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Burton A. Weichenthal
University of Nebraska-Lincoln, bweich@comcast.net

David D. Baltensperger
University of Nebraska-Lincoln, dbaltensperger@tamu.edu

Kenneth P. Vogel
University of Nebraska-Lincoln, kvogel1@unl.edu

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Feed Values for Annual Forages in Western Nebraska

Burton A. Weichenthal
David D. Baltensperger
Kenneth P. Vogel[1]

Summary

Forage quality testing was completed on annual forages grown during 1998 and/or 1999. Included were spring cereals, legumes and summer annuals like sorghum and millets. Using a single cut harvest system when the majority of summer annuals had produced seed heads, crude protein (CP) was generally more than 8% and total digestible nutrients (TDN) more than 63% of dry matter. Annual legumes had 12 to 18% CP and more than 63% TDN. Pearl and irrigated foxtail millets had higher crude protein levels than sorghum forages, but nitrate levels were also higher. Some mineral contents varied by location and associated management.

Introduction

Results of forage production and quality comparisons of individual annual forage cultivars were presented in the 2001 Nebraska Beef Cattle Report, pp. 26-28. However, only one year of forage quality results (1998) was available at that time. The purpose of this report is to summarize quality results by forage crops rather than individual cultivars and to show the results from macro- and micro-mineral tests for 1999 crops grown on the high plains of western Nebraska or eastern Wyoming.

Procedure

Dryland and irrigated annual forage trials were conducted over two years (1998 and/or 1999) to update forage production and quality characteristics of cultivars of spring triticale, oat, barley, pea, vetch, soybean, forage sorghum, sorghum x sudangrass, sudangrass, pearl millet and foxtail millet. A single cut harvest system was used for each group when the majority of grass cultivars had produced seed heads or when the legumes had reached early bloom

Table 1. Feed analyses for dryland spring planted cereal and legume annual forages grown in 1998-99.[a, b]

			Protein		Nitrate	Fiber			Energy				Digestibility
Forage Name Harvest Stage	Year	DM %	CP %	UIP %/CP	NO_3N ppm	NDF %	ADF %	ADL %	NE_m Mcal	NE_g Mcal	NE_l Mcal	TDN %	IVDMD %
Spring cereal													
Barley	98, 99	40	8.2	8	220	65	34	5.4	.68	.41	.68	66	69
Fresh,	N	16	16	6	16	16	16	16	16	16	16	16	16
soft dough	SD	6	.9	3	380	2.3	2	.4	.01	.01	.01	.6	3
Oat	98, 99	30	9.5	8	360	65	34	5.1	.68	.41	.67	66	73
Fresh,	N	24	24	9	24	24	24	24	24	24	24	24	24
head exerted	SD	3	1.6	3	530	4	2.2	.7	.01	.01	.01	.7	5.3
Triticale	98, 99	38	9.3	6	130	66	36	5.5	.67	.40	.67	65	70
Fresh,	N	16	16	6	16	16	16	16	16	16	16	16	16
head exerted	SD	25	1.6	1	140	2.2	2.3	.6	.01	.01	.01	.7	4.5
Legume													
Pea	99	26	17.1	9	—	40	33	—	.65	.38	.65	64	75
Fresh,	N	32	32	4	—	32	32	—	32	32	32	32	4
early bloom	SD	4	2.2	—	—	2.6	2.2	—	.03	.03	.03	2.4	1.3
Soybean	99	32	12.2	5	110	43	28	6.8	.72	.45	.71	68	77
Fresh,	N	24	48	10	48	48	48	48	48	48	48	48	48
early to mid pod-fill	SD	—	1.4	—	120	2.6	2.3	.7	.04	.03	.03	2.4	1.9
Vetch	99	29	18.3	8	—	40	32	—	.67	.40	.67	65	72
Fresh,	N	8	8	8	—	8	8	—	8	8	8	8	8
early bloom	SD	4	1.8	—	—	2.9	2	—	.03	.03	.02	2.1	—

[a]Dryland spring planted cereal, pea and vetch forages were grown at the University of Nebraska High Plains Agricultural Laboratory near Sidney, where the altitude is about 4300 ft above sea level. Soybean forages were grown at the University of Wyoming Research and Extension Center near Cheyenne, where the altitude is about 6000 ft. All contents are expressed on a dry matter basis.

