Herbage Dynamics and Forage Quality of Texas Cupgrass (*Eriochloa sericea*)

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Abstract

Herbage dynamics and forage quality of Texas cupgrass (*Eriochloa sericea*) were monitored during the 1977 and 1978 growing seasons on the Edwards Plateau, Texas. This species was dominant on a shallow rocky range site which had been excluded from grazing for 30 years. Average herbage production was low (527 kg/ha), and mulch constituted 85% of the total biomass. Peak live standing crop was only 145 kg/ha during the study. Green herbage production reflected the ability of this taxon to adjust phenological stage in response to precipitation. Litterbag studies showed decomposition rates of herbage held flat on the soil surface to be twice as rapid as herbage held upright in clumps of Texas cupgrass. This difference in decomposition illustrated the necessity for herbage removal to prevent dead centers and degradation of the stand. Crude protein content of live material averaged 9.8 and 10.7% during 1977 and 1978, respectively. Digestible energy of live herbage averaged 2300 kcal/kg and never went below 2,100 kcal/kg during the study. Forage quality parameters also reflected phenological stage of development.

Eriochloa is a member of the Paniceae and is represented by 7 native species (3 perennials and 4 annuals) within the U.S. (Hitchcock 1951). Only one taxon, Texas cupgrass [*E. sericea* (Scheele) Munro ex Vasey], is abundant enough to be considered an economically important forage plant. Texas cupgrass is a warm-season (C_4) perennial bunchgrass (Shaw and Smeins 1981). It typically initiates growth in February and flowers by May or June. Some plants may form an inflorescence as late as November if climatic conditions are ideal.

The geographic distribution of this species is restricted to Texas, Oklahoma, and Coahuila, Mexico. It is normally confined to a grassland habitat and occurs in the True, Coastal, and Mixed Prairie Grassland Associations of North America. In Texas, it is found in the Gulf Coast Prairies, Blackland Prairies, Cross Timbers and Prairies, South Texas Plains, Edwards Plateau, and Rolling Plains vegetation areas (Gould 1975). As Texas grasslands have been overgrazed or converted into cropland and tame pastures, the abundance of this species has declined.

Allred (1956) included Texas cupgrass as a climax dominant decreaser species in the Shinnery Oaks Savannah postclimax community of the Edwards Plateu, Texas. Dyksterhuis (1946) referred to this species as a secondary climax species of lowland sites on the Fort Worth Prairie. Collins et al. (1975) described this species as a climax dominant on the Blackland Prairies vegetation area of Texas, where it approached 25% of the herbaceous composition by weight on some Blackland sites. Smeins et al. (1976) found Texas cupgrass had an absolute foliar cover in excess of 40% on deep soil areas in grazing exclosures on the Edwards Plateau near Sonora. Historical data showed that 10 years was required for Texas cupgrass to become re-established following protection from heavy continuous grazing. However, it tripled in abundance during the second 10-year period of protection (Smeins et al. 1976).

Taylor et al. (1980) reported Texas cupgrass composed only 1.5% of the botanical composition of cattle diets on the high intensity-low frequency grazing system on the Edwards Plateau. Bryant et al. (1979) found the seedheads of this grass constituted 7% of Spanish goat diets during May at the same study area. The primary objectives of this study were to monitor the herbage dynamics and determine the forage quality of Texas cupgrass on the Edwards Plateau, Texas.

Study Area and Methods

This study was conducted at the Texas A&M University Agricultural Research Station approximately 56 km south of Sonora, Sutton Co. The station is located near the western edge of the Edwards Plateau vegetation area (Gould 1975). The potential vegetation has been described as Oak-Juniper Savannah by Kuchler (1964) and the climate is classified as a warm, tropical, semiarid steppe with no distinct dry season. Mean temperature is

Table 1. Monthly and total precipitation (cm) for the long term average, 1977 and 1978 at the Texas A&M University Agricultural Research Station, Sonora, Sutton Co.

