Fall-Growth Potential of Cereal-Grain Forages for Livestock

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Introduction

Site prepared for winter annual forage plots

For decades, livestock producers in the southern Great Plains, and throughout the southeastern US, have utilized winter-annual cereal grains and/or annual ryegrass as high-quality forage to meet the nutritional requirements of stockers, replacement beef heifers, or dairy cattle. While the quality of these forages remains exceptionally high throughout most of the late fall and spring, forage availability is frequently limiting. This is especially true during the early fall, when producers need high-quality forage for recently weaned steers, and then during the coldest periods of the winter when forage growth slows dramatically.

Throughout Texas, Oklahoma, and Kansas, stocker cattle are allowed to graze hard-red winter wheat pastures until the plants reach the first hollow stem stage of development, at which time cattle must be relocated to prevent the removal of meristematic tissue critical to grain production. Throughout these states, much of the wheat is utilized as a ‘dual purpose’ crop that supplies high-quality forage for growing steers, and then as a grain crop during the early summer. In Arkansas, the production of cereal grains is centered within the Mississippi River Delta, which is an area with relatively few beef or dairy cattle. In contrast, most of the livestock producers in Arkansas are located within the Ozark and Ouachita Mountains in the northern and western parts of the state; typically, these producers are not interested in grain production and utilize cereal grains only as forages. This strict segregation of cereal grain usage into either grain or livestock production suggests that species/varietal selection should be based on vastly different criteria, depending on how the plant will be utilized. Traditionally, breeding programs have focused on traits that are critical to grain production with relatively little attention given to forage production and quality. One of the most important criteria for evaluating cereal grains as forage crops is the potential for fall growth. Two keys to maximizing profit in the stocker business are: 1) to move recently weaned calves to cereal-grain forages as quickly as possible in the fall; and 2) to maximize the number of grazing days on cereal-grain forages throughout the late fall and winter, while minimizing reliance on harvested or dormant forages. To meet both of these goals, it is essential to maximize fall forage growth. The objectives of this research were: 1) to evaluate the fall growth potential of eight cereal-grain forages obtained from diverse sources; 2) to evaluate the re-growth potential for these same forages following an initial harvest in the fall; and 3) to establish some simple guidelines for estimating available forage based solely on forage canopy height.

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Materials and Methods

Johnny Gunsaulis monitors small grain seeding

Site Preparation. Sites at both the Livestock and Forestry Branch Station, near Batesville, and at the Agriculture Experiment Station in Fayetteville were selected for this project. Each site was clean-tilled and fertilized to meet the soil-test recommendations for establishment of cereal grains described by the Arkansas Cooperative Extension Service. At both sites, 50 lbs N/acre was applied as ammonium nitrate (34-0-0) at planting; no additional fertilizer was applied on any later date during the trial.

At each site, varietal entries were arranged in a randomized complete block design with four replications; individual plot sizes were 21 x 25 and 30 x 25 feet at the Fayetteville and Batesville sites, respectively.

Establishment. Plots were established with a 7-foot Marliss Pasture King (Marliss Industries, Jonesboro, AR) drill with 7-inch row spacings at Fayetteville, and a 10-foot John Deere Model 750 (Deere and Co., Moline, IL) drill with 7.5-inch row spacings at Batesville. Cereal grains were seeded at rates typical for the region, which were 120 lbs/acre for wheat, 112 lbs/acre for rye and triticale, and 96 lbs/acre for oat. Plots were drilled into a clean-tilled seedbed on September 8 and 10, 2004 at the Fayetteville and Batesville sites, respectively.

Harvest Management. Beginning in mid-October, a single 25-foot strip was mowed to a 2-inch stubble height from each plot with a 3-foot wide sickle-bar mower. All (wet) clipped forage was then weighed, and a subsample of each forage was dried to constant weight at 50^{o}C to determine the percentage of dry matter (DM) in each sample. This value was then used to calculate the yield of DM from each plot. Plots were clipped at intervals of approximately two weeks through the end of December, but intervals varied somewhat due to prolonged periods of wet or inclement weather. On each sampling date throughout the October through December initial harvest period, a different strip within each plot was randomly selected for harvest, and no strip was harvested more than once during this time period. In addition to DM yield, canopy height was measured at three locations across each plot immediately prior to clipping.

At the Fayetteville site, all plots were harvested a second time on February 15, 2005 to assess the re-growth potential of each cereal grain as affected by initial harvest date. Procedures for harvesting forage re-growth were identical to those described previously.

Description of Cereal-Grain Entries. Entries in this study (Table 1) were selected such that several species (wheat, oat, rye, and triticale) were represented. Varieties were selected from various breeding programs and other commercial sources from across the country. Most of the entries in this study are relatively recent releases.

