass and legume forages is limited. The purpose of this study is to look at both yield and quality of irrigated annual and perennial forages in order to help producers determine the suitability of this option.

Methods

An irrigated forage trial was established in 2001 on the USDA Central Great Plains Research Station at Akron, Colorado. Perennial and annual grasses were planted with a no-till drill in the spring of 2001. The plots were irrigated with a solid set irrigation system. Scheduling of irrigation was done by the checkbook method with estimated crop water use obtained from a weather station at Akron. Water use of alfalfa was multiplied by a coefficient of 0.85 to determine water use for irrigated grasses. This trial was established to evaluate the relative suitability of 15 perennial and 5 annual forages.

Perennial grass planting was initiated in the spring of 2001. Three legumes (alfalfa, birdsfoot trefoil, and sainfoin) were interseeded with orchardgrass to compare that mixture's quality and yield with that of orchardgrass alone. An experimental perennial bromegrass was also planted in April 2002. The study was planted in a randomized complete block design with four replications.

Forage was harvested using a Carter flail harvester. Plots were harvested at the boot stage for optimum quality and yield. Samples were taken for hay moisture content and laboratory analysis of crude protein (CP), acid detergent fiber (ADF), net energy, Ca, and P. Samples were sent to an independent laboratory for analysis. Harvest intervals were typically between 25 and 30 days, depending on regrowth.

In fall 2001, nitrogen fertilizer was applied to half the plot area. Fertilizer was broadcast applied as ammonium nitrate (32-0-0). This was done to investigate nitrogen response of fall-applied fertilizer. An application of 40 lbs N was applied to half the plot area. Nitrogen applications for 2002 were 120 lbs of N per acre. This application was made after 30 May 2002, following the first cutting.

Results

Table 1 lists the forage entries, yields, CP, and ADF values obtained in the study. Fall-applied nitrogen increased yields of irrigated grass compared to no fall applied nitrogen (Fig. 1). Total forage yield increased with the application of 40 lbs of N and ranged from as little as two times to over six times the yield of the untreated check, depending upon the forage variety. Statistical analysis was not performed because the treatment pairs were not randomized across each of the individual treatment blocks.

Total forage production for 2002 is shown in Fig. 2. Overall, the greatest production was from an annual system of triticale and sorghum-sudan with yields of 6.5 tons/acre adjusted to 10% moisture content. The highest producing perennial grass was tall fescue with a yield of 4.5 tons/acre. Annual systems such as triticale and sorghum-sudan resulted in greater forage production than any perennial system in 2002. The majority of perennial grasses produced yields between 3 and 4 tons/acre.

The addition of legumes into a grass mixture did not appear to increase production as compared to a grass monoculture. Production of pure orchardgrass was similar to that of orchardgrass with alfalfa, sainfoin, or birdsfoot trefoil added into the mixture. Average yields of orchardgrass were 3.5 tons/acre compared to 3.6 tons/acre when a legume was added to the mixture.

Quality

Forage quality was accessed based on CP and ADF. The relative qualities of most treatments were similar with the majority being within 10% of average for CP and ADF. Acid detergent fiber for all systems were within 10% of the average value. The treatment with the highest CP was the triticale and sorghum-sudan system with an average CP 20% greater than the plot average, and 10% more than the next treatment (pubescent wheatgrass). The treatments with the lowest CP, less than 90% of average, were winter wheat and forage millet, switchgrass, and Matua bromegrass.

The addition of a legume did not increase the nutrient content of the forage. The lack of increase of either yield or quality by addition of a legume may be due to the lack of adequate legume establishment. Legumes were present after planting in 2001 but stands were reduced in 2002. This reduction may have been caused by orchardgrass competitiveness.

Competitiveness

Each treatment was visually evaluated for its competitive ability against grassy and broad-leafed weeds. The following grasses were found to be the most competitive: orchardgrass, meadow brome, tall fescue, and perennial ryegrass. The annual small grains, sorghum-sudan and foxtail millet were found to be competitive with annual weeds. Wheatgrasses were rated only moderately competitive with Newhy wheatgrass being the most competitive followed by Luna pubescent wheatgrass.

The warm season grasses, switchgrass, eastern gamagrass, and big bluestem were found to be very slow to establish and consequently poor competitors even after two years. Switchgrass establishment was greater than all other warm season perennials with the first harvest being taken in the late summer of 2002.

Matua bromegrass established well in 2001 but was a poor competitor to weeds and reduced vigor in 2002. The experimental bromegrass planted in 2002 established well in the test plots but failed to fill between the plants and was a poor competitor to the weeds. Both species appear to produce seed heads rapidly, which may have a negative impact on forage quality.

Conclusion

The 2002 growing season was hot and dry. The irrigation system was able to minimize water stress, but the excess heat may have influenced some varieties more than others. Many plant species showed nitrogen deficiency symptoms during the latter half of the growing season and yield potential may have been influenced. This was the first year of the study. Recommendations for irrigated grass production will be made after the growing season of 2003.

Table 1. Species of forages used in this study and the summary of 2002 results.

Treatment no.	Treatment description	2002 total yield 10% DM	Season average Dry matter (100%) CP	Season average Dry matter (100%) ADF
		tons/acre	-----------%-----------	
1	Triticale/Sorghum X Sudan	6.4 a[1]	14.4 de	30.5 a
2	Wheat/Forage Millet	4.2 bc	8.9 f	31.9 abc
3	Experimental Bromegrass	1.6 g	17.1 ab	34.8 ef
5	Meadow Brome	2.9 f	14.8 cde	36.2 fg
6	Orchardgrass	3.2 def	17.3 ab	32.3 abc
7	Smooth Brome	3.2 ef	16.2 bcd	36.0 f
8	Perennial Ryegrass	2.9 f	14.7 cde	32.1 abc
9	Tall Fescue	4.5 b	14.0 de	33.3 bcde
10	Orchardgrass	3.9 bcd	17.7 ab	32.3 abc
12	Switchgrass	3.6 cdef	9.8 f	34.5 def
13	Orchardgrass/Alfalfa	3.6 cdef	17.0 abc	31.7 ab
14	Orchardgrass/Trefoil	3.5 def	16.8 abc	32.9 bcde
15	Orchardgrass/Sainfoin	3.8 bcde	15.8 bcd	33.1 bcde
16	Wheatgrass – Newhy	3.8 bcde	14.7 cde	32.9 bcde
17	Tall Wheatgrass	2.9 f	13.2 e	33.8 cde
18	Pubescent Wheatgrass – Luna	3.0 f	18.5 a	32.8 bcd
19	Bromegrass – Matua	2.1 g	14.7 cde	38.1 g
Experimental Mean		3.5	15.0	33.5
Least Significant Difference (0.05)		0.725	2.3	2.0

[1] Means followed by the same letter are not significantly different.
DM, dry matter; CP, crude protein; ADF, acid detergent fiber.