[b]Abbreviations are: DM = dry matter; CP = crude protein; UIP = ruminally undegradable intake protein; NO_3N = nitrate nitrogen; NDF = neutral detergent fiber; ADF and ADL = acid detergent fiber and lignin, respectively; NE_m, NE_g and NE_l = net energy for maintenance, gain, and lactation, respectively; TDN = total digestible nutrients; IVDMD = in vitro dry matter digestibility; N = number of observations; and SD = standard deviation.

Table 2. Feed analyses for dryland and irrigated summer annual forages grown in western NE in 1998-99.[a,b]

			Protein		Nitrate	Fiber			Energy				Digestibility
Forage Name Harvest Stage	Year	DM %	CP %	UIP %/CP	NO_3N ppm	NDF %	ADF %	ADL %	NE_m Mcal	NE_g Mcal	NE_l Mcal	TDN %	IVDMD %
Dryland													
Forage Sorghum	98, 99	26	9.6	10	1170	59	30	3.6	.70	.43	.69	67	78
Fresh,	N	24	72	24	58	72	72	72	72	72	72	72	72
early heading	SD	2.7	2.8	4	570	4.8	4.5	1.6	.04	.04	.03	2.7	4.2
Sorghum x sudan	98, 99	24	9.0	10	1010	61	32	4.2	.69	.42	.69	66	72
Fresh,	N	18	54	18	41	54	54	54	54	54	54	54	54
head exerted	SD	1.9	2.9	4	450	4.3	4.3	1.2	.05	.04	.04	3.3	3
Sudangrass	98, 99	30	7.6	11	690	65	36	4.9	.67	.40	.68	66	66
Fresh,	N	4	9	3	7	9	9	9	9	9	9	9	9
head exerted	SD	1.8	2.3	1	380	4.4	4.5	1	.08	.07	.06	5.2	2.4
Pearl Millet	98	23	15.3	8	2090	60	30	3.5	.70	.43	.69	67	78
Fresh,	N	9	15	9	15	15	15	15	15	15	15	15	15
head exerted & vegetative[c]	SD	1.7	2	2	920	1.9	1.3	.3	.01	.01	.01	.4	3.2
Foxtail Millet	99	32	8.9	9	320	61	32	3.5	.69	.42	.68	66	73
Fresh,	N	27	36	27	36	36	36	36	36	36	36	36	36
head exerted & vegetative[c]	SD	4	1.1	2	230	2.2	2	.6	.04	.03	.04	4	3.8
Irrigated													
Forage Sorghum	98, 99	23	9.8	9	1040	61	35	4.9	.68	.41	.67	65	70
Fresh,	N	42	90	42	90	90	90	90	90	90	90	90	90
head exerted	SD	1.9	1.2	2	420	3.4	2.3	1.1	.04	.03	.03	2.4	3.5
Sorghum x sudan	98, 99	25	8.9	9	740	61	36	6.1	.67	.40	.67	65	64
Fresh,	N	30	50	30	50	50	50	50	50	50	50	50	50
head exerted	SD	2	.9	3	390	2	2	.8	.03	.03	.02	2.2	3.2
Sudangrass	98, 99	30	9.0	10	1050	66	40	6.5	.65	.39	.66	64	60
Fresh,	N	6	10	6	10	10	10	10	10	10	10	10	10
head exerted	SD	3.8	1.4	3	880	3.5	3.5	.8	.08	.07	.05	5	4
Pearl Millet	98, 99	20	11.3	9	2340	67	40	5.7	.65	.39	.66	64	64
Fresh,	N	27	30	27	30	30	30	30	30	30	30	30	30
head exerted & vegetative[c]	SD	4.6	1.7	4	1150	2.4	2.5	.7	.06	.06	.05	4.1	4
Foxtail Millet	98, 99	27	12.1	6	2010	62	36	4.9	.67	.40	.67	65	70
Fresh,	N	27	55	27	27	55	55	55	55	55	55	55	55
head exerted & vegetative[c]	SD	4.8	.9	3	770	2.9	2.5	.6	.01	.01	.01	.8	3.4