Month	Average	1977	1978
Jan.	2.7	3.4	1.3
Feb.	2.6	3.9	4.0
Mar.	2.6.	4.9	0.6
Apr.	4.4	15.6	1.3
May	7.9	5.2	4.3
Jun.	7.6	8.0	8.2
Jul.	5.1	3.0	7.5
Aug.	4.9	0.8	11.1
Sep.	8.0	1.7	11.0
Oct.	5.7	3.7	4.9
Nov.	2.3	2.5	9.0
Dec.	2.8	-0-	0.9
Total	56.6	52.7	64.1

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highest in July (30°C) and lowest in January (9°C) (Carr 1967). Mean annual rainfall at the Station is approximately 57 cm (Table 1). May and September are the wettest months, while November is the driest.

The specific study site was within a 16-ha pasture that had been protected from livestock grazing for 30 years. Wildlife, particularly white-tailed deer (*Odocoileus virginianus* Boddaert), eastern cottontail rabbits (*Sylvilagus floridanus* Allen), and other small mammals had access to the area; however, disturbance by these animals was minimal. This site was selected because of: (1) the abundance of Texas cupgrass, (2) soil uniformity, and (3) the absence of livestock disturbance.

Soils in the exclosure are Tarrant stony clays (Lithic Haplustolls), which vary in depth from 1 to 30 cm with large limestone fragments over much of the surface (McGinty et al. 1979). The substratum consists of fractured and porous limestone. Slopes are less than 5%.

Important interstitial grass species within the cupgrass stands are common curlymesquite [*Hilaria belangeri* (Steud.) Nash], sideoats grama [*Bouteloua curtipendula* (Michx.) Torr. var. *curtipendula*], cane bluestem [*Bothriochloa barbinodis* (Lag.) Heter var. *barbinodis*], and hairy grama (*Bouteloua hirsuta* Lag.). Dominant woody plants scattered throughout the site include plateau liveoak [*Quercus virginiana* Mill. var. *fusiformis* (Small) Sarg.], Vasey shinoak [*Q. pungens* Liebm. var. *vaseyana* (Buckl.) C.H. Muller], honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*), Ashe juniper (*Juniperus ashei* Buchholz), and redberry juniper (*J. pinchoti* Sudw.).

Fifteen 1/8m² quadrats were clipped monthly from March to November (excluding October) 1977 and in March, May, August, and October 1978 to obtain standing crop values for Texas cupgrass. Sample quadrats were randomly located along 2 lines through dense stands of naturally occurring Texas cupgrass. Each cupgrass plant rooted within the quadrat was individually clipped 5 cm above ground level and the basal area was recorded for each plant. Clipped samples were separated into standing green and standing mulch components, dried at 60°C for 24 hr and weighed.

Litter decomposition was monitored using the litterbag technique (Bocock and Gilbert 1957, Crossley and Hoglund 1962). Litterbags were 5 cm² and composed of 2 mm² mesh fiberglass screening. Approximately 5 gm of dried green herbage were placed in each bag. On November 21, 1977, 2 groups of litterbags with 3 replications in each group were situated in the field. One group of bags was placed flat on the soil surface to simulate decomposition of surface litter. The second group of bags was held upright in clumps of Texas cupgrass by steel wires in order to simulate decomposition of standing litter. Three litterbags (1/replication) from each group were collected 21, 48, 72, 125, 180, 228, 282, and 360 days after placement, dried at 80°C for 24 hr and weighed to determine weight loss. Decomposition rate was determined using the formula of Weigert and Evans (1964).

Standing crop samples were used for nitrogen and digestible energy determination. Duplicate green and mulch samples from 5 quadrats from each sample date were ground in a Wiley mill to pass a 1-mm screen. Total organic nitrogen was determined following the micro-Kjeldahl procedure (A.O.A.C. 1970). Crude protein was estimated by multiplying total organic nitrogen by 6.25. Digestible energy was determined following Van Soest (1970) and Bryant et al. (1980).

All data were subjected to analysis of variance using the statistical analysis system (SAS) (Barr et al. 1976). Differences in means between years and among harvest dates were evaluated using Duncan's multiple range test.

Results and Discussion

Stand Characteristics

Total herbaceous basal cover for all species during the study was 9.8%. Texas cupgrass contributed 94% of the total, while sideoats grama (2%), curlymesquite (2%), and purple threeawn (*Aristida purpurea* Nutt.) (1%) were the most common interstitial species. Average basal cover of Texas cupgrass was fairly consistent between growing seasons; however, there was considerable variation among harvest dates within growing seasons (Table 2).