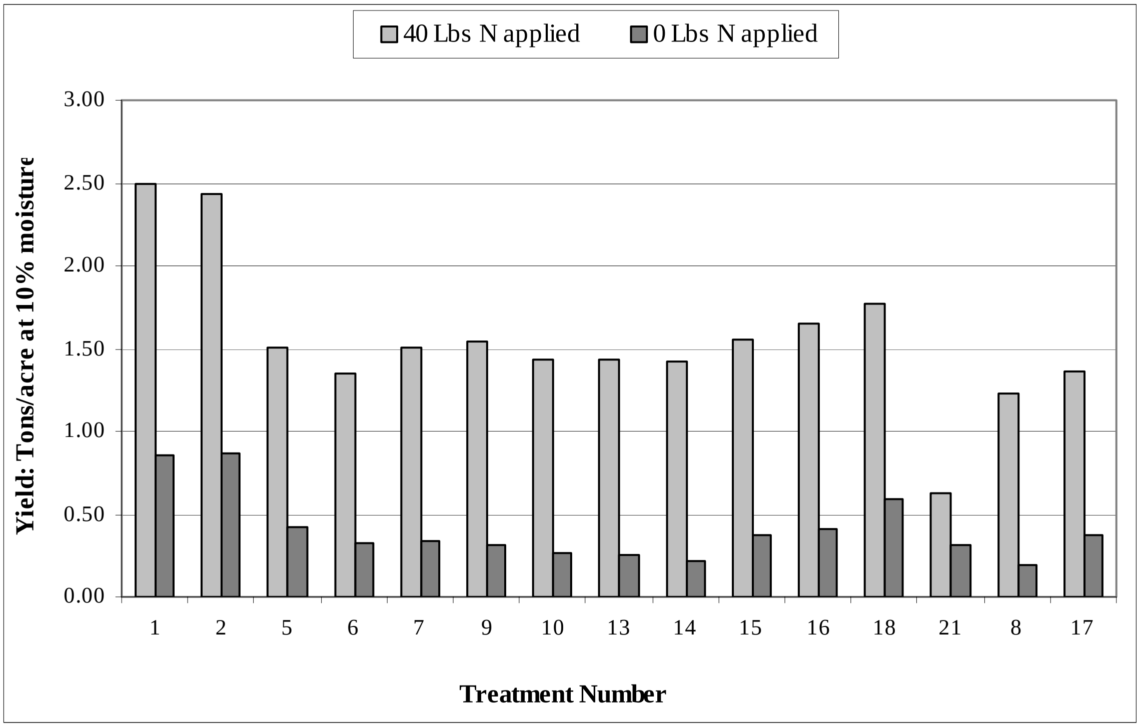

Fig. 1. Forage yield as affected by nitrogen fertilizer.

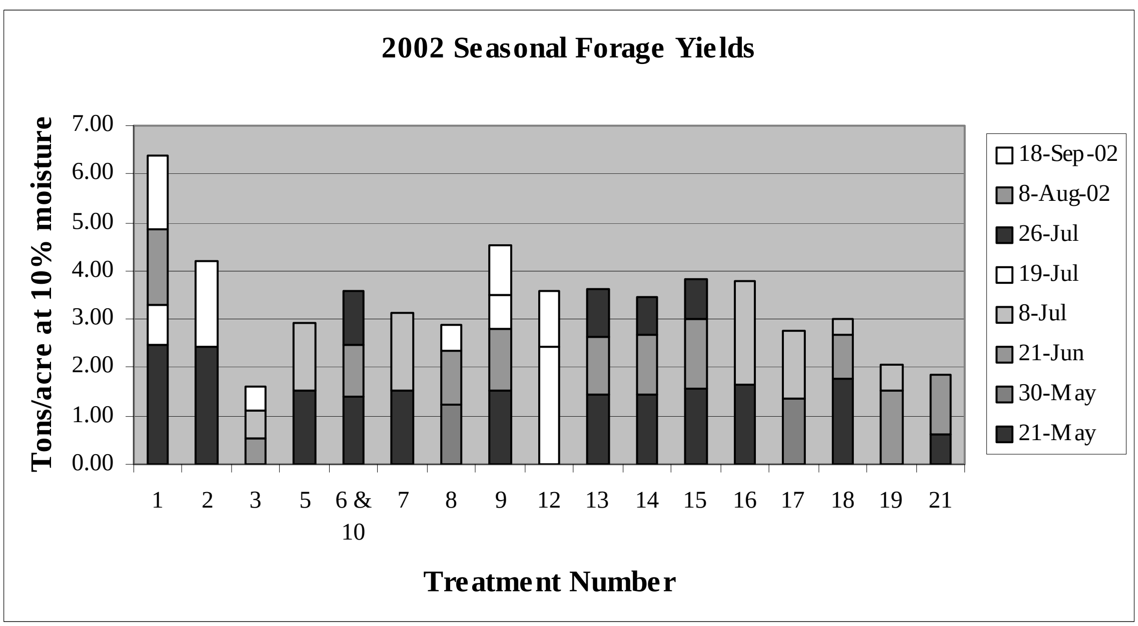

Fig. 2. 2002 seasonal forage yields.

RESULTS OF THE IRRIGATED WINTER TRITICALE YIELD TRIALS AT YELLOW JACKET 1996-1999

Abdel Berrada

Introduction

Irrigated winter triticale (x *Triticosecale* Wittmack) trials were conducted at the Southwestern Colorado Research Center in Yellow Jacket from 1996 to 1999 to evaluate the yield potential of several varieties and experimental lines. This research was part of a program to evaluate alternative crops in southwestern Colorado. Triticale is a cross between wheat and rye. It combines the grain quality, yield, and disease resistance of wheat with the vigor and hardiness of rye (Wichman et al., 1995). Triticale seed yield and other agronomic traits have improved greatly since the initiation of the triticale breeding program at the International Maize and Wheat Improvement Center (CYMMYT) in 1968. Spring, facultative and winter triticales are increasingly used for grazing, forage, forage/grain dual purpose, and silage. They are also an acceptable partial to complete replacement for corn and other grains and as an energy source in some poultry and swine rations (Varughese et al., 1996).

Materials and Methods

The soil at the experimental site is a Wetherill loam (fine-silty, mixed, superactive, mesic Aridic Haplustalfs). The 30-year average annual precipitation at the Southwestern Colorado Research Center is 15.9 in., of which approximately 40% comes from snow. June is usually the driest month (0.5 in.) and August through October receives the most precipitation (1.4 to 1.7 in./mo.). Elevation is approximately 6900 ft. and the number of frost-free days averages 120 days (http://www.wrcc.dri.edu/index.html).

Most of the entries in the triticale variety trials were provided by Resource Seeds, Inc. Triticale was planted with a Kincaid spinner planter at approximately 80 lb/acre, except in 1997 when the seeding rate was 110 lb/acre. The entries were assigned at random to three complete blocks. 'Fairview', a hard red winter wheat variety, was used every year for comparison. Other checks used were 'TAM107', 'Garland', and 'Quantum 555' (hard red winter wheats) and 'Presto' winter triticale (public variety). Plot size was 5 ft. by 20 ft. but the planted (and harvested) width was only 4 ft. (6 rows spaced 8 in. apart). Grain yield was estimated based on 5-ft. plot width to account for border effects. Triticale was threshed with a Hege plot combine (a different combine was used in 1999) and cleaned with a small fanning mill to remove excess straw and chaff. The yields in bu/acre were not adjusted for grain moisture or test weight. Grain moisture at harvest was generally 8 to 12%. Grain samples of selected entries were sent to Resource Seeds, Inc. for feed analysis but the results are not available. Heading date (50% of the plants headed) was recorded, except in 1997.