[a]Dryland and irrigated summer annual forages were grown at the University of Nebraska High Plains Agricultural Laboratory near Sidney, NE, and the Panhandle Research and Extension Center near Scottsbluff, NE, respectively. All contents are expressed on a dry matter basis.
[b]Abbreviations are: DM = dry matter; CP = crude protein; UIP = ruminally undegradable intake protein; NO_3N = nitrate nitrogen; NDF = neutral detergent fiber; ADF and ADL = acid detergent fiber and lignin, respectively; NE_m, NE_g and NE_l = net energy for maintenance, gain, and lactation, respectively; TDN = total digestible nutrients; IVDMD = in vitro dry matter digestibility; N = number of observations; and SD = standard deviation.
[c]One pearl millet cultivar and one foxtail millet cultivar were genetic types that generally would not produce seed heads, remaining vegetative in the environments tested.

or pod-fill stages of maturity. Plots in Nebraska were planted in rows 12 inches apart with a double disc grain drill with a cone seed distribution system. Fertilizer was applied preplant or as a side-dress and legume seed was treated with inoculants. Nitrogen application rates were 45 to 60 lb per acre for dryland grass forages and 120 lb per acre for irrigated forages.

There were generally 4 to 7 replications of cultivars per trial. Forage samples were taken and chopped immediately after harvest with a plot swather and then dried for quality analyses at the USDA Forage Research Laboratory and the University of Nebraska Soil and Plant Analysis Laboratory in Lincoln, or sampled immediately for freezing and subsequent determination of ruminally undegradable intake protein (UIP) at the Ruminant Nutrition Laboratory in the University of Nebraska Department of Animal Science (1997 Nebraska Beef Report, pp. 38-39).

Forage quality tests were conducted using a combination of near infrared reflectance spectroscopy (NIRS) and wet lab chemistry analyses as suggested by the National Forage Testing Association or established against standard reference materials by the labs in Lincoln. Ruminally undegradable intake protein was determined

(Continued on next page)

Table 3. Mineral analyses for dryland spring planted cereal and legume annual forages grown in 1999.[a, b]

Forage Name	Ca %	P %	K %	Mg %	S %	Na %	Cl %	Si %	Mn ppm	Fe ppm	Cu ppm	Zn ppm	Ti ppm	Ni ppm
Spring cereal														
Barley	.30	.20	2.3	.09	.13	.17	.18	4.3	45	460	5	10	30	25
N	8	8	8	8	8	8	8	8	8	8	8	8	8	8
SD	.04	.03	.5	.02	.02	.08	.05	.8	12	230	1.1	2.2	19	10
Oat	.35	.24	3.5	.11	.19	.09	.20	4.7	110	470	6	15	60	30
N	12	12	12	12	12	12	12	12	12	4	12	12	12	12
SD	.05	.04	.4	.02	.03	.09	.09	.8	29	120	.9	3.8	28	14
Triticale	.27	.24	2.7	.09	.16	.07	.14	4.5	70	350	7	16	25	20
N	8	8	8	8	8	8	8	8	8	8	8	8	8	8
SD	.05	.02	.3	.02	.02	.06	.03	.14	23	120	.6	3	7	7
Legume														
Pea	1.2	.33	2.8	.26	.19	.06	.06	3.9	105	—	8	23	—	—
N	32	32	32	32	32	4	4	4	4	—	4	4	—	—
SD	.2	.04	.4	.04	.02	.07	.01	1.6	23	—	2.4	5.8	—	—
Soybean	1.7	.24	1.9	.48	.21	.04	.01	.8	45	220	5	20	25	6
N	48	48	48	48	48	48	48	48	48	48	48	48	48	48
SD	.2	.03	.3	.06	.03	.05	.02	.6	10	150	1.1	4.8	6	1.9
Vetch	1.5	.31	2.9	.26	.20	—	—	—	—	—	—	—	—	—
N	8	8	8	8	8	—	—	—	—	—	—	—	—	—
SD	.3	.04	.3	.03	.02	—	—	—	—	—	—	—	—	—