Table 2. Average basal cover (BC), basal area per plant (BA/P) and plants per M² (P/M²) of Texas cupgrass harvested during 1977 and 1978 at the Texas A&M University Agricultural Research Station, Sonora, Sutton Co.

Harvest date	BC (%)	BA/P (cm²)	P/M²
1977			
Mar.	9.6b[1]	21.6b	44a
Apr.	9.9b	21.6b	46b
May	13.9a	29.9a	46a
Jun.	10.7b	27.7a	40a
Jul.	6.5cd	12.6d	46a
Aug.	7.8bc	17.8c	44a
Sep.	8.9b	28.4a	31b
Nov.	5.4d	16.2c	34b
Mean	9.1	22.0	41
1978			
Mar.	8.8b	25.4b	35a
May	11.0a	38.3a	29b
Aug.	9.7b	28.3b	29b
Oct.	9.3b	27.4b	30b
Mean	9.7	29.9	31
Overall Mean	9.3	24.6	38

[1]Values followed by different letters in the same column are significantly different at the 0.05 level.

Overall average basal area per Texas cupgrass plant clipped was 24.6 cm² (Table 2). Plants sampled in 1977 tended to be slightly smaller in basal area compared to those clipped in 1978. This smaller area per plant was due to a large number of seedlings which developed during the spring and early summer of 1977.

Density of Texas cupgrass plants averaged 10 more plants per m² in 1977 than in 1978 (Table 2). This higher density in 1977 again is the result of seed germination and seedling establishment in the spring and early summer of 1977. Conversely, there was little seed germination observed in 1978, due primarily to the low precipitation during the spring and early summer of the second growing season (Table 1).

Herbage Dynamics

Total standing crop of Texas cupgrass was low during the 2-year study ($\bar{x}$ = 527 kg/ha). There was significant variation in herbage production between the 2 growing seasons with over 143 kg/ha more biomass produced in 1978 than in 1977. Mulch (standing dead) constituted over 85% of the total standing crop and averaged 457 kg/ha across the 2 growing seasons (Fig. 1). Significant variation in mulch biomass was found between growing seasons as well as among harvest dates within growing seasons. Live herbage composed 15% of the total standing crop (Fig. 1). Peak live herbage production was similar between 1977 and 1978 (approximately 145 kg/ha); however, live standing crop for the 12 harvest dates averaged only 60 kg/ha.

Response of Texas cupgrass to precipitation and the phenological plasticity of this species was illustrated by the live standing crop. Precipitation was normal in the spring and early summer of 1977 (Table 1), and growth initiation began in late February and early March. The steady increase in standing crop in April related to maximum herbaceous growth and initiation of flowering culms (Fig. 1). Peak herbage production in May corresponded to the full flowering of the plants, while the decline in June was the result of seed head maturation and death of flowering culms. Subsequent decline in green biomass from June to November was a response to