Results

The results of the triticale yield trials are shown in Tables 1 to 4. Winter triticale produced as much as 157 bu/acre in 1998 and as little as 58 bu/acre in 1999. Yield averaged (including the checks) 99, 100, 137, and 79 bu/acre in 1996, 1997, 1998, and 1999, respectively. It is not possible to compare entries over the 4-year period since different entries were tested each year, with few exceptions. Differences in seed yield from year to year are likely due to variations in genetic material, climatic conditions, and management (planting and harvest dates, irrigation scheduling, fertilizer amounts, pest control, etc.). It is likely that the higher seeding and fertilizer rates in 1998 and adequate precipitation (rain and irrigation) led to the higher seed yield compared to the other years. In addition, there were fewer entries in 1998 and possibly only the best selections were entered that year. Poor weed control, low irrigation amount, and harvest conditions (10 to 20% shattering) may have contributed to the relatively low yields in 1999 (Table 4). Russian wheat aphids (RWA) were observed on Fairview and TAM107 in 1996 (Table 1). None of the triticale entries showed susceptibility to RWA in any of the 4 years of testing. Most of the winter and spring wheat varieties currently grown in southwestern Colorado and southeastern Utah are susceptible to RWA. No other disease or insect problems were noted. In general, wheat yield was substantially lower than that of most of the triticale entries. In contrast, wheat test weight was higher than that of triticale. The test weight of triticale was generally in the low to mid 50 lb/bu while that of wheat consistently measured around 60 lb/bu.

References

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Wichman. D., L. Talbert, S. Lanning, G. Kushnak, G. Stallknecht, G. Carlson, and T. Keener. 1995. Triticale grain production and quality performance in Montana. Montana AgResearch: 23-26. Spring 1995.

Other sources of information on triticale (verified on 30 March 2003):

Purdue University Alternative Field Crops Manual
http://www.hort.purdue.edu/newcrop/afcm/triticale.html

Forage Information System at Oregon State University
http://www.forages.css.orst.edu/Topics/Species/Grasses/Triticale/index.html

Resource Seeds, Inc.
http://www.resources.com
http://www.tricaltrit.com

Acknowledgment

Funding for this study was provided by Resource Seeds, Inc., Mid-Kansas Agri Co., the Dolores Water Conservancy District, and the Colorado Agricultural Experiment Station.

Table 1. Results of the irrigated winter triticale yield trial at Yellow Jacket 1996.

Entry	Grain yield lbs/ac	Grain yield bu/acre	Test wt. lbs/bu	Heading date	Other
6003	7118	130	55	3 June	
6001	6936	129	53	10 June	
27355-94	6805	122	56	10 June	
24167-94	6648	123	54	3 June	
24167-93	6350	118	54	3 June	
6202	6259	114	55	10 June	
23879-94	6221	133	48	3 June	
LKO5001020	6171	113	55	3 June	
28999-94	6134	112	55	10 June	uneven stand
6005	6094	112	55	3 June	some lodging
6034	6006	111	54	10 June	
Stan I	5967	107	56	3 June	
LKO1020	5929	109	55	10 June	
RSI 1087	5784	105	55	3 June	
6027	5768	105	55	3 June	
6002	5738	105	55	3 June	
6126	5711	106	54	3 June	
RSI 108	5687	113	51	10 June	
L1326	5607	105	54	10 June	
6024	5573	105	53	3 June	
33881	5510	105	52	3 June	short plants
6111	5489	101	55	3 June	
6106	5449	102	53	3 June	
Presto	5174	93	56	10 June	
6215	5161	97	53	3 June	
RSI 786	5158	99	52	5 June	
KS154-6534-93	5107	90	57	3 June	
KS49-6441	5103	101	51	10 June	
6130	5059	95	53	10 June	
6043	5017	93	54	3 June	
XT 498	4983	97	52	3 June	
6209	4974	90	55	3 June	
6206	4963	90	55	3 June	
6105	4932	95	52	10 June	lodging
RSI 815	4904	94	53	10 June	
6104	4870	90	54	3 June	
CGG 1210	4870	90	54	3 June	
Fairview	4756	78	60	3 June	RWA and severe lodging
TRICALE 2700	4716	85	55	3 June	some lodging
6115	4642	89	52	10 June	
31702	4566	85	54	10 June	
22187-93	4554	83	55	3 June	
37361-95	4506	81	56	10 June	
6125	4453	86	52	3 June	lodging
31240	4447	87	51	10 June	
6103	4436	84	53	-	
22187-94	4228	78	54	10 June	
TAM 107	4036	66	61	3 June	Russian wheat aphids (RWA)
RSI 762	3840	74	52	24 June	lodging
L419	3826	71	54	3 June	
Average	**5325**	**99**	**54**		
$LSD_{0.05}$	**1598**	**30**	**2**		

Planting date: 20 Sept. 1995 Harvest date: 6 Aug. 1996
Fertilizer: 100 lbs. N/acre preplant + 30 lbs. N/acre topdressed
Pest control: None
Irrigation amount (gross) ~ 19 in.
Precipitation: 5.2 in. (21 Sept. 1995 to 31 July 1996)

Table 2. Results of the irrigated winter triticale yield trial at Yellow Jacket 1997.

Entry	Grain yield lbs/ac	Grain yield bu/acre	Test wt.[1] lbs/bu	Plant ht.[1] in.
42621	6379	123	52	36
42879	6289	119	53	41
48831	6231	120	52	40
1439-981	6180	117	53	36
43932	6144	116	53	33
43259	6137	112	55	38
41995	6097	113	54	34
48980	6022	108	56	34
L815	5929	108	55	41
9626331	5922	112	53	37
43903	5863	109	54	35
44136	5860	111	53	39
51344	5740	108	53	39
Presto	5713	108	53	41
51550	5635	104	54	37
42664	5624	108	52	36
42008	5580	107	52	30
52018	5568	105	53	36
44151	5393	98	55	35
43929	5359	101	53	37
9626330	5303	100	53	37
42885	5291	100	53	33
42403	5289	106	50	28
44213	5288	102	52	40
44021	5245	99	53	38
49206	5213	97	54	34
48149	5195	96	54	36
43980	5193	98	53	37
48327	5192	94	55	34
42316	5161	103	50	38
1439-960	5159	105	49	38
44155	5045	95	53	36
44212	5041	99	51	38
Fairview	5004	83	60	37
48749	4958	95	52	37
9626332	4940	93	53	35
51559	4891	94	52	32
44009	4843	93	52	40
42671	4757	91	52	32
51079	4744	91	52	34
44201	4695	89	53	39
41611	4661	95	49	43
CGG863	4610	100	46	33
Q555	4599	77	60	22
42039	4513	98	46	37
41476	4362	91	48	32
Garland	4324	86	50	26
44061	4286	84	51	34
1996-103	4170	83	50	37
44135	4096	76	54	31
Average	**5283**	**100**	**53**	**36**
$LSD_{0.05}$	**1389**	**27**		

[1]Data from one replication only

Note: All the entries were in the boot stage on 2 June 1997.

