Herbage Production and Nutritive Value of Small Grain Forages

W. E. Pinchak, L. J. Hunt, W. D. Worrall, L. W. Greene, S. P. Caldwell, N. J. Worrall, and D. P. Hutcheson

Summary

In Texas, about 10 million acres of Texas' lands are sown annually to small grains. Most of this acreage is grazed with cattle at some point during the growing season, the duration of which is dependent largely upon government programs and weather. Germplasm enhancement efforts in small grains have focused historically on improved grain yield and quality without consideration of associated responses in forage production or nutritive value. Because dual use of these pastures is of major economic benefit to small grain producers, knowledge of the degree of variation among cultivars in forage production and nutritive value is needed for producers to make cultivar selections best suited to their particular grazing strategy (grain/grazeout). A 2-year cooperative project was initiated in 1987 to evaluate the forage value of small grain cultivars in beef cattle production systems.

Methods

In mid-September 1987, and experiment was initiated at the Texas Agricultural Experiment Station Research Farm (Miles fine sandy loam of <1 percent slope) near Chillicothe to compare the forage yield and quality to 18 commercially available varieties (Table 1) of small grains. On September 17, three replications of each variety were randomly sown in plots on a continuously cropped field. The plots consisted of four 11-ft rows, planted on 1-ft centers. The field was fertilized on September 2 at a rate of 40 lbs N/A with 26-32-0. It was later top dressed at a rate of 40 lbs N/A with 46-0-0.

Forage was harvested in December, March, and April. Harvesting consisted of cutting the two center rows of each plot with a Bell Glade flail mower to a stubble height of 2 inches. Samples were weighed in the field, then sub-sampled (100-150g) and dried at 55^{0}C to a constant weight.

TABLE 1. SEASONAL STANDING CROP DYNAMICS AND FORAGE PRODUCTION (LBS/A/OM) OF 18 COMMERCIAL SMALL GRAIN VARIETIES DURING THE 1988 PRODUCTION YEAR NEAR CHILLICOTHE, TEXAS

	Date			
Variety	12-87 Standing Crop (lbs om/A)	3-88 Standing Crop (lbs om/A)	4-88 Standing Crop (lbs om/A)	Forage Production (lbs om/A)
CENTURY[1]	1075[ab5]	1537[abc]	1665[ab]	4313[ab]
CHISOLM[1]	1107[ab]	1871[ab]	1557[abcd]	4535[ab]
COLLIN[1]	1494[a]	2237[a]	1210[bcdef]	4941[a]
LANCOTA[1]	1459[a]	2322[a]	1173[cdefg]	4954[a]
MATON[2]	105.7[b]	1010[bc]	1344[abcde]	2460[b]
MIT[1]	1337[ab]	2023[ab]	741[g]	4101[ab]
MUSTANG[1]	787[ab]	1742[abc]	1151[defg]	3679[ab]
NORA[3]	954[ab]	1451[abc]	1631[abc]	4036[ab]
PIONEER 2157[1]	1103[ab]	2185[a]	1439[abcd]	4728[a]
PROBRAND 812[1]	1203[ab]	1892[ab]	868[fg]	3963[ab]
SIOUXLAND[1]	1791[a]	2040[ab]	1745[a]	5577[a]
TAM-101[1]	779[ab]	2151[a]	1115[defg]	4045[ab]
TAM-105[1]	528[ab]	1574[abc]	1477[abcd]	3580[ab]
TAM-107[1]	743[ab]	1700[abc]	1585[abcd]	4028[ab]
TAM-200[1]	1137[ab]	1947[ab]	1129[defg]	4213[ab]
TAM-201[1]	829[ab]	2131[a]	940[efg]	3899[ab]
TAMBAR-401[4]	1865[a]	771[c]	1449[abcd]	4085[ab]
VONA[1]	892[ab]	1406[abc]	1652[ab]	3950[ab]

[1]Winter wheat.
[2]Winter rye.
[3]Winter oat.
[4]Winter barley.
[5abcdefg] Means within a column not having a common superscript differ at P<.05.

