Clipping Frequency and Fertilization Influence Herbage Yields and Crude Protein Content of 4 Grasses in South Texas

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Abstract

Crude protein content of herbage produced by buffelgrass, blue panicgrass, and Bell rhodesgrass was improved with nitrogen and phosphorus fertilization and clipping every 4 or 8 weeks, compared to harvests only at the end of the growing season. Within a fertilization level, the 8-week clipping frequency generally increased dry matter production of the grasses over the 4-week clipping frequency or the end-of-season single harvest. Kleberg bluestem herbage generally contained less protein at all phenological stages than that of buffelgrass, blue panicgrass, or Bell rhodesgrass, and dry matter production was not increased by fertilization. Crude protein content of Kleberg bluestem herbage was only slightly increased with the highest level of fertilization, regardless of clipping frequency.

The South Texas Plains occupies nearly 9 million hectares of level to rolling terrain with elevations ranging from sea level to 95 m. Annual rainfall ranges from 45 to 75 cm with peaks occurring in May and September. Because of the long growing season and rainfall patterns, this area has a high potential for forage production. However, primarily as a result of continued excessive grazing of domestic livestock and cessation of fires, undesirable woody species have increase to the detriment of naturally occurring desirable vegetation (Scifres 1980).

Brush management as a part of overall sound range management has proven its merit in restoring forage production (Scifres et al. 1976, 1980; Polk et al. 1976). Generally, natural revegetation through secondary succession is too slow for economical returns following high-cost mechanical control of undesirable woody species. Artificial revegetation with commercially available, adapted species is often considered the most feasible alternative for rapid restoration of these grazing lands. Major species that have been seeded successfully include buffelgrass *(Cenchrus ciliaris),* Bell rhodesgrass *(Chloris gayana),* Kleberg bluestem *(Dicanthium annulatum),* and blue panicgrass *(Panicum antidotale).*

Although these grasses have been utilized in the overall range improvement program in south Texas for the past 4 decades, little is known about specific post-seeding management practices which could improve forage yield and quality. Brief descriptions, planting dates, seeding rates, and responses to irrigation and fertilization are found in experiment station leaflets (Novosad and Pratt n.d., Lancaster n.d., Lancaster 1949, and Anon. 1968).

Since most of the livestock in this area are raised in yearlong cow-calf operations, high protein forage is required throughout the year to meet demands of growing calves and lactating cows. Waite (1958) states that heavy fertilization and regular close cutting or grazing of a grass during the growing season is usually necessary to obtain maximum yield of dry matter and protein from tropical grasslands. The optimum level of fertilization and frequency of harvest vary with the grass.

Since little information on management of buffelgrass, Bell rhodesgrass, blue panicgrass, and Kleberg bluestem for maximum production is available, a study was designed to test the effects of fertilizer rates and clipping frequencies on dry matter production and crude protein content of the herbage of these grasses.

Study Area and Methods

The study was conducted during the 1972 and 1973 growing seasons on the Texas A&I University farm approximately 1.5 km north of Kingsville in Kleberg County, Texas. The soil in the study area was a Clareville loam, a member of the fine, mixed hyperthermic family of Pachic Arguistolls.

Average rainfall for Kingsville is about 64 cm with peaks in May and September of 8 cm and 12 cm, respectively. March is usually the driest month with an average of about 4 cm. Occasionally, tropical hurricanes, which occur from June to November, add large amounts of rainfall. Otherwise, these months are usually relatively dry (Climatogical Summary 1971). During the 1972 growing season, precipitation was above average in February, June, and July with 44, 22, and 14 cm, respectively. Spring 1973 precipitation was slightly below average, but not severe enough to reduce growth.

Temperature in Kingsville averages 9° C in January and 36° C in July, and the average frost-free period is 314 days (Texas Almanac 1971). The first killing frost during the study occurred in November 26, 1972, and the last killing frost occurred on February 12, 1973.