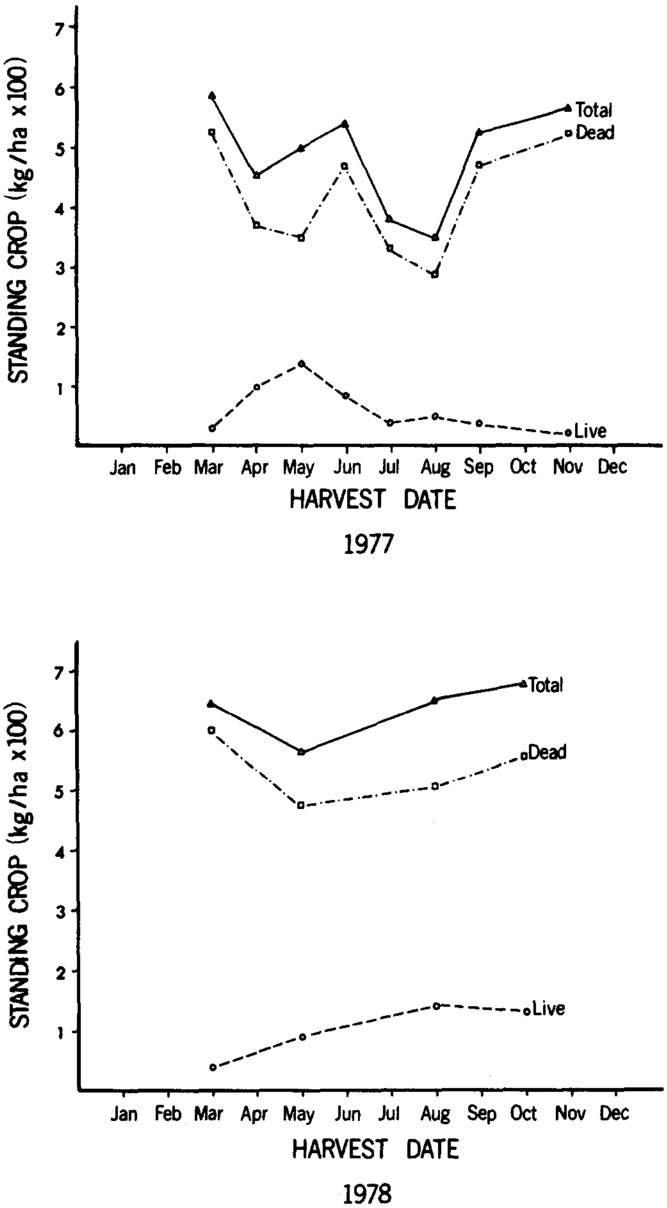

Fig. 1. *Total, live and dead standing crop (kg/ha) of Texas cupgrass herbage during the 1977 and 1978 growing seasons from a 30-year livestock grazing exclosure, Texas A&M University Agricultural Research Station, Sonora, Sutton Co., Texas.*

below-normal precipitation. Some seed germination and seedling establishment occurred in the spring of 1977, but seedling survival was low as indicated by the decline in plant density from August to September 1977 (Table 2). This decline in density corresponded to poor moisture conditions throughout the summer of 1977.

Precipitation was extremely low during the winter and spring of 1978 (Table 1), and growth initiation did not occur until late April. Some herbaceous growth and flowering took place in late May of the second growing season (Fig. 1); however, full flowering of the Texas cupgrass plants did not occur until late August after high precipitation in June and July. Above normal precipitation throughout the late summer and fall promoted herbaceous growth until October. There was no indication of seed germination or seedling development in the spring of 1978. This was due primarily to the lack of precipitation during the spring.

Litter decomposition showed significant differences between bags placed upright in clumps of cupgrass and those placed flat on the soil surface (Fig. 2). Over a 360-day period nearly 60% of the cupgrass herbage decomposed in the bags in contact with the soil

Table 3. Average decomposition rates of Texas cupgrass herbage in upright and flat litterbags placed in the field from November 1977 to November 1978 at the Texas A&M University Agricultural Research Station, Sonora, Sutton Co.

Time (days)	Decomposite rate (mg/g/day)	
	Upright	Flat
21	4.11	7.76
48	2.48	9.29
72	7.76	8.29
125	1.71	5.70
180	0.96	0.37
228	0.37	2.11
282	0.07	0.56
360	0.00	0.96
Mean	2.18	4.38

surface. Conversely, the bags held upright lost only 25% of the original material. Flat litterbags exhibited the characteristic exponential weight loss curve (Olson 1963, George and Smeins (1982). These bags showed a rapid initial decomposition rate for the first 125 days followed by a slower rate until the end of the study (Table 3). The upright bags also exhibited exponential weight loss but at a lower rate than the flat bags until the 72nd day. The decomposition rate then declined until there was no loss from the upright right herbage.

This differential in decomposition was obvious in the Texas cupgrass stand. There was little litter on the soil surface between the plants; however, there were large amounts of standing dead material within the plants (over 85% of the standing crop was mulch). This dead material was concentrated in the center of the plants, and mulch from at least two previous growing seasons could be distinguished. Hyder (1974) found that tillering from auxillary buds on the crown can elevate successive tillering crowns, which can eventually result in dead centers. This form of tillering, which results in new tillers being produced only from the periphery of the plant, tends to support older culms. Removal of herbage by grazing, burning, or mowing can prevent these dead centers (Hyder 1974).