Forages were analyzed for crude protein (CP) utilizing Kjeldahl nitrogen procedures. Organic matter digestibility (OMD) was estimated utilizing a modified two-stage in vitro technique, with a 48-hour incubation in rumen fluid/buffer first stage followed by neutral detergent extraction. Rumen inoculum was collected from a single cross-bred steer maintained on a bermuda grass hay. Mineral analyses were conducted utilizing a dry ashing-acid digestion procedure (Pinchak et al. 1989). Calcium (Ca), potassium (K), and magnesium (Mg) concentrations were determined by atomic absorption spectrophotometry (Varian AA6) using an air/acetylene flame. Phosphorus (P) was determined by a colorometric procedure (Fiske and Subarrow 1925). Forage production was calculated by summing standing crop estimates for the three sample dates.

Standing crop and nutrient composition data were analyzed with a repeated measure factorial analysis of variance (AOV). Differences among variety were tested utilizing the replicate within variety as the error term. Date and variety x date interactions were tested by residual error. Forage production was analyzed as randomized complete block AOV.

Results

Precipitation and temperature patterns during the 1987-1988 growing season were comparable to the 73-year average at the Chillicothe Research Farm (Figs. 1 and 2). Maton rye produced significantly ($P<.05$) less forage organic matter than all other species/varieties (Table 1). Production ranged from 5,577 lbs/A (Siouxland) to 3,580 lbs/A (TAM-107). Standing crop dynamics followed similar trends as forage production (Table 1). A significant ($P<.001$) variety x date interaction (Table 1) resulted from TAMBAR-401 standing crops decreasing from December 1987 to March 1988, while all other varieties increased. Additionally, standing crop of Chisolm, Maton, Nora, TAMBAR-401, and VONA increased from March to April while the remaining varieties' standing crop decreased. Temporal differences between small grain species in standing crop dynamic was not unexpected, and the reasons Chisolm and Vona standing crops increased while that of all other wheat varieties decreased is unknown.

Seasonal distribution of standing crop varied among varieties within dates. However, there were few statistical differences (Table 1) thereby indicating a considerable amount of variation existed among replications. Early season forage production (i.e., to 12-87) of TAMBAR-401, Sioux-

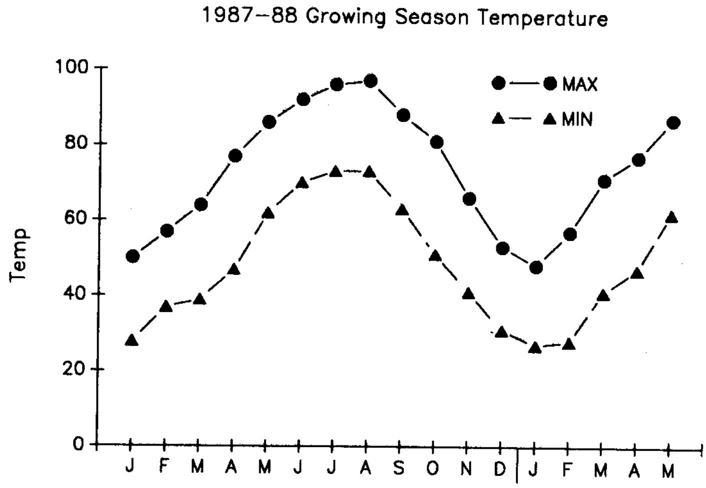


Figure 2. a. Long-term (73 years) monthly maximum and minimum temperatures (°F) at the Chillicothe Research Farm.