Before the grasses were planted, 3 composite soil samples from 0 to 15 cm deep were randomly collected and sent to the Texas A&M Soil Testing Laboratory, College Station, Texas, for analysis of mineral deficiencies (Table 1). The laboratory recommended a fertilizer rate of 156 kg/ha of nitrogen (N) and 44 kg/ha of phosphorus (P). The other rates of 78 kg/ha of N plus 22 kg/ha of P and 312 kg/ha of N plus 88 kg of P were half and twice the recommended rate, respectively.

Three plots, 5.5 by 30.5 m, of each of the 4 grasses were established on May 1, 1972. Plant cuttings including roots, crowns, and approximately 5 cm of top growth above the crown were planted in 6 rows in each plot. The experimental design was a randomized complete block arranged in a split-plot with species constituting the main plot effect. Clipping frequencies and fertilizer levels were subplots in the split-plot design.

On August 15, 1972, when all plants were well established, each plot was clipped to a uniform 5-cm stubble height. Immediately after clipping, fertilizer was surface applied at 0–0, 78–22, 156–44, or 312–88 kg/ha N-P in 7.5 m wide strips across each block.

Two rows of each plot were assigned a 4-week clipping frequency (clipped on September 15 and October 16, 1972; and April 15 and

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Table 1. Fertility levels and pH of the soil of the study area where clipping frequency and fertilization was evaluated relatived to crude protein constants and herbage production of 4 grass species near Kingsville, Texas, during 1972-1973.[1]

		Nutrient availability								
		Ca		Mg		N	P_2O_5		K_2O	
Soil series	pH	kg/ha	Level[2]	kg/ha	Level	Level	kg/ha	Level	kg/ha	Level
Clareville	7.73	6720	VH	560	H	L	110	H	1344	VH

[1]Based on testing procedures used by the Texas A&M University Soil Testing Laboratories.
[2]Indicates general level where L = low, VL = very low, M = medium, H = high, VH = very high.

May 15, 1973). Two rows were assigned an 8-week clipping frequency (clipped on October 16, 1972, and April 15, 1973) and 2 rows were clipped only on January 15, 1973.

Standing crop was estimated from harvest of 2 m by 6.5 m areas to a 5 cm stubble height at each clipping date. Herbage was air dried at 50° C for 48 hours in a forced-air dryer. Dried samples were ground to pass a 1-mm mesh using a Wiley mill. Crude protein content was determined by the Kjeldahl procedure as described by Brenner (1965).

Data were subjected to analysis of variance and treatment means were separated based on least significant differences at $P<.05$ (Steel and Torrie 1960).

Results

Buffelgrass

Crude Protein Content

Buffelgrass clipped to a 5 cm stubble height every 4 weeks produced herbage higher in crude protein content than when clipped every 8 weeks, or when clipped only at the end of the growing season, regardless of fertilizer level (Table 2). Herbage produced by buffelgrass clipped every 8 weeks was higher in crude protein than when clipped only at the end of the growing season in all plots receiving fertilizer. Crude protein content of herbage produced by buffelgrass harvested only at the end of the growing season was not influenced by fertilizer rate. At the end of the growing season, the majority of the vegetative matter was stems, while during other sampling dates the majority of the herbage was leaves which are higher in crude protein.

Dry Matter and Total Crude Protein Content

Dry matter production by buffelgrass increased with increasing rates of fertilization for all clipping frequencies except for the zero level. Buffelgrass clipped every 4 or 8 weeks produced more dry matter than when clipped only at the end of the growing season (Table 2). Compared to nonfertilized plots, dry matter production was approximately doubled by fertilizing at 312-88 kg/ha N-P and harvesting every 4 or 8 weeks.

Total annual crude protein produced by buffelgrass was increased with increasing rate of fertilization for all frequencies except the two higher fertilizer rates clipped every 8 weeks (Table 2). However, more crude protein was produced when buffelgrass was clipped every 4 or 8 weeks than when it was clipped only at the end of the growing season. The highest yield of crude protein by buffelgrass herbage occurred in plots receiving 312-88 kg/ha N-P and clipped every 4 weeks. Plots which were clipped once at the end of the growing season produced 110 kg/ha of crude protein with no fertilization and 180 kg/ha of crude protein with 312-88 kg/ha N-P.