[a]Dryland spring planted cereal, pea and vetch forages were grown at the University of Nebraska High Plains Agricultural Laboratory near Sidney, where the altitude is about 4300 ft above sea level. Soybean forages were grown at the University of Wyoming Research and Extension Center near Cheyenne, where the altitude is about 6000 ft. All contents are expressed on a dry matter basis. Mineral contents were determined with the use of X-ray analysis.

[b]Abbreviations are: Ca = calcium; P = phosphorus; Mg = magnesium; S = sulfur; Na = sodium; Cl = chlorine; Si = silicon; Mn = manganese; Fe = iron; Cu = copper; Zn = zinc; Ti= titanium; Ni = nickel; N = number of observations; and SD = standard deviation.

on frozen and freeze dried forage samples that were suspended in nylon bags in the rumen of fistulated beef cattle fed a high forage diet. Mineral contents of the 1999 forage crops were determined by x-ray analysis. Results for all quality tests were expressed on a dry matter basis. Data were analyzed with the SAS General Linear Model.

Results

Forage quality results (Tables 1 and 2) include columns for UIP as a percentage of crude protein to indicate the ruminally undegradable portion that bypasses to the intestinal tract. There was considerable variation in the UIP values for most of the cultivars, but UIP was generally in a range of 5 to 10% of CP for the fresh-cut, growing annual forages tested. These values were slightly lower than UIP levels suggested by the National Research Council (1996) for fresh grass and legume forages.

Crude protein levels were similar among cereal and sorghum forages when they were harvested after the majority of the cultivars had produced seed heads. Irrigated foxtail millet was higher in CP and in nitrate nitrogen than the sorghum forages. However, irrigated foxtail millet was fertilized with 120 lb of N per acre, which was the same rate used for the taller growing summer annuals. This rate was too high for the foxtail millet, resulting in nitrate nitrogen values greater than 2000 ppm, a threshold level for toxicity concern in ruminants. Although 1998 dryland foxtail millet was lost to poor stand, the 1999 dryland foxtail millet was lower in CP and nitrate nitrogen due to advanced maturity in a hot, dry growing season and nitrogen application limited to 45 lb of N per acre preplant. While pearl millet was higher in CP and nitrate nitrogen than sorghum forages, the highest levels among three cultivars were in a vegetative cultivar that would not mature and produce seed heads in the environments tested. Thus, variety, maturity and nitrogen management were factors in level of CP and nitrate nitrogen observed in these summer annuals.

Crude protein levels ranged from 12 to 18% of dry matter for soybean, pea and vetch forages when harvested at mid pod-fill (soybean) and

Table 4. Mineral analyses for dryland and irrigated summer annual forages grown in western NE in 1999.[a, b]