Planting date: 21 Oct. 1996 Harvest date: 8 Sept. 1997

Fertilizer: 80 lbs. N/acre (34-0-0) on 7 May 1997

Pest control: Harmony Extra @ 0.5 oz/acre + 2,4-D Amine @ 4.0 oz/acre on 14 May 1997

Irrigation amount (gross) ~ 12.5 in. (5 applications)

Precipitation: 14.8 in. (22 Oct. 1996 to 31 Aug. 1997)

Table 3. Results of the irrigated winter triticale yield trial at Yellow Jacket 1998.

Entry	Grain yield lbs/acre	Grain yield bu/acre	Test wt. lbs/bu	Plant ht. in.	Heading date
No.10	8729	157	55.5	43	12 June
43259	8623	158	54.5	43	15 June
9723139	8537	157	54.5	42	15 June
9723155	8509	148	57.5	43	15 June
9723175	8412	148	57.0	41	15 June
9723129	8380	157	53.5	46	15 June
9723198	8248	153	54.0	41	15 June
9723099	8213	155	53.0	45	15 June
61781	8010	142	56.5	39	12 June
9723101	7993	140	57.0	43	15 June
9723151	7903	139	57.0	42	15 June
41995	7780	145	53.5	41	15 June
RSI-815	7758	139	56.0	44	15 June
42621	7734	143	54.0	41	15 June
9723121	7680	136	56.5	44	15 June
48980-5L6	7635	139	55.0	39	15 June
42879	7564	143	53.0	42	15 June
48831	7351	146	50.5	43	20 June
61405	7330	127	57.5	41	12 June
1439981	7127	126	56.5	40	-
60741	6862	121	56.5	39	12 June
RSI-154	6746	116	58.0	42	10 June
Fairview	6617	105	63.0	39	18 June
60375	6297	112	56.0	42	15 June
61669	5706	104	55.0	37	10 June
43756	5397	98	55.0	30	15 June
Mean	**7582**	**137**	**55.6**	**41**	
$LSD_{0.05}$	**957**	**17**	**0.0**	**2**	

Planting date: 20 Oct. 1997 Harvest date: 19 Aug. 1998

Fertilizer: 100 lbs. N/acre (34-0-0) on 16 Oct. 1997 + 30 lbs. N/acre (34-0-0) on 1 June 1998

Pest control: Harmony Extra @ 0.5 oz/acre + 2,4-D Amine @ 4.0 oz/acre on 18 May 1998

Irrigation amount (gross) ~ 20.5 in. (6 applications)

Precipitation: 10 in. (21 Oct. 1997 to 11 Aug. 1998)

Table 4. Results of the irrigated winter triticale yield trial at Yellow Jacket 1999.

	Grain yield		Test wt.[1]	Plant ht.[1]	Heading
Entry	lbs/acre	bu/acre	lbs/bu	in.	date
AL-98	5301	97	54.7	39	14 June
LKO-10207*	4888	87	55.9	37	1 June
L1657-X35272	4852	91	53.2	32	1 June
L117	4839	94	51.5	41	7 June
VICT-1439A	4798	87	55.4	38	11 June
1439-960	4732	85	55.7	36	1 June
2700-BABY	4665	87	53.7	32	1 June
L815	4645	86	53.9	43	7 June
22288	4642	85	54.9	34	MDW[2]
C360-1087	4636	87	53.0	41	7 June
MAL-1439A	4603	82	56.2	34	MDW
L1815	4562	82	55.5	36	1 June
LKO-102	4562	84	54.5	35	11 June
1439-804	4547	92	49.2	42	7 June
L-830	4526	87	52.1	40	11 June
B6-98	4491	89	50.7	37	7 June
RS1154	4429	79	56.2	39	MDW
MAL-1439B	4403	80	55.1	38	4 June
MAL-SWT832	4392	85	51.8	39	1 June
PRESTO	4360	77	56.4	40	1 June
B807/MZ18//2050	4264	90	47.2	37	9 June
XR066A/XR040A	4256	78	54.3	37	7 June
LKO-PRE	4253	80	53.0	43	9 June
L815BR	4252	79	54.1	43	4 June
B807-PRE	4223	76	55.2	36	4 June
VICT-1439B	4141	78	52.8	37	7 June
LKO-1102	4112	75	54.5	35	9 June
1439-70	4104	76	53.7	37	7 June
1439-C174	4094	74	55.5	32	MDW
IVAN-XR066A	4082	79	51.6	33	4 June
876-XRO72-1439	4066	79	51.2	41	1 June
1439-35272	4044	74	54.6	32	MDW
LKO-142	4036	74	54.4	34	7 June
BABY807/L888//BABY	4019	75	53.7	31	11 June
1439-WYT	3933	72	54.4	34	MDW
1439-981	3852	73	53.0	35	4 June
FAIRVIEW	3790	65	58.2	37	14 June
VICT-X5087	3676	68	54.3	42	4 June
LKO-BAC	3469	65	53.0	39	4 June
1439-LKO	3395	61	55.7	35	1 June
LKO-TM76	3266	60	54.1	40	4 June
UGO-BABY	3036	58	52.1	37	2 June
Mean	**4268**	**79**	**53.8**	**37**	
LSD(0.05)	**684**				

[1]Data from one replication only [2]MDW: Memorial Day Weekend

*LKO-10207 is marketed as TriMark™ 336 and TRICAL®336.

Planting date: 20 Oct. 1998 Harvest date: 23 Aug. 1999

Fertilization: 100 lbs. N/acre + 52 lbs. P_2O_5/acre on 15 Oct. 1998

Precipitation: 13.6 in. (21 Oct. 1998 to 15 Aug. 1999)

Irrigation amount (gross): 7.3 in. (3 applications)

Previous crop: Pinto bean

EVALUATION OF SPRING CEREALS FOR DUAL USE

Abdel Berrada and Joe Brummer

Introduction

The acreage of spring cereals in southwestern Colorado is negligible compared to that of other crops such as alfalfa, dry bean, and winter wheat (Colorado Agricultural Statistics, 2000 and 2001). Among the spring cereals, oat is by far the largest crop, followed by spring wheat and barley. A small acreage of triticale (mostly winter triticale) is grown in Montezuma County for grazing and/or seed production. Spring wheat and barley are mostly grown for grain while oat production is probably evenly divided between forage (hay) and grain. There is a good market for oat as horse feed in Colorado and neighboring states. Most of the barley grown in Delta, Montrose, and Garfield counties is used for malting. At least two-thirds of the acreage in spring cereals is irrigated. Cereal crops play an important role in cropping systems in southwestern Colorado. They are used for mining nitrogen and other nutrients produced by legume crops, such as alfalfa or dry bean or left over from intensively managed crops such as onions. Non-irrigated spring cereals: e.g., spring wheat and oat, are also used as a hedge against the climatic uncertainties, particularly in southwestern Colorado. For example, less winter wheat and more spring grains are planted in years with a dry fall but adequate winter precipitation.