Bell Rhodesgrass

Crude Protein Content

Crude protein content of Bell rhodesgrass increased with increasing rates of fertilization within each clipping frequency. The greatest increase was obtained from the 4-week clipping frequency where crude protein was 11.3% in plots which received 312-88 kg/ha N-P compared to 7.8% in nonfertilized plots (Table 3). Crude protein content of Bell rhodesgrass herbage harvested every 8 weeks was generally lower than when clipped every 4 weeks at a given level of fertilization. Herbage on fertilized plots harvested every 8 weeks averaged 5.1% crude protein content, while forage on plots receiving 312-88 kg/ha N-P contained an average 9.4% crude protein (Table 3). Crude protein content in herbage from nonfertilized Bell rhodesgrass clipped only at the end of the growing season was equal to nonfertilized herbage harvested every 8 weeks.

Dry Matter and Crude Protein Produced

Topgrowth produced by Bell rhodesgrass was generally greater on plots clipped every 4 weeks than on those clipped every 8 weeks or only once at a given level of fertilization. Although crude protein content was equal in nonfertilized herbage from samples harvested

Table 2. Herbage standing crop, crude protein content of herbage, and total crude protein standing crop under different clipping and fertilization treatments of buffelgrass near Kingsville, Texas.[1]

Clipping frequency	Fertilization rate (N-P, kg/ha)	Dry matter (kg/ha)	Crude protein content (%)	Crude protein produced (kg/ha)
Every 4 weeks	0–0	4002 a	7.3 a	291 a
	78–22	5979 b	8.9 b	533 b
	156–44	6062 b	10.9 c	661 c
	312–88	7115 c	10.9 c	775 d
Every 8 weeks	0–0	3338 a	4.9 a	163 a
	78–22	7016 b	7.7 b	543 b
	156–44	7265 b	8.0 b	578 c
	312–88	8104 c	8.1 b	656 c
End-of-growing season	0–0	2131 a	5.2 a	110 a
	78–22	2910 b	5.2 a	152 b
	156–44	2907 b	5.1 a	149 b
	312–88	3004 b	6.0 a	180 c

[1]Means within a clipping frequency followed by the same letter are not significantly different at the 95% level.

Table 3. Herbage standing crop, crude protein content of herbage and total crude protein standing crop under different clipping and fertilization treatments of Bell rhodesgrass near Kingsville, Texas[1].

Clipping frequency	Fertilization rate (N-P, kg/ha)	Dry matter (kg/ha)	Crude protein content (%)	Crude protein produced (kg/ha)
Every 4 weeks	0–0	4562 a	7.8 a	358 a
	70–20	6015 a	9.3 b	563 b
	140–40	7821 c	10.3 c	802 c
d	280–80	6349 b	11.3 c	718 c
Every 8 weeks	0–0	4365 b	5.1 c	222 c
	70–20	5297 b	5.9 a	311 b
	140–40	6012 c	9.0 b	543 c
	280–80	6540 c	9.4 b	612 d
Once during year	0–0	2090 a	5.0 a	105 a
	70–20	2096 a	6.0 a	125 a
	140–40	2760 a	6.2 a	171 b
	280–80	2715 a	6.7 b	179 b

[1]Means within a clipping frequency followed by the same letter are not significantly different at the 95% level.

every 8 weeks and once at the end of the growing season, there was more total crude protein content produced from the 8-week clipping frequency. This increase was attributed to the higher dry matter produced on plots clipped every 8 weeks. The highest crude protein content of Bell rhodesgrass herbage was 802 kg/ha on plots clipped every 4 weeks and fertilized with 156-44 kg/ha N-P. Clipping Bell rhodesgrass once during the year resulted in lowest crude protein content for most fertilizer rates.

Blue Panicgrass

Crude Protein Content

At a given harvesting frequency and fertilization rate, blue panicgrass appeared to have the highest crude protein content of the grasses studied (Table 4). This apparent inherent ability to produce herbage of relatively high crude protein content resulted in a higher nitrogen demand as indicated by lack of plant vigor and chlorotic plants on nonfertilized plots. Crude protein content of blue panicgrass clipped every 4 weeks on nonfertilized plots was 9.2%. Addition of 312/88 kg/ha N-P increased crude protein content to 16.9%.