Forage Quality

Crude protein content of green Texas cupgrass herbage averaged 10.3% during the 2-year study. These levels of crude protein meet or surpass the maintenance requirements of a lactating or dry pregnant cow (N.R.C. 1976). During 1977 and 1978 crude protein averaged 9.8 and 10.7%, respectively. Highest protein levels

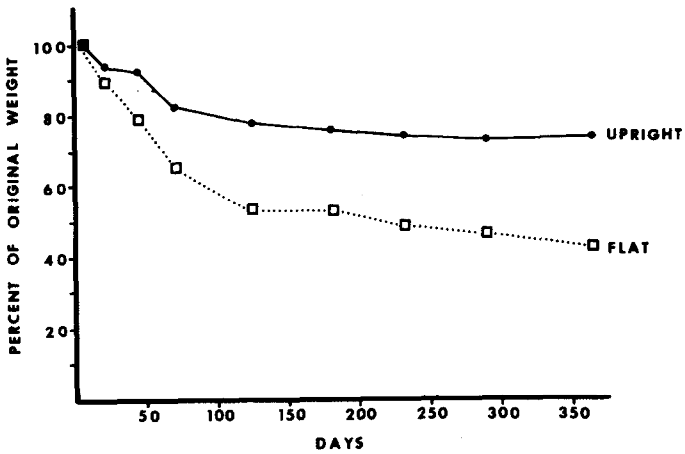

Fig. 2. *Decomposition of Texas cupgrass herbage (loss expressed as percent of original weight) from litterbags at a 30-year livestock grazing exclosure, Texas A&M University Agricultural Research Station, Sonora, Sutton Co., Texas.*

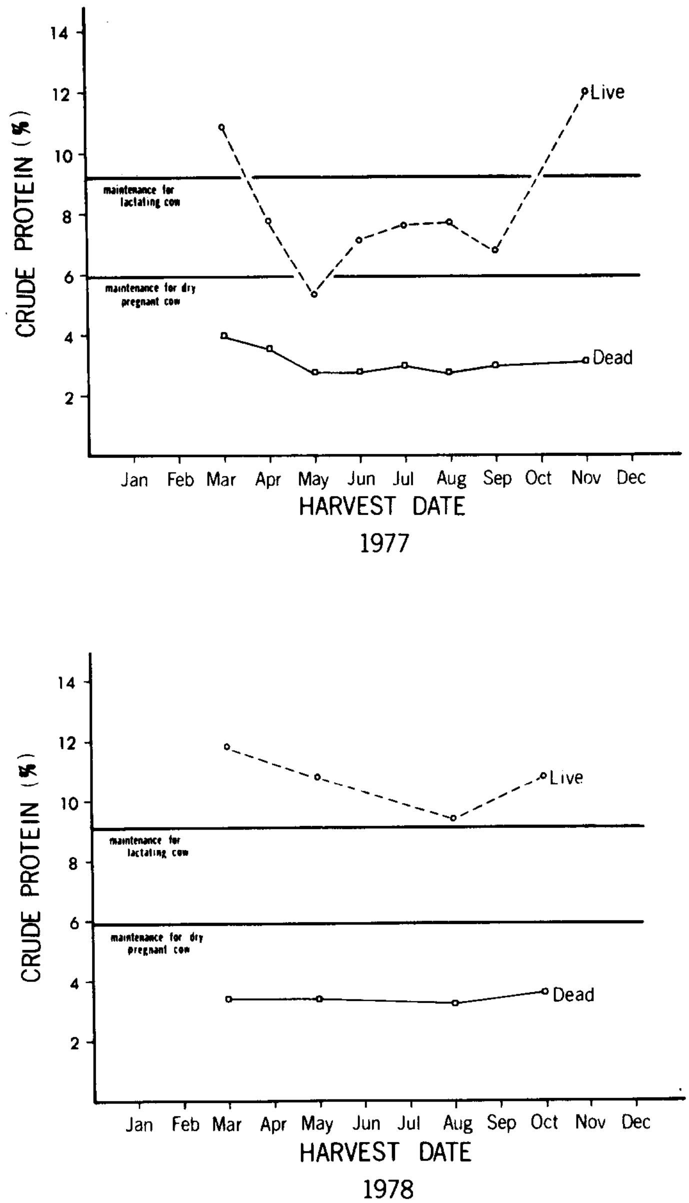

Fig. 3. *Crude protein (%) of live and dead Texas cupgrass herbage during the 1977 and 1978 growing seasons from a 30-year livestock grazing exclosure, Texas A&M University Agricultural Research Station, Sonora, Sutton Co, Texas.*