Numerous investigators have evaluated the use of cereal crops for dual purposes. From reviewing the literature, McCartney and Vaage (1994) found that forage oat generally outyielded other cereal crops such as barley, wheat, triticale, and rye. The results varied depending on the cultivar, stage of growth, year, and location. In contrast to yield, the nutritional value of oat was generally lower than that of other cereals. Crude protein concentrations tended to be higher in wheat, triticale and barley than in oat silage. In vitro dry matter and organic matter digestibilities appeared to be greatest for barley and lowest for oat silage. McCartney and Vaage (1994) found greater acid detergent fiber (ADF) levels at harvest in oat and triticale than in barley. Barley was harvested at the soft dough stage, oat at the milk stage, and triticale between the milk and soft dough stage. Barley was the preferred of the three cereal silages for feeding cattle. Triticale produced a less acceptable silage because of poor palatability and low dry matter intake.

Triticale is a cross between wheat and rye. It combines the grain quality, yield, and disease resistance of wheat with the vigor and hardiness of rye (Wichman et al., 1995). Triticale seed yield and other agronomic traits have improved greatly since the initiation of the triticale breeding program at the International Maize and Wheat Improvement Center (CYMMYT) in 1968. In Montana, the seed yield of nine spring triticale varieties was equal to or greater than that of 'Newana' spring wheat. Several winter triticale varieties and experimental lines produced significantly more seed yield than ‘Fairview’ or 'TAM 107' winter wheat at Yellow Jacket, Colorado, 1996 to 1999 (study reported elsewhere in this technical report).

Triticale grows well under relatively cool temperatures, making it an excellent forage crop. It produces high biomass and has a high regrowth production potential after grazing. Spring, facultative and winter triticales are increasingly used as crops for grazing, forage, forage/grain dual purpose, and silage in developing and developed countries. They are also an acceptable partial to complete replacement for corn and other grains and as an energy source in some poultry and swine rations (Varughese et al., 1996).

Mitchell (1989) deduced from a 2-year trial at Pt. Mackenzie in Alaska that triticale could outyield oat and barley under relatively warm, dry conditions while giving up little in crude protein and digestible dry matter. In moist years, oat would be expected to outyield triticale, although triticale could be higher in crude protein and digestible matter.

Shands and Chapman (1961) recommended that wheat and barley should be cut between the boot and soft dough stages and oats at the boot stage or earlier to optimize their digestibility. The highest digestibility of oats is attained in boot and early head stages, decreasing thereafter more rapidly than in wheat and barley. Total dry matter production of oats increases rapidly up through the milk stage, but very slowly or not at all thereafter. According to these authors, “Wheat and barley harvested in the soft dough stage contain 65-70% moisture and can be ensiled directly without seepage loss.”

The objective of this study was to evaluate the comparative advantages of irrigated barley, oat, spring wheat, and triticale for forage or grain production in SW Colorado.

Materials and Methods

Four varieties of oat, three of barley, four of triticale (three in 1998), and one spring wheat were planted at the Southwestern Colorado Research Center in 1997 and 1998 to evaluate their potential as a forage or grain crop in southwestern Colorado. The varieties and their characteristics are listed in Table 1. Trical® 2700 was omitted from the 1998 trial. The soil type in the plot area is a Wetherill loam (fine, silty, mixed, mesic Aridic Haplustalfs). The experimental design in 1997 was a split plot with crop species x crop variety as the main plot and end use (forage or grain) as the subplot. Extensive lodging occurred in the grain plots after the forage was harvested, particularly where there was a forage plot on each side of the grain plot. Consequently, the experimental design was changed to a split-split plot arrangement in 1998 to minimize lodging in the grain plots. Crop species were assigned to the main plots, the end use to the subplots, and varieties to the sub-subplots. The treatments were randomized within each of three complete blocks (replications) in 1997 and 1998. Plot size was 4 ft. x 40 ft. Spring grains were planted with a Kincaid spinner planter in six rows spaced 8 in. apart, at 90 lb/acre. A one-foot border was left between plots to facilitate harvest. Crop yield was estimated based on 5-ft plot width to account for border effect. All the spring crops were planted on 5 May in 1997 and 7 May in 1998. The alleyways (20 ft. in width) between blocks and the area surrounding them were planted to ‘Ajay’ oat in both years. Commercial fertilizer was broadcast with a 10-ft JD spreader as pre-plant incorporated at the rate of 140 lb of N + 40 lb of P_2O_5 per acre in 1997 and 120 lb of N + 40 lb of P_2O_5 in 1998. The plot area was sprayed with Harmony Extra at 0.5 oz/acre plus 2,4-D Amine at 8 oz/acre on 29 May 1997 and with Harmony Extra at 0.5 oz/acre plus 2,4-D Amine at 4 oz/acre on 18 June 1998. Total precipitation (from rain and snow) from planting to harvest was approximately 6.2 in. (1997) and 3.5 in. (1998). In addition, irrigation water was applied with a linear-move, sideroll sprinkler irrigation system, totaling 13.5 in. during 1997 and 20 in. during 1998.

The plots designated as “forage” were cut with a Carter forage harvester at 1.0 to 1.5 in. above ground level. A Weigh-Tronix electronic scale (Model 615, Fairmont, MN) mounted on the forage harvester was used to record the fresh weight of each plot. A composite sample was taken from each plot, weighed, air-dried for at least a week, and weighed again to determine the plant material’s moisture content at harvest. A subsample was sent to the Mountain Meadow Research Center in Gunnison, Colorado for crude protein (CP) and in-vitro dry matter disappearance (IVDMD) analyses. IVDMD is a measure of how well the plant material would be digested by ruminants. The crops were harvested for forage on 21 July 1998 and on two separate dates in 1997, 17 July (oats and ‘Steptoe’ barley) and 22 July (triticale, ‘Sylvan’ wheat, forage barleys). The corresponding growth stage was soft dough in 1997 and watery ripe to soft dough in 1998. The grain plots were threshed with a Hege plot combine on 29 Sept. 1997 and on 2 Sept. 1998. The grain was cleaned with a small fanning mill to remove excess straw and chaff. Grain moisture was 11 to 13% in 1997 and 9 to 11.5% in 1998.

Results and Discussion

Dry matter (DM) yield of all the entries was much greater in 1997 than in 1998, possibly due to the cooler and wetter conditions in 1997 (Tables 2a and 2b). Season length was about the same (74 to 77 days) but May precipitation was much higher in 1997. In contrast, grain yield was greater in 1998 than in 1997. Extensive lodging occurred after the forage was cut in 1997, which delayed harvest and lowered grain yield. The barley and oat varieties, except ‘Ajay’ oat, lodged the most. Factors that contributed to lodging and late harvest in 1997 include plot arrangement (See explanation in Materials and Methods), above normal precipitation in July, August and September, and possibly high soil nitrogen level. (The plot area was in chickpeas in 1996. In addition, 140 lb. N/acre was applied in 1997). A hailstorm on 21 Sept. 1997 caused some seed shattering, especially in oats. ‘Washford’ barley had about a 5% loose smut infestation in 1997.