Blue panicgrass herbage from the every 8 weeks harvest was lower in crude protein content than that from clipping every 4 weeks (Table 4). However, within the 8-week clipping frequency, the highest level of protein occurred in herbage from plots fertilized with the recommended rate (156-44 kg/ha N-P) or twice the recommended rate (312-88 kg/ha N-P). Crude protein content was doubled by the highest fertilization rate when clipped once during the year, compared to unfertilized herbage.

Although no statistical comparisons were made between clipping frequencies, there was a trend for herbage harvested every 4 weeks to contain more crude protein than that from the 8-week clipping frequency. Plots harvested only at the end of the growing season were clearly lowest in crude protein content (Table 4).

Dry Matter and Crude Protein Produced

Although more dry matter was produced by clipping every 8 weeks, the greater amount of protein produced per hectare by the 4-week clipping frequency was caused by a higher protein content. Blue panicgrass harvested every 4 or 8 weeks produced the least dry matter with no fertilization, and dry matter production increased with increasing rate of fertilization (Table 4).

Within a clipping frequency total crude protein produced by blue panicgrass was lowest on unfertilized plots (Table 4). The lowest amount of total crude protein was produced on plots harvested only at the end of the growing season. At a given level of fertilization, blue panicgrass herbage produced more crude protein when clipped every 4 weeks than when clipped every 8 weeks.

Table 4. Herbage standing crop, crude protein content of herbage and total crude protein standing crop under different clipping and fertilization treatments of Blue panicgrass near Kingsville, Texas[1].

Clipping frequency	Fertilization rate (N-P, kg/ha)	Dry matter (kg/ha)	Crude protein content (%)	Crude protein produced (kg/ha)
Every 4 weeks	0–0	2868 a	9.2 a	264 a
	78–22	4750 b	12.8 b	608 b
	156–44	6797 c	13.0 c	908 c
	312–88	6681 c	16.9 c	1126 d
Every 8 weeks	0–0	3576 a	6.5 a	232 a
	78–22	6334 b	7.0 a	446 b
	156–44	7228 b	10.6 b	768 c
	312–88	7789 b	10.6 b	823 c
Once during year	0–0	1017 a	3.2 a	32 a
	78–22	1377 b	3.4 a	47 a
	156–44	1345 b	4.2 a	56 a
	312–88	1355 b	6.2 b	84 b

[1]Means within a clipping frequency followed by the same letter are not significantly different at the 95% level.

Kleberg Bluestem

Crude Protein Content

Kleberg bluestem herbage generally contained less crude protein than other species studied. Fertilization did not significantly increase the crude protein of Kleberg bluestem herbage unless it was harvested every 4 or 8 weeks and fertilized at 312-88 kg/ha N-P (Table 5). Crude protein content of Kleberg bluestem herbage ranged from 5.0 to 7.5% when clipped every 4 or 8 weeks with no fertilization, or rates of 78-22 and 156-44 kg/ha N-P. Crude protein content of Kleberg bluestem herbage was increased to 8.3% or 8.4% when clipped every 4 or 8 weeks, respectively, and fertilized at 312-88 kg/ha N-P. When clipped only once during the year, the crude protein content of Kleberg bluestem was not significantly increased by fertilization.

Dry Matter and Crude Protein Produced

Although there was a considerable amount of variability in the dry matter and crude protein produced by Kleberg bluestem herbage among fertilizer rates and clipping frequencies, there was a trend for slightly more dry matter production when Kleberg bluestem was clipped every 8 weeks. However, a slightly higher crude protein content produced by the 4-week clipping frequency resulted in crude protein production approximately equal to that produced on plots clipped every 8 weeks. Within a clipping frequency, dry matter production was not increased significantly by fertilization. Of all 4 species, Kleberg bluestem produced more total protein with no fertilization at all clipping frequencies. This is attributable to its maximum production of dry matter under the same conditions.