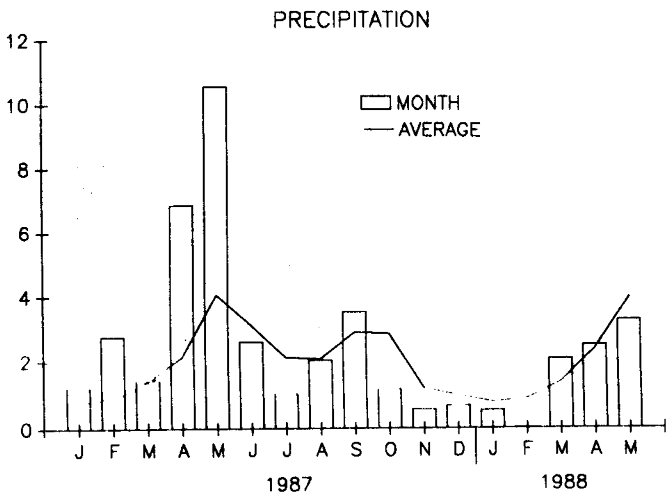
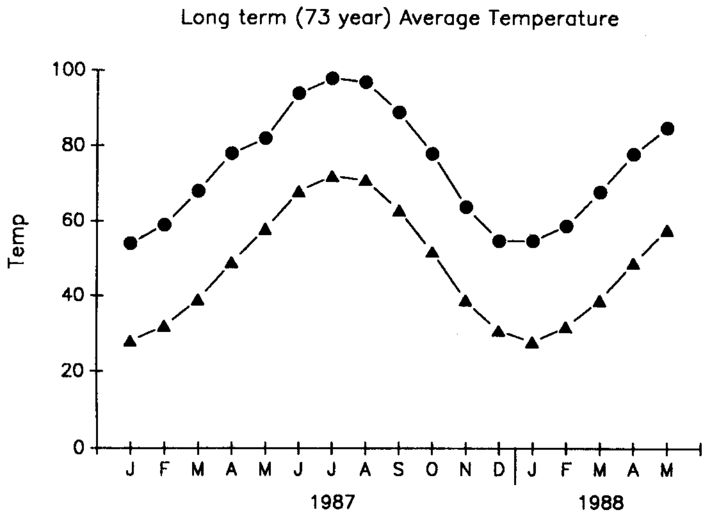


Figure 1. Long-term (73 years) average monthly (solid line) and actual monthly (bars) precipitation during 1987-1988 wheat production year at the Chillicothe Research Farm.



b. Monthly maximum and minimum temperatures (°F) during the 1987-1988 wheat production year at the Chillicothe Research Farm.

land, Collin, Lancota, and MIT tended (P<.10) to be greater than other varieties. Collin, Lancota, Pioneer 2157, TAM-101, and TAM-201 produced significantly more winter to early spring forage than Maton or TAMBAR-401.

Nutritive Value

In vitro organic matter digestibility (IVOMD) generally decreased from December through March and remained unchanged from March through April (Table 2). MIT, TAM-105, and TAM-107 were the only varieties that exhibited IVOMD increases from December to March, all of which had unexpectedly low IVOMD percentages in December. The reasons these varieties were less digestible in December and increased in March is unknown.

Forage CP varied as a function (P<.001) of date and the variety x date interaction (Table 2). There were no differences in CP because of variety. There were no differences among varieties in CP content between the December and March harvest dates; however, there was a significant (P<.001) decline in CP content from March to April as reproductive culm elongation and flowering progressed. The variety x date interaction, while significant, resulted from CP content of some varieties remaining relatively constant from March to April while the majority exhibited significant declines.

Forage Ca, K, and P concentrations varied as a function of date (P<.001), but not variety or the variety x date interaction (Table 3). Peak Ca and K concentrations occurred in March, immediately preceding or in early jointing. In contrast, March forage P concentrations were lower than December and April. Forage Ca and K concentrations generally exceeded beef cattle requirements, whereas P concentrations were well-below animal requirements (NRC 1984) throughout the growing season. There were significant (P<.05) variety and variety x date interaction (P<.07) effects on forage Mg concentrations (Table 3). Averaged across dates, Maton rye had significantly (P<.05) greater Mg concentration than all other varieties. The date x variety interaction resulted primarily from Mg levels increasing from April to March in Maton, Chisolm, and TAM-107 whild decreasing significantly in TAMBAR-401 and Pioneer 2157 and not changing in the remaining varieties.