In 1997, barley had the highest DM yield, 4.4 to 5.0 tons/acre. ‘Ajay’ oat had the lowest DM yield of 3.7 tons/acre. It was also the shortest entry (Table 2a). The other oat, wheat, and triticale varieties produced 3.9 to 4.2 tons/acre. The barley varieties had the lowest CP (8.3 to 8.7%), followed by ‘Russell’ oat. ‘Trical® 105’ and ‘Trical® 301’ had the highest CP (12.1%). There were no significant differences in IVDMD values in 1997 at the 95% probability level. Sylvan wheat produced significantly more seed yield and had greater test weight than all the other entries in 1997. The triticale entries had similar seed yield to ‘Steptoe’ barley, which was significantly more than that of the other two barley varieties and all the oats, except for ‘Monida’, which was similar to ‘Grace®’. Triticale seed tested 50 to 52 lb/bu, while the oats tested 36 to 38 lb/bu and the barleys 37.5 (‘Washford’) to 45 lb/bu (‘Steptoe’). ‘Sylvan’ had the highest test weight of all the entries but fell below the standard for hard red wheat (60 lb/bu).

As in 1997, ‘Steptoe’ had the highest DM in 1998, a yield that was significantly higher than the other two barleys, ‘Sylvan’ wheat, ‘Ajay’ oat, and ‘Trical® 105’. ‘Steptoe’ had a significantly lower CP than ‘Sylvan’ wheat, ‘triticale’, and ‘Ajay’ oat. ‘Steptoe’ had the highest IVDMD value while ‘Russell’ oat had the lowest value. ‘Sylvan’ and ‘Trical® 301’ produced the highest grain yield, significantly more than ‘Washford’ and ‘Westford’ barleys, ‘Colo 37’ and ‘Russell’ oats. Seed test weight varied in a similar fashion in 1997 and in 1998 but was higher in 1998 for wheat and triticale. ‘Steptoe’ barley and ‘Trical® 105’ reached 50% heading 5 days or more earlier than the other entries. Plant height was generally lower in 1998 than in 1997, with ‘Ajay’ oat being the shortest, followed by ‘Trical® 105’ and ‘Sylvan’ wheat. ‘Steptoe’ barley was much shorter in 1998 than in 1997.

In summary, forage DM yield of all the entries was much greater in 1997 than in 1998. IVDMD was also greater (except for ‘Steptoe’), but CP was generally lower as was grain yield. The wetter and cooler conditions in 1997 favored DM production but contributed to lodging, which reduced grain yield and quality. ‘Steptoe’ barley appears to be well-suited for forage or grain production in southwestern Colorado, while ‘Sylvan’ wheat and ‘Ajay’ oat might be better suited for grain production, given their short stature. Triticale had comparable DM yield to oat and wheat in 1997 and to oat and barley in 1998. Triticale seed yield was significantly greater than that of most oat and barley varieties in 1997 and similar to wheat, ‘Monida’ and ‘Ajay’ oat, and to ‘Steptoe’ barley in 1998. Triticale CP was similar to that of wheat or oat and its IVDMD was comparable to that of wheat and barley. Oat digestibility at harvest was the lowest of the four cereals in 1998. The results appear to be variety-dependent, as reported by McCartney and Vaage (1994).

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Table 1. Type and source of the entries in the split forage/grain trial at Yellow Jacket, 1997-1998.

Variety	Species	Type	Source
Steptoe	Spring barley	Feed	Colorado State Univ.
Washford	Spring barley (hooded)	Feed	Washington State Univ.
Westford	Spring barley (hooded)	Feed	Western Plant Breeders
Ajay	Spring oat	Feed	USDA-Idaho
Colorado 37	Spring oat	Feed	Colorado State Univ.
Monida	Spring oat	Feed	USDA-Idaho
Russell	Spring oat	Feed	USDA-Idaho
Grace®*	Spring triticale	Feed	RSI-Resource Seeds, Inc
Trical® 105	Spring triticale	Feed	RSI-Resource Seeds, Inc.
Trical® 2700	Spring triticale (blend)	Feed	RSI-Resource Seeds, Inc.
Trical® 301	Spring triticale	Feed	RSI-Resource Seeds, Inc.
Sylvan	Hard red spring wheat	Grain	Colorado State Univ.

*Grace® has been discontinued and replaced by Trical® 2700.

Table 2a. Results of the split forage/grain trial at Yellow Jacket 1997.

		Forage				Grain			
Variety	Species	Dry matter[1]	Moisture[2]	Crude protein	IVDMD[3]	Grain yield	Test weight	Heading date[4]	Height[5]
		tons/acre	-------------------%------------------			lbs/acre	lbs/bu		in.
Steptoe	barley	5.0	68.4	8.3	61.3	4832	45.1	25 June	40.8
Washford	barley	4.4	72.4	8.5	60.4	2566	37.5	6 July	42.0
Westford	barley	4.8	72.0	8.7	62.2	3573	39.9	5 July	41.5
Ajay	oat	3.7	78.8	11.5	61.7	3203	37.9	9 July	32.8
Colo 37	oat	4.0	79.0	9.4	61.5	2919	36.5	9 July	50.8
Monida	oat	4.0	79.6	10.0	62.1	4082	37.0	9 July	44.3
Russell	oat	4.1	77.0	8.8	59.6	3204	35.8	7 July	47.0
Grace®	triticale	3.9	72.1	10.3	62.0	4309	49.5	6 July	50.5
Trical® 105	triticale	4.1	66.6	12.1	61.1	4913	50.4	30 June	36.8
Trical® 2700	triticale	4.2	68.8	9.6	59.3	4935	51.3	6 July	60.5
Trical® 301	triticale	3.9	70.9	12.2	63.1	4609	52.0	5 July	43.0
Sylvan	wheat	4.0	70.8	10.1	61.4	6029	57.8	6 July	38.3
Average		4.2	73.1	10.0	61.6	4098	44.2		44.0
CV (%)		7.1	2.6	15.3	3.9	10	2.3		3.6
$LSD_{0.05}$		0.4	2.8	2.2	NS	617	1.4		2.3

[1]DM is on an air-dry basis.
[2]Forage moisture content at harvest.
[3]In-vitro dry matter disappearance (IVDMD).
[4]Date of 50% heading.
[5]Crop height was measured shortly before the crop was cut for forage.

Table 2b. Results of the split forage/grain trial at Yellow Jacket 1998.