Discussion

The 4 grasses selected for this study are planted widely in south Texas. Bufflegrass is planted most extensively, with smaller acreages of Kleberg bluestem, blue panicgrass, and Bell rhodesgrass, roughly in that order.

Fertilization has produced varying results on native ranges in south Texas. High rates of nitrogen fertilization increased forage production in the higher rainfall area along the coast (Drawe and Box 1967). No increase in forage production was obtained under lower rainfall (Drawe 1976). Conversely, McCawley et al. (1977) have obtained consistent increases in forage and livestock production using moderate levels of fertilization on Kleingrass, coastal bermudagrass, and Bell rhodesgrass. Our data indicated that each of the 4 species studied has the potential to respond to fertilization with the possible exception of Kleberg bluestem in the once-a-year clipping frequency. Further study is needed to determine optimum

Table 5. Herbage standing crop, crude protein content of herbage and total crude protein standing crop under different clipping and fertilization treatments of Kleberg bluestem near Kingsville, Texas[1].

Clipping frequency	Fertilization rate (N-P, kg/ha)	Dry matter (kg/ha)	Crude protein content (%)	Crude protein produced (kg/ha)
Every 4 weeks	0–0	5961 a	6.6 a	390 a
	78–22	6495 a	7.5 a	485 a
	156–44	5932 a	7.1 a	422 a
	312–88	6243 a	8.4 b	521 b
Every 8 weeks	0–0	8153 b	5.2 a	425 a
	78–22	8930 b	5.5 a	494 a
	156–44	6368 a	7.1 a	453 a
	312–88	6302 a	8.3 b	526 a
Once during year	0–0	3262 c	4.7 a	152 a
	78–22	2391 b	4.4 a	104 b
	156–44	2455 b	4.1 a	100 b
	312–88	1670 a	4.5 a	79 a

[1]Means within a clipping frequency followed by the same letter are not significantly different at the 95% level.

rates, combinations, and timing of fertilization.

Buffelgrass is used most extensively of the four species studied because of its adaptability to the soils of the area, its productive potential, palatability, nutritive value, seed availability, and ease of establishment, among other factors. Our data indicate that buffelgrass has the potential to almost double production under proper conditions of fertilization and management. Its productive potential is greater than Bell rhodesgrass and Kleberg bluestem and comparable to blue panicgrass. Crude protein production was second only to blue panicgrass.

Long et al. (1969) found native Rhodesgrass in Uganda to contain 5.99% crude protein. This compares most closely to the crude protein content obtained in our study on plants clipped once during the year with no fertilizer, i.e., 5.0%.

At College Station, Texas, Potts and Hansel (1947) reported Rhodesgrass furnished grazing from June 1 to November 1. Crude protein varied from 6.77% with no fertilizer to 10.73% with 400 pounds of superphosphate plus 400 pounds of sodium nitrate per acre. In our study, crude protein varied from 5.0% with no fertilizer and clipped once during the year to 11.3% with 280N-80P and clipped every 8 weeks.

Blue panicgrass requires a high level of management for its full potential to be realized. Without proper grazing use, it becomes stemmy and unpalatable. Our study bears this out, in that we obtained very low dry matter yield under no fertilization and under once a year clipping. With higher fertilization rates and more frequent clipping, dry matter yields were increased two- to six-fold.

In the arid and semiarid lands of western Rajasthanm Mondal and Chakavarty (1968) determined the crude protein of blue panicgrass to range from 8.65% to 16.28%. In Pakistan, Malik and Klan (1967) reported that blue panicgrass contained more crude protein (21.1 to 24.3%) than any other native grass present. At College Station, Texas, Lancaster (n.d.) reported blue panicgrass contained 11.52% crude protein with no fertilization and 14.32% crude protein with nitrogen and phosphorus added. Rates of fertilization were not given for that study. In our study, crude protein varied from 3.2% on unfertilized plots clipped once during the year to 16.9% on plots with 312N-88P and clipped every 4 weeks.