TABLE 2. SEASONAL TRENDS IN PERCENTAGE ORGANIC MATTER DIGESTIBILITY AND CRUDE PROTEIN CONTENT IN 18 SMALL GRAIN VARIETIES DURING THE 1988 PRODUCTION YEAR AT THE CHILLICOTHE RESEARCH FARM

	Organic Matter Digestibility (%) Date			Variety		Crude Protein (%) Date			Across Dates	
Variety	12-2-87	3-15-88	4-12-88	x̄	s.d.[5]	12-87	3-88	4-88[6]	x̄	s.d.
CENTURY[1]	88	78	73	80	(8)	26	26	19*[2]	24	(4)
CHISOLM[1]	84	78	80	81	(3)	24	23	19	22	(3)
COLLIN[1]	83	78	76	79	(4)	25	24	19*	23	(3)
LANCOTA[1]	86	76	72	78	(7)	28	25	22	25	(3)
MATON[2]	81	78	78	79	(2)	34[1]	28	21*	28	(6)
MIT[1]	74	82	80	79	(4)	23	25	23	24	(1)
MUSTANG[1]	85	82	80	82	(2)	27	24	20*	24	(3)
NORA[3]	88	75	81	81	(6)	31	27	20*	26	(6)
PROBRAND 812[1]	86	77	78	80	(5)	27	25	22	25	(2)
PIONEER 2157[1]	83	80	75	79	(4)	26	26	20*	24	(3)
SIOUXLAND[1]	87	80	76	81	(6)	25	28	20*	24	(4)
TAM W-101[1]	85	79	77	80	(4)	29	25	21*	25	(4)
TAM-105[1]	60	79	77	72	(10)	28	23	18*	23	(5)
TAM-200[1]	86	83	86	85	(2)	27	25	20*	24	(4)
TAM-201[1]	86	78	78	81	(5)	28	22	20	23	(4)
TAMBAR-401[4]	88	81	83	84	(4)	27	27	21*	25	(3)
VONA[1]	87	78	82	82	(4)	26	26	18*	23	(5)
DATE -x̄	83	79	78			27[a3]	25[a]	20[b]		
s.d.	(7)	(4)	(6)			(3)	(2)	(2)		

[1]Winter wheat.
[2]Winter rye.
[3]Winter oat.
[4]Winter barley.
[5]s.d. Standard deviation of the mean.
[6] *Indicates there was a significant (P<.05) decline in CP within variety from March to April.
[7ab]Means within a row not having a common superscript different <.05.

TABLE 3. SEASONAL TRENDS IN FORAGE CALCIUM, PHOSPHORUS, MAGNESIUM, AND POTASSIUM CONTENT OF 18 SMALL GRAIN VARIETIES DURING THE 1988 PRODUCTION AT THE CHILLICOTHE RESEARCH FARM