Regression of DM Yield on Canopy Height. A quick, simple estimator of available forage is a valuable tool for producers managing grazing livestock. This is especially true when strip grazing techniques are used because forage must be allotted to grazing cattle on a frequent basis. When simple measurements, such as canopy height, can be used to estimate available forage, the allotment of forage is made much easier. For this reason, canopy height was measured on each harvest date, and simple linear regression techniques were used to relate canopy height to available forage DM. These relationships were evaluated for harvests of initial growth at both Fayetteville (n =192) and Batesville (n = 192), the harvest of forage re-growth in Fayetteville on February 15, 2005 (n = 192), and for all harvested forages combined (n = 576).

Results and Discussion

Small grains plots 36 days after planting

For both canopy height and DM yield, there generally were strong entry x harvest date interactions ($P < 0.0001$) for forages harvested during the fall in Fayetteville and Batesville, and for the forage re-growth harvested in Fayetteville in mid-February. A lone exception was observed for DM yield at Batesville, where there was only a tendency for interaction ($P = 0.069$). Because of these interactions, canopy height and DM yield for each entry were evaluated independently for linear, quadratic, cubic, or quartic effects of time.

Fall Forage Growth in Fayetteville. Soil moisture in Fayetteville was adequate for immediate germination, but droughty conditions during the first month after establishment greatly limited forage growth and accumulation of DM (Table 2). Most forage entries exhibited increases in canopy height and accumulated DM in curvilinear patterns over time. This was not totally unexpected because growth rates typically slow as temperatures decrease in the late-fall, but several other factors probably contributed to these responses. During the 2004 growing season, the droughty conditions during the first month after establishment were followed by relatively wet and warm conditions throughout the rest of the fall. As a result, DM yield for all entries increased sharply between the November 5 and December 14 harvest dates. These increases ranged from 461% for Blaze oat down to 150% for Wintergrazer 70 cereal rye.

A second factor affecting the accumulation of forage DM was the inconsistent physiological development observed across entries. Four entries (AR 910, OK 101, and Armor Prograze wheat, and Wintergrazer 70 rye) remained vegetative (did not joint) throughout the fall, and did not exhibit any evidence of stem elongation. It is interesting that three of these entries (AR 910 and OK 101 wheat, and Wintergrazer 70 cereal rye) accumulated DM in a linear pattern with time, and were the only exceptions to the curvilinear responses observed for all other entries. Armor Prograze wheat appeared to be especially susceptible to leaf disease during the warm and wet late-fall and did not accumulate any DM between the November 16 and December 14 harvest dates. All other entries exhibited jointing and stem elongation in at least some tillers. For both oat entries and the triticale, virtually all tillers jointed and elongated, and a few seedheads were observed in the Horizon 474 oat and the Monarch triticale. For AGS 104 cereal rye, a relatively small proportion of all tillers jointed and elongated (about 3 tillers/foot of drill row), but many of these developed to the point that a seedhead was visible.

A final factor affecting the yield of DM was the sensitivity of some entries, especially those that elongated, to freeze damage. This was particularly true for Blaze spring oat, which exhibited a 1022 lbs DM/acre decrease in yield between the December 14 and 29 harvest dates. In contrast, the three wheat varieties and the Wintergrazer 70 cereal rye, all of which remained vegetative throughout the study, exhibited numerical increases in DM yield ranging from 13.1 to 35.7% over the same time period.

Averaged over all entries, the maximum numerical yield of DM was observed on the December 14 harvest date. On that date, yields of DM for all entries that exhibited stem elongation (Horizon 474 and Blaze oat, Monarch triticale, and AGS 104 cereal rye) averaged 3667 lbs DM/acre compared to only 1543 lbs DM/acre for those entries that remained in the vegetative stage of development. Of those entries that jointed and elongated, Blaze spring oat exhibited the greatest numerical DM yield (4153 lbs DM/acre).

Fall Forage Growth in Batesville. Unlike the Fayetteville site, soil moisture immediately after planting was not adequate for germination, and there was no forage that could be harvested for any entry on the initial October 20 harvest date (Table 3). Because of delayed germination, overall forage yields were far lower at Batesville than observed in Fayetteville. However, canopy height and DM yield increased over time in primarily curvilinear patterns, which was consistent with observations for Fayetteville. Although there was little evidence of jointing or stem elongation for any entry until the January 10 harvest date, Blaze spring oat, Horizon 474 winter oat, Monarch triticale, and AGS 104 cereal rye averaged 969 lbs DM/acre compared to only 557 lbs DM/acre for the other entries on the December 16 harvest date. As observed at the Fayetteville site, the oat varieties were particularly sensitive to freeze damage and/or winterkill.