occurred in the early spring and late fall of both growing seasons (Fig. 3) during periods of cool temperatues and rapid growth. Conversely, the lowest levels were found during the peak flowering periods. Similar trends in protein levels of herbage on the Edwards Plateau have been reported by Vallentine and Young (1959) and George (1977). Protein content of standing dead herbage was consistently between 3 and 4% for all harvest dates. George (1977) has reported the crude protein content of dead curlymesquite herbage as high as 6%.

Average digestible energy of Texas cupgrass green herbage was about 2,300 kcal/kg during the 2-year study and did not differ significantly between years. Peak digestible energy from green herbage occurred in April 1977 and May 1978, while the lowest values were in May 1977 and September 1977 (Fig. 4). These values corresponded closely to phenological stage of development of the plants. Digestible energy of Texas cupgrass surpassed the energy maintenance requirements for a dry pregnant cow at all harvest dates except in May 1977, September 1977, and November 1978 (N.R.C. 1976). Only in May 1978 did the energy in Texas cupgrass approach the energy required by a lactating cow (Fig. 4). Digestible

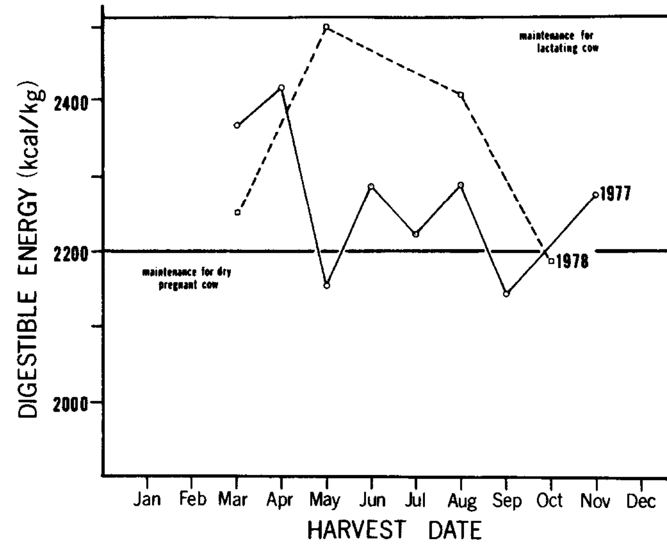

Fig. 4. *Digestible energy (kcal/kg) of live Texas cupgrass herbage during the 1977 and 1978 growing seasons from a 30-year livestock grazing exclosure, Texas A&M University Agricultural Research Station, Sonora, Sutton Co., Texas.*

energy in mulch was consistently between 1,200 and 1,500 kcal/kg.

Conclusions

These data indicate the ability of Texas cupgrass to dominate a shallow rocky range site on the Edwards Plateau, Texas. While herbage production was less than expected from a climax dominant species, it can be explained by the poor site and poor health of the plants due to "mulching-out." Smeins et al. (1976) found that green herbage production for this species exceeded 4,000 kg/ha on deep soil sites on the Sonora Research Station. The decomposition study demonstrated the necessity of herbage removal to correct the adverse characteristics which lead to dead centers and periphery tillering. The green herbage production illustrated the phenological plasticity and response to precipitation of this species.

Forage quality of Texas cupgrass during the growing season appeared to be good. Crude protein levels tended to be high except during the most severe months. Digestible energy for the species, while not meeting all the energy requirements of lactating cows, easily meets the maintenance requirements for dry pregnant cows throughout most of the growing season. Both forage quality parameters reflected the phenological stage of development of the Texas cupgrass plants during the 2-year study.

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