	Calcium (%)				Phosphorus (%)				Magnesium				Potassium			
Variety	12-87	3-88	4-88	Across Dates ($\overline{x}$)	12-87	3-88	4-88	Across Dates ($\overline{x}$)	12-87	3-88	4-88	Across Dates ($\overline{x}$)	12-87	3-88	4-88	Across Dates ($\overline{x}$)
CENTURY[1]	.29	.31	.27	.29	.14	.10	.11	.12	.19	.16	.15	$.17^{b5}$	3.81	3.21	2.62	3.21
CHISOLM[1]	.26	.29	.25	.27	.12	.10	.13	.12	.19	.15	.19	.18	3.53	3.43	2.64	3.20
COLLIN[1]	.24	.39	.26	.31	.14	.10	.12	.12	.18	.17	.18	$.18^{b}$	3.17	3.43	2.40	3.00
LANCOTA[1]	.32	.36	.31	.33	.12	.11	.12	.12	.20	.18	.20	$.19^{b}$	2.63	2.13	2.54	2.43
MATON[2]	.31	.42	.46	.40	.12	.12	.16	.13	.26	.25	.34	$.28^{a}$	2.25	3.82	3.94	3.34
MIT[1]	.26	.42	.33	.34	.11	.10	.13	.11	.18	.20	.21	$.20^{b}$	2.61	3.31	3.20	3.04
MUSTANG[1]	.26	.47	.29	.34	.12	.11	.13	.12	.18	.17	.15	$.17^{b}$	2.49	3.48	2.65	2.87
NORA[3]	.26	.35	.33	.31	.14	.11	.14	.13	.21	.21	.19	$.20^{b}$	2.35	3.58	3.40	3.11
PROBRAND 812[1]	.36	.38	.30	.35	.13	.09	.13	.12	.20	.21	.22	$.21^{b}$	2.88	3.38	2.91	3.06
PIONEER 2157[1]	.33	.40	.29	.34	.12	.10	.13	.12	.18	.19	.15	$.17^{b}$	2.76	2.96	2.53	2.75
SIOUXLAND[1]	.32	.38	.29	.33	.12	.10	.12	.11	.20	.19	.20	$.20^{b}$	3.31	4.41	3.24	3.65
TAM W-101[1]	.33	.37	.31	.34	.13	.11	.13	.12	.21	.18	.20	$.20^{b}$	3.52	3.34	2.81	3.22
TAM-105[1]	.21	.33	.34	.29	.12	.10	.13	.12	.17	.16	.13	$.15^{b}$	2.57	3.15	3.16	2.96
TAM-107[1]	.17	.27	.27	.24	.09	.09	.13	.10	.14	.15	.21	$.17^{b}$	2.18	2.87	2.71	2.59
TAM-200[1]	.29	.38	.31	.33	.12	.10	.12	.11	.20	.21	.22	$.21^{b}$	3.57	3.97	2.58	3.37
TAM-201[1]	.27	.38	.30	.32	.12	.10	.13	.12	.17	.17	.20	$.18^{b}$	2.46	3.20	2.70	2.79
TAMBAR-401[4]	.40	.43	.29	.37	.15	.10	.12	.12	.21	.19	.13	$.18^{b}$	4.15	3.19	2.10	3.15
VONA	.25	.34	.25	.28	.13	.10	.13	.12	.18	.18	.18	$.18^{b}$	2.81	3.34	2.34	2.83
Across Varieties	$.29^{b1}$	$.37^{a}$	$.30^{b}$		$.12^{ab}$	$.10^{b}$	$.13^{a}$		.19	.18	.19		2.95^{ab}	3.29^{a}	2.80^{b}	

[1]Winter wheat.
[2]Winter rye.
[3]Winter oat.
[4]Winter barley.
[5ab]Means within a row or column not having a common superscript differ at <.05.

Discussion and Conclusions

Based upon one year's data, there was little statistical difference in forage production among species and varieties of small grains because extreme variation among replicates masked any varietal differences. However, the magnitude of differences in production would indicate varieties such as Siouxland, Lancota, and Chisolm have sufficiently greater forage production potential to warrant consideration in management strategies involving grazing, particularly grazeout, of wheat acreage. Equally important to the suitablity of a variety for grazing, is its seasonal distribution of forage because that effects the frequency which stocking rate adjustments must be made. Early season (fall-winter) forage production ultimately limits initial stocking rates and total beef production. Therefore, fall forage production potential should be considered in variety selection for grazing purposes. Eight of the 18 varieties produced less than 1,000 lbs/A from September to December, indicating these may not be well suited to season long grazing strategies.

There was little apparent differentiation among varieties within a species in nutritive value. In terms of OMD and CP concentration, nutrient value of all varieties was sufficient on all dates to meet stocker cattle requirements (NCR 1984). Similarly there was little difference among varieties in Ca, P, Mg, and K content. Throughout the season, forage levels of Ca, Mg, and K were sufficient to meet animal requirements. However, P contents were marginal to deficient throughout the grazing season, even though the plots had been fertilized with P.

In conclusion, there appear to be sufficient differences in forage production potential to warrant further investigation of commercial small grain varieties and selection for it in experimental lines. The absence in nutritive value differentiation among small grain varieties is not surprising because: 1) all 18 species/varieties studied were cool-season annual grasses of very similar ontogeny and phylogeny, and 2) small grain breeding programs have not selected germplasm and developed varieties based upon forage production or its nutritive value. Instead most have focused on improving yield and quality of grain.

Literature Cited

1. National Research Council. 1984. Nutrient Requirements of Beef Cattle Sixth Edition. Washington, D.C.
2 Pinchak, W.E., L.W. Greene, and L.J. Hunt. 1989. Bias in relative estimates of dietary mineral status from esophageal extrusa. J. Range Manage. (In Press).
3. Fiske, C.H. and Y. Subarrow. 1925. The colorimetric determination of phosphorus. J. Biol. Chem. 66:375-400.