Forage Name	Ca %	P %	K %	Mg %	S %	Na %	Cl %	Si %	Mn ppm	Fe ppm	Cu ppm	Zn ppm	Ti ppm	Ni ppm
Dryland														
Forage Sorghum	.49	.13	2.7	.18	.11	.04	.07	4.2	50	240	7	15	20	14
N	32	32	32	32	32	32	32	32	32	32	32	32	32	32
SD	.09	.03	.4	.03	.02	.05	.05	.7	12	170	1.6	3.5	13	8.9
Sorghum x sudan	.43	.12	2.6	.15	.10	.04	.07	4.1	50	180	6	15	16	12
N	24	24	24	24	24	24	24	24	24	24	24	24	24	24
SD	.06	.02	.3	.02	.01	.05	.03	.6	7	80	1.2	2.4	5.7	4.7
Sudangrass	.41	.10	2.5	.17	.06	.011	.06	3.3	40	180	6	13	17	9
N	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SD	.04	.02	.2	.02	.05	.01	.04	1.6	5	28	1	3.5	3.5	.8
Foxtail millet	.35	.12	3.2	.23	.14	.06	.03	3.9	60	100	6	13	12	7
N	36	36	36	36	36	36	36	36	36	36	36	36	36	36
SD	.09	.03	.9	.03	.01	.07	.01	.7	14	18	1.4	3.6	4.3	1.5
Irrigated														
Forage Sorghum	.44	.22	2.6	.29	.14	.16	.50	4.8	90	140	7	25	10	10
N	63	63	63	63	63	63	63	63	63	63	63	63	63	63
SD	.05	.05	.36	.04	.02	.09	.08	.8	20	50	1.6	5.6	5.7	4
Sorghum x sudan	.43	.20	2.5	.29	.13	.13	.48	4.7	100	110	8	26	9	9
N	35	35	35	35	35	35	35	35	35	35	35	35	35	35
SD	.04	.03	.4	.03	.02	.1	.07	.4	11	19	1.2	4.4	5.3	2.9
Sudangrass	.47	.19	2.8	.31	.15	.15	.52	4.7	90	110	7	24	9	7
N	7	7	7	7	7	7	7	7	7	7	7	7	7	7
SD	.05	.04	.5	.02	.02	.13	.06	.6	11	28	1.3	3.7	4.9	2.6
Pearl Millet	.51	.24	4.3	.33	.23	.26	.70	4.1	80	150	8	25.4	9	8
N	42	42	42	42	42	42	42	42	42	42	42	2	42	42
SD	.07	.04	.9	.06	.04	.09	.15	.7	14	38	1.7	5	6.2	4.7
Foxtail Millet	.48	.22	4.7	.31	.21	.14	.43	5.1	105	170	9	35	12	8
N	35	35	35	35	35	35	35	35	35	35	35	35	35	35
SD	.07	.03	.6	.05	.02	.09	.06	1	19	40	1.4	4.6	5.3	2.3

[a]Dryland and irrigated summer annual forages were grown at the University of Nebraska High Plains Agricultural Laboratory near Sidney, and the Panhandle Research and Extension Center near Scottsbluff, respectively. All contents are expressed on a dry matter basis. Mineral contents were determined with the use of X-ray analysis.
[b]Abbreviations are: Ca = calcium; P = phosphorus; Mg = magnesium; S = sulfur; Na = sodium; Cl = chlorine; Si = silicon; Mn = manganese; Fe = iron; Cu = copper; Zn = zinc; Ti= titanium; Ni = nickel; N = number of observations; and SD = standard deviation.

early bloom stages of maturity (pea and vetch). Available energy levels for the legumes were similar to those for the cereal, sorghum and millet forages, averaging about 65% TDN. All energy contents were predicted from acid detergent fiber (ADF) by formulas suggested by the National Forage Testing Association and used by the University of Nebraska Soil and Plant Analysis Laboratory.

Forage mineral levels are shown in Tables 3 and 4 for most of the annual forages harvested in 1999. The differences in mineral levels for the same cultivars and crops grown at different locations were likely due to differences in dryland versus irrigated management, soil type, soil fertility, and cropping history. Means and standard deviations are provided for the contents of macro- and micro-minerals that should be helpful in evaluating the mineral contributions from these annual forages to animal mineral requirements. For example, growing beef cattle weighing 660 lb and gaining 2 lb per day would require 0.36% Ca and 0.19% P in the dry matter of a diet containing 60% TDN. Cattle consuming irrigated sorghum and millet forages grown in this study could have met those requirements.

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[1]Burton A. Weichenthal, professor emeritus, Animal Science; David D. Baltensperger, professor, Agronomy, Panhandle Research and Extension Center, Scottsbluff; Kenneth P. Vogel, professor, Agronomy, and research geneticist, USDA-ARS, Lincoln.