Kleberg bluestem, a bunchgrass, grows in clumps with numerous slender stems 1–3 feet high. Most of the leaves are basal, and its stemmy growth habit is related to the poor response to fertilization and increased clipping frequency as found in our study.

Our study has shown that Kleberg bluestem has a low potential for improvement through management, at least with clipping or fertilization. Previously planted in mixtures with buffelgrass over much of the Rio Grande Plain, Kleberg bluestem is voluntarily spreading along roadsides, man-made drainages, and other disturbed areas from established stands. Planted with buffelgrass and grazed continously, the more palatable buffelgrass soon disappears from the stand and Kleberg bluestem becomes dominant. This may have led to an erroneous interpretation that Kleberg bluestem is a vigorous plant, more tolerant of grazing; thus many seeded ranges are left with a grass stand poor in nutritional quality, but not necessarily quantity.

Literature Cited

Anon. 1966. Bell Rhodesgrass. Tex. Agr. Exp. Sta. Bull. L-689.

Anon. 1968. Higgins buffelgrass. Tex. Agr. Exp. Sta. Bull. L-731.

Anon. 1971. Texas Almanac. Dallas Morning News. Dallas, Texas.

Anon. 1971a. Climatological Summary. Climatography of the U.S. (Kingsville, Texas, Station) Bureau of Business Research. Univ. Texas. Austin.

Brenner, R.M. 1965. Methods of soil analysis-Part 2. Amer. Soc. Agronomy, Inc. Madison, Wisc.

Drawe, D.L. 1976. Effects of nitrogen and phosphorus fertilization on south Texas native rangeland. Texas A&I Univ. Studies. 76(1):99-109.

Drawe, D.L., and T.W. Box. 1967. High rates of nitrogen fertilization influence Coastal Prairie range. J. Range Manage. 22:32-36.

Lancaster, R.R. n.d. Blue panicgrass. Tex. Agr. Ext. Serv. Farm and Home Hint. No. 369.

Lancaster, R.R. 1949. Rhodesgrass for hay and pasture in south Texas. Tex. Agr. Exp. Sta. Bull. C-245.

Long, M.I.E., E. Thornton, and B. Marshall. 1969. Nutritive value of grasses in Ankole and the Queen Elizabeth National Parks, Uganda. Tropical Agr. Trin. 66:31-42.

McCawley, P.F., J. Naderman, B.E. Dahl, and J.P. Goen. 1977. Potentially useful forages for brush cleared rangeland in the Texas Coastal Bend. *Research highlights—Noxious Brush and Weed Control*, Range and Wildlife Manage. Dep., Texas Tech Univ., Lubbock.

Malik, M.K. and A.A. Khan. 1967. Nutritive value of grasses of Kula Chittar Forests, Pakistan. Pak. J. For. 17:29-37.

Mondal, R.C., and A.K. Chakavarty. 1968. Nutrient content of some perennial pasture grasses of the arid and semiarid lands of western Rajasthan Ann. Arid Zone Res. 7:55-66.

Novosad, A.O., and J.N. Pratt. n.d. Introduced bluestem grasses for cultivated pastures. Tex. Agr. Exp. Sta. Mp-340.

Polk, D.F., Jr., C.J. Scifres, and J.L. Mutz. 1976. Establishment, production and protein content of four grasses in south Texas. J. Range Manage. 29:240-243.

Potts, R.L., and R.L. Hansel. 1947. Rhodesgrass in Texas. Tex. Agr. Exp. Sta. Bull. C-116.

Schuster, M.F., H.A. Dean, and J.N. Pratt. 1963. Former king returns to the throne. Tex. Agr. Prog. No. 9.

Scifres, C.J. 1980. Brush management. Texas A&M Press. College Station, Texas.

Scifres, C.J., J.L. Mutz, and G.P. Durham. 1976. Range improvement following chaining of south Texas mixed brush. J. Range Manage. 29:418-421.

Steel, R.G., and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc. New York.

Waite, R. 1958. The water soluble carbohydrates of grasses—the effects of different levels of fertilizer treatments. J. Sci. Food Agr. 9:39-43.