		Forage				Grain			
Variety	Species	Dry matter[1]	Moisture[2]	Crude protein	IVDMD[3]	Grain yield	Test weight	Heading date[4]	Height[5]
		tons/acre	-------------------%-----------------			lbs/acre	lbs/bu		in.
Steptoe	barley	3.3	68.5	10.4	64.8	5399	47.5	29 June	29.0
Washford	barley	2.8	76.8	11.3	57.2	4596	38.0	10 July	34.4
Westford	barley	2.8	77.9	12.2	57.4	4592	41.0	10 July	39.0
Ajay	oat	2.4	80.9	12.9	55.1	5405	36.5	9 July	27.9
Colo 37	oat	3.0	78.4	12.0	52.2	4586	38.0	8 July	46.5
Monida	oat	3.1	79.7	12.4	53.4	5835	36.0	9 July	38.8
Russell	oat	3.2	76.9	11.8	49.4	4783	37.5	5 July	41.3
Grace®	triticale	3.0	79.5	13.9	57.3	5746	53.0	6 July	45.5
Trical® 105	triticale	2.9	70.5	13.0	57.9	5052	55.5	29 June	31.3
Trical® 301	triticale	3.1	74.5	12.9	55.1	6149	57.0	6 July	39.0
Sylvan	wheat	2.7	76.0	13.9	57.6	6144	62.0	9 July	33.8
Average		2.9	76.3	12.8	57.0	5299	45.6		38.5
CV (%)		9.9	1.3	7.6	3.4	12			2.6
$LSD_{0.05}$		0.4	1.5	2.2	2.8	883			2.2

[1]DM is on an air-dry basis.
[2]Forage moisture content at harvest.
[3]In-vitro dry matter disappearance (IVDMD).
[4]Date of 50% heading.
[5]Crop height was measured shortly before the crop was cut for forage.

DRYLAND ANNUAL FORAGES

Ron F. Meyer, D. Bruce Bosley, Joel P. Schneekloth
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Introduction

Dryland forage production within Colorado's High Plains has become increasingly important. As a result of recent dry growing season conditions, cattlemen are searching for dryland forage options. Even when normal growing conditions resume, cattlemen oftentimes are in need of supplemental forages. The objective of this study was to evaluate various annual forages for yield and forage quality under dryland conditions in northeastern Colorado.

Materials and Methods

Dryland annual forages were planted during the 2001, 2002, and 2003 growing seasons at the USDA-ARS Central Great Plains Research Station near Akron, Colorado. Ten forages were investigated in 2001 and 2002, with three more added in 2003 (Table 1). During the 2001 and 2002 seasons, the following forages were planted: oats, barley, triticale, soybean, forage sorghum, proso millet, foxtail millet, pearl millet, sorghum sudan, and forage kochia. Oats, barley, triticale, and forage kochia were planted in late March or early April with the other entries planted in late May or early June, depending on the year. During the 2003 growing season, three additional sorghum sudan varieties were added: a photo period sensitive brown mid-rib, a photo period insensitive brown mid-rib, and a variety called Atta Graze. Forage kochia did not establish in any year and those plots were allowed to go to weeds. A "weed" plot was subsequently harvested for yield and forage quality as a potential indicator of emergency feed. The experimental design was a randomized complete block with 4 replications.

The plots were no-till planted into corn stubble all three seasons. No fertilizer was applied. The only herbicide application was 1 quart per acre of Roundup pre-plant in 2001 and 2002. There was no herbicide application to plots in 2003. The oat, barley, and triticale plots were harvested on 26 July 2001, 24 June 2002, and 18 June 2003. All other plots were harvested on August 1 and September 23 in 2001 and 2002, respectively. In 2003, the proso millet and weed plots were harvested on August 13 with all remaining plots harvested on August 29.

Results

Sorghum sudan entries consistently yielded the highest over all 3 years of this study, regardless of precipitation received. However, yields from 2003 were not significantly different due to excess weed infestations. Triticale and oats also yielded well. It does appear, however, that when spring conditions are favorable, triticale yields better than oats, but when dryer conditions exist, oats may be a better choice, as was observed in 2002. This condition appears to hold for protein produced per acre as well.

Other quality parameters were measured in an effort to gain incite into which cultivar would produce the highest forage quality in conjunction with yield. Not all quality parameters were measured from each entry every year. However, when protein produced per acre was measured, sorghum sudan produced well most years, as did triticale. Both triticale and oats appeared to be a satisfactory protein source most years. Soybean was found to produce above average protein percentages, but could not compete from a yield standpoint and as a result, pounds of protein produced per acre was reduced accordingly. Proso millet produced the highest TDN levels in 2001 and 2003, but was not harvested in 2002 due to drought conditions and weed infestations. Dry weather in 2002 prevented harvest of the weed, foxtail millet, proso millet, and soybean plots.

Barley had the highest ADF values in 2002, but not in the other years. In 2001, sorghum sudan, triticale, barley, oats, forage sorghum, foxtail millet, and pearl millet had the highest ADF values. In 2003, pearl millet and oats produced the highest ADF values. NDF values were measured only in 2001, with sorghum sudan, forage sorghum, foxtail millet, and pear millet having the highest levels.

Nitrates were measured from some entries in 2001 and 2003. All nitrate levels were below toxic levels.

In summary, it appears that sorghum sudan is a good dryland forage choice from both a yield and forage quality standpoint. Triticale and oats can also perform well when early season moisture exists.

Table 1. Various species, varieties, and seeding rates of annual forages planted under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado.

Crop	Planting Rate (lbs/acre)	Variety
Oats	100	Ogle
Barley	100	Otis
Triticale	100	Presto
Soybean	60	Agripro 2802rr
Forage Sorghum	25	Kaystar Millenium
Proso Millet	18	Huntsman
Foxtail Millet	15	White Wonder
Pearl Millet	20	Pawnee
Sorghum Sudan	25	Triumph Sooner Sweet
Added in 2003		
Sorghum Sudan	25	311 Brown Mid-rib (Photo period sensitive)
Sorghum Sudan	25	211 Brown Mid-rib (Photo period insensitive)
Sorghum Sudan	25	Atta Graze

Table 2. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2001.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Sorghum/Sudan	2.54a	346bc	62cd	36a	62ab	63a
Triticale	2.40ab	609a	63cd	37a	--	--
Barley	2.30ab	600a	65bc	33a	--	--
Proso Millet	2.10abc	329bc	70a	29b	57bc	21a
Oats	1.90abcd	415b	61d	37a	--	--
Forage Sorghum	1.70bcd	291bc	64cd	35a	61ab	114a
Foxtail Millet	1.50cd	218c	64cd	34a	62a	44a
Soybean	1.50cd	346bc	68ab	25c	36d	41a
Pearl Millet	1.30d	210c	63cd	35a	63a	63a
Weeds	1.20d	216c	63cd	35a	54c	199a

Numbers within a column followed by the same letters are not different.

Table 3. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2002. Dry weather in 2002 prevented harvest of the weed, foxtail millet, proso millet, and soybean plots.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Forage Sorghum	1.98a	527a	66b	32b	--	--
Sorghum Sudan	1.86a	552a	70a	29c	--	--
Oats	1.7a	222bc	51d	--	--	--
Pearl Millet	1.2ab	429ab	68ab	29c	--	--
Triticale	0.7b	97cd	49d	--	--	--
Barley	0.6b	49d	54c	37a	--	--

Numbers within a column followed by the same letters are not different.

Table 4. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2003.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Atta Graze Sorghum Sudan	2.1a	--	--	32de	--	394bc
Forage Sorghum	2.0a	718a	54d	34cd	--	--
Triticale	1.9a	519ab	60bc	36abc	--	393bc
Weeds	1.9a	322bc	64ab	35bc	--	--
Pearl Millet	1.8a	--	--	38a	--	578ab
Photo Period Insensitive S/S	1.6a	--	--	31e	--	378bc
Soybean	1.6a	551a	59bcd	35bc	--	--
Sorghum Sudan	1.6a	--	--	34cd	--	880a
Photo Period Sensitive S/S	1.5a	--	--	34cd	--	298bcd
Proso Millet	1.5a	300c	68a	34cd	--	--
Oats	1.3a	327bc	57cd	37ab	--	575ab
Barley	0.9a	279c	65ab	34cd	--	192cd
Foxtail Millet	--	--	--	--	--	--

Numbers within a column followed by the same letters are not different.