Re-growth Potential in Fayetteville. As expected, accumulation of re-growth for all entries declined in curvilinear patterns as the interval between the initial and final (February 15, 2005) harvest date became shorter (Table 4). Because of their sensitivity to freeze damage and advanced physiological development on the later initial harvest dates, oat and triticale entries exhibited little or no re-growth if the initial harvest date was later than November 16. In contrast, the wheat entries exhibited excellent re-growth potential between the final harvest of initial growth (December 29) and February 15, accumulating an average of 787 lbs DM/acre, compared to only 447 lbs DM/acre for the two cereal-rye entries.

Regression of DM Yield on Canopy Height. A simple linear relationship that allows producers to quickly calculate available forage DM is a very valuable management tool, particularly when strip grazing techniques are used to limit forage waste. Unfortunately, a detailed statistical analysis of the relationship between canopy height and DM yield for the eight cereal-grain entries (data not shown) indicated that the eight entries accumulated DM at different rates and/or in different patterns with canopy height. In part, this can be explained on the basis of stem elongation in some entries, but not in others, and because the rye forages were observed to tiller aggressively, while the oat and triticale varieties did not. However, the statistical standards necessary for formal scientific work are much more restrictive than those needed to establish quick, rule-of-thumb guidelines for producer use. Linear regressions of DM yield on canopy height for initial fall forage growth in Fayetteville (Figure 1) and Batesville (Figure 2), forage re-growth in Fayetteville (Figure 3), and for all forages combined (Figure 4) indicate that a simple measure of canopy height may be useful as an quick estimator of forage DM. When all cereal-grain forages in this study ($n = 512$) were evaluated together, 169 lbs DM/acre were accumulated for every inch of canopy height greater than 3 inches.

Implications

Winter annuals, Batesville, Fall 2004

When the criteria for evaluation are limited to fall forage growth potential, these data suggest that oat and triticale varieties are considerably more productive than wheat. However, oat and triticale varieties also were most sensitive to freeze damage, and re-growth potential appeared to be limited. Some of this sensitivity to freeze damage probably could be reduced by applying grazing or clipping pressure to keep these forages in a vegetative stage of development throughout the fall and early winter, but this option was not evaluated in these studies.

Canopy height may be useful as a quick estimator of forage availability; when all forages, sites, dates, and conditions were considered together, DM yield increased by 169 lbs DM/acre for every inch of canopy height greater than 3 inches.

Table 1. Description of varietal entries for fall forage production studies in Fayetteville and Batesville during 2004.

Species	Variety	Type	Origin/Distribution
Oat	Horizon 474	winter oat	developed in the University of Florida breeding program; licensed currently to Plantation Seed in Newton, GA
	Blaze	spring oat	developed in the University of Illinois breeding program
Wheat	AR 910	soft-red winter wheat	developed by Dr. Robert Bacon at the University of Arkansas; licensed currently to Delta King
	OK 101	hard-red winter wheat	developed in the Oklahoma State University breeding program; public variety
	Armor Prograze	winter wheat	used extensively in the stocker program at the Batesville Livestock and Forestry Branch Station; available through Collum Seeds of Fisher, AR
Triticale	Monarch	winter triticale	developed in the University of Florida breeding program; a relatively recent release, seed may not be available
Rye	AGS 104	winter cereal rye	developed within the University of Florida breeding program; licensed currently to Ag South Genetics
	Wintergrazer 70	winter cereal rye	used extensively in the stocker program at the Batesville Livestock and Forestry Branch Station; available from Pennington Seed, Inc.

Table 2. Canopy height and fall forage DM yield from eight cereal-grain forages planted on September 8, 2004 in Fayetteville, AR.

Harvest date	Horizon 474 Oat	Blaze Oat	AR 910 Wheat	OK 101 Wheat	Armor Wheat	Monarch Triticale	AGS 104 Rye	Wintergrazer 70 Rye
Canopy Height [1]				inches				
Oct 19	7.7	10.2	7.0	6.9	6.1	9.1	8.4	6.6
Nov 5	16.4	15.9	10.7	11.3	9.3	14.0	12.3	8.0
Nov 16	20.7	23.3	12.6	12.3	13.2	19.2	15.0	9.1
Dec 2	18.4	21.7	10.6	10.2	9.8	17.7	12.8	7.7
Dec 14	18.4	22.6	10.4	10.0	9.2	19.1	11.5	7.3
Dec 29	13.5	12.2	9.3	10.0	9.8	17.2	11.8	8.1
Effects[2]	L, Q, C	L, Q, C	L, Q, C	L, Q, C	L, Q	Q, C	Q, C	L, Q, C, Qu
DM Yield [1]				lbs/acre				
Oct 19	226	403	246	284	209	436	440	552
Nov 5	1078	900	856	975	499	1467	1185	1059
Nov 16	1971	2098	855	1403	1035	1966	1787	1380
Dec 2	3168	3390	1849	2085	1076	3176	2489	1946
Dec 14	3343	4153	1464	2013	1102	3806	3364	1591
Dec 29	3430	3131	1844	2276	1495	3528	2889	1926
Effects[2]	L, Q, C	L, Q, C	L	L	L, Q, C	L, Q, C	L, Q	L

[1] Standard errors of the forage x harvest date interaction means for canopy height and DM yield were 0.58 inches and 201.7 lbs/acre, respectively.
[2] Abbreviations: L, linear; Q, quadratic; C, cubic; and Qu, quartic effects of time, where $P \leq 0.05$.

Table 3. Canopy height and fall forage DM yield from eight cereal-grain forages planted on September 10, 2004 in Batesville, AR.

Harvest date	Horizon 474 Oat	Blaze Oat	AR 910 Wheat	OK 101 Wheat	Armor Wheat	Monarch Triticale	AGS 104 Rye	Wintergrazer 70 Rye
Canopy Height [1]	----------	----------	----------	inches	----------	----------	----------	----------
Oct 20	2.7	3.1	2.8	2.9	2.8	2.9	3.2	3.1
Nov 9	8.5	10.0	7.4	8.2	8.8	8.9	8.0	6.9
Nov 18	10.1	11.1	8.1	8.3	8.5	11.0	10.0	7.5
Dec 3	10.2	12.0	7.8	8.6	8.1	10.7	8.4	6.4
Dec 16	9.7	12.2	7.0	7.5	7.2	11.2	8.8	5.8
Jan 10	8.1	7.5	7.0	7.2	6.9	11.1	9.9	5.6
Effects[2]	L, Q, C	L, Q	L, Q, C	L, Q, C	L, Q, C	L, Q, C	L, Q, C	L, Q, C
DM Yield [1]	----------	----------	----------	lbs/acre	----------	----------	----------	----------
Oct 20	0	0	0	0	0	0	0	0
Nov 9	279	342	198	246	238	260	345	166
Nov 18	566	509	290	381	388	480	666	239
Dec 3	831	919	464	601	455	739	843	325
Dec 16	1214	901	577	693	485	882	878	473
Jan 10	708	395	460	512	341	721	720	258
Effects[2]	L, Q, C	L, Q, C	L	L, Q	L, Q, C	L, Q	L, Q	L, Q

[1] Standard errors of the forage x harvest date interaction means for canopy height and DM yield were 0.44 inches and 120.5 lbs/acre, respectively.

[2] Abbreviations: L, linear; Q, quadratic; and C, cubic effects of time, where $P \leq 0.05$.

Table 4. Canopy height and DM yield for re-growth of cereal-grain plots on February 15, 2005 in Fayetteville, AR following an initial harvest between October 19 and December 29, 2004.

Initial Harvest Date	Horizon 474 Oat	Blaze Oat	AR 910 Wheat	OK 101 Wheat	Armor Wheat	Monarch Triticale	AGS 104 Rye	Wintergrazer 70 Rye
Canopy Height [1]	---------- inches ----------							
Oct 19	8.5	6.8	10.7	9.3	8.7	11.9	11.8	7.8
Nov 5	5.8	2.0	9.8	8.1	7.2	8.4	10.9	6.1
Nov 16	3.4	2.0	8.6	7.5	8.1	4.3	9.6	5.8
Dec 2	2.0	2.0	7.3	6.9	6.5	2.0	7.1	5.9
Dec 14	2.0	2.0	7.1	6.5	6.7	2.0	6.0	5.7
Dec 29	2.0	2.0	7.6	6.8	7.2	2.0	6.3	5.9
Effects[2]	L, Q	L, Q, C, Qu	L, Q	L, Q	L, Q, Qu	L, C	L	L, Q
DM Yield [1]	---------- lbs/acre ----------							
Oct 19	1576	1418	2170	2462	1226	2179	2429	1824
Nov 5	633	0	1469	1353	668	978	1407	710
Nov 16	158	0	1105	1160	821	353	998	534
Dec 2	0	0	680	690	437	0	526	433
Dec 14	0	0	548	630	454	0	406	587
Dec 29	0	0	760	906	695	61	453	441
Effects[2]	L, Q	L, Q, C, Qu	L, Q	L, Q	L, Q	L, Q	L, Q	L, Q

[1] Standard errors of the forage x harvest date interaction means for canopy height and DM yield were 0.39 inches and 140.2 lbs/acre, respectively.

[2] Abbreviations: L, linear; Q, quadratic; C, cubic, and Qu, quartic effects of time, where $P \leq 0.05$.