MOUNTAIN MEADOWS

QUALITY COMPARISON OF WINDROW GRAZING VERSUS TRADITIONAL HAYING METHODS IN MOUNTAIN MEADOWS

Beth LaShell, Doug Zalesky, Dan Selzer, and Joe Brummer

Summary and Recommendations

Data from SPA (Standardized Performance Analysis) indicate that for cattle producers to increase their profits they need to: 1) increase the number of animals sold, 2) reduce feed costs, or 3) generate additional income from given resources. Grazing of windrowed forages has been used during open winters and in snow depths of over 2 ft. with no apparent problems, but this method has not been tested in the high altitude environment of southwestern Colorado.

Quality comparisons of harvested hay, windrowed, and standing forage in both grass and grass/alfalfa meadows were obtained in this study. Results indicate that windrowed grass is a better source of forage than standing grass in both fall and spring evaluations. While both methods resulted in a decrease in crude protein (CP) as compared to the harvested hay, digestibility of the forage was acceptable when utilized in the fall. Standing grass had digestibility levels below 29% when allowed to overwinter, which makes grazing difficult. The grass/alfalfa forage left in the field, either in windrows or standing, should be grazed in the fall because of potential wildlife damage and deterioration. In the fall, the CP values for both the windrowed and standing grass/alfalfa were very similar to the harvested hay. Additionally, even though the plant material remained in the field for nearly 3 months, the grass/alfalfa digestibility values were still above 55%.

Introduction and Objectives

In a normal year, the San Juan Basin Research Center (SJBRC) produces 600 to 900 tons of grass, grass/alfalfa, and oat/alfalfa hay on 400 acres of irrigated fields. Research from Montana State University indicates that in addition to reducing summer labor requirements, windrow grazing can reduce feed costs by a minimum of $16.00 per acre plus the cost of feeding (Surber et al., 2001). Research conducted in the Tri-River area of Colorado in the winter of 1998-99 indicated that cost savings of $13.50 per cow were possible by utilizing windrow grazing versus feeding harvested forages (LeValley, 2000).

The objectives of this study were to obtain protein and digestibility levels of harvested, standing, and windrowed forages at harvest, early fall, and the following spring. Given the different types of hay grown in southwest Colorado, both straight grass hay and a grass/alfalfa mixture were evaluated.

Documentation as to the effect of wildlife on windrowed forages is limited. Potential problems include consumption, scattering, and crusting of the snow on top of the windrow due to trampling.

Materials and Methods

The SJBRC is located 5 mi. south of Hesperus, Colorado at an elevation of 7,600 ft. and receives 18.5 in. of precipitation annually. Crop varieties adapted to the 100-day frost free growing season have been limited to small grains, forages, and hay crops.

Two meadows containing grass and grass/alfalfa were used in the study. For the grass/alfalfa field, first cutting was baled and removed in mid-July. At the time of the second cutting in mid-September, a

200 by 3 ft. windrow section and a 200 by 50 ft. standing section were left in the field. The grass meadow was only cut and baled in mid-August. A windrow and standing plot of the same size were left in the grass meadow.

Forage samples were obtained from both the grass and grass/alfalfa hay harvested in August. Field samples were taken on 10 October from all four plots. Due to a lack of plant material, field samples were only taken from the grass plots in the spring of 2001. All samples were dried at SJBRC and sent to the Mountain Meadow Research Center to be analyzed for CP and *in vitro* dry matter digestibility.

Because we primarily wanted to look at change in nutritional value, none of the plots were grazed during the winter of 2001. To determine the potential effect of wildlife on windrows and standing plots through the winter, a 30 x 30 ft. area was fenced off in each of the plots. Visual observations of consumption and scattering were taken in the fall and spring in all plots.

Results and Discussion

The grass hay had a crude protein concentration of 8.1% and was 52.4% digestible (Table 1). In comparison, the CP concentration of the standing grass forage was significantly lower in the fall than the harvested hay at 3.0% CP with a corresponding lower value (4.6 percentage points) for digestibility. Because the plant continued to mature through the fall, these values were expected. After overwintering, the CP concentration in the standing forage increased to 4.4%. This increase is due to the soluble carbohydrates and other plant fractions leaching out over the winter, causing the CP to become more concentrated. However, the digestibility of the standing grass in the spring was the lowest of all samples at 28.6%.

The corresponding windrowed grass had a CP concentration of 4.1% and was 48.9% digestible in the fall. While the CP concentration of the windrowed grass was significantly higher than in the standing grass, digestibility was not different. The following spring, the CP concentration increased to 5.6% due to the carbohydrates and other plant fractions leaching over the winter while the digestibility dropped slightly (3.6 percentage points).

Table 2 shows the CP and digestibility values for the harvested, standing, and windrowed grass/alfalfa plots. The grass/alfalfa hay had a CP concentration of 14.5% and was 59.6% digestible. These values were higher, as expected, than those found in the grass hay due to the higher quality of the alfalfa. The fall values for the standing grass/alfalfa were lower than for the harvested hay. While the grass/alfalfa plants stood in the field for the same amount of time, the alfalfa held its nutritional value much better than the grass. The windrowed grass/alfalfa had a CP concentration of 17.6%, which was 3.1 percentage points higher than the harvested hay. The effect of the leaching of carbohydrates had already begun in the fall as the digestibility had dropped 4.3 percentage points to 55.3%. Because of extensive wildlife damage and plant deterioration, no plant material was available for spring samples.

Observations of wildlife damage differed in the grass and grass/alfalfa plots. Little to no damage was observed in the grass plots. The plant material inside and outside of the fenced barriers was very similar and did not appear to be disturbed by wildlife. Additionally, both grass plots withstood the water and snow damage of the winter exceptionally well. However, in the grass/alfalfa plots, wildlife consumed, scattered, and trampled the plots outside of the fenced barrier. Inside the fenced barrier, water and frost damage destroyed the plant material.

Upon completion of this project, all grass plots were grazed off in the spring. We saw no detrimental effects to grass regrowth in either of the plot areas.

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Table 1. Crude Protein and Digestibility Values for Grass Plots.

Sample Description	Crude Protein (%)	Digestibility (%)
Harvested Hay	8.1	52.4
Standing Forage October 2000	3.0	47.8
Standing Forage Spring 2001	4.4	28.6
Windrowed Forage October 2000	4.1	48.9
Windrowed Forage Spring 2001	5.6	45.3

Table 2. Crude Protein and Digestibility Values for Grass/Alfalfa Plots.

Sample Description	Crude Protein (%)	Digestibility (%)
Harvested Hay	14.5	59.6
Standing Forage October 2000	13.6	57.4
Windrowed Forage October 2000	17.6	55.3