

# Defoliation Impacts on Quality and Quantity of Forage Harvested from Big Sacaton (*Sporobolus wrightii* Munro)

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## Abstract

Forage quality and quantity and stand vigor of big sacaton were evaluated for seven defoliation systems during 1977 and 1978. Big sacaton plants were either shredded monthly, shredded in spring/midsummer, spring/early summer, spring, spring/late summer/fall, midsummer/fall, or late winter. Forage quality of big sacaton was improved by defoliation during both years. With few exceptions, crude protein content was highest in plants defoliated the previous month. IVDOM contents were also improved by defoliation. Digestibility decreased to below 50% in early summer in nonshredded plants and in mid summer in all plants regardless of prior defoliation treatment. IVDOM increased to above 50% in late summer and fall in plots defoliated the previous month. Forage harvests during the growing season were greatest from plots that were defoliated three or more times and were defoliated in the fall. The least amounts of forage were harvested from the plots defoliated in spring, spring/early summer and spring/midsummer. In the fall and winter the nonshredded and spring defoliated plots supported relatively large amounts of forage, and the spring/early summer and spring/midsummer plots supported intermediate amounts of forage for winter grazing. Stand vigor was maintained best by brief periods of defoliation in the spring or spring/early summer, followed by defoliation of old forage in late winter. Vigor appeared to be decreased by early fall defoliations to a 7.5 cm stubble height. The spring/early-summer system provided large amounts of high quality forage and maintained stand vigor. This system defoliated plants when soil moisture was usually adequate for plant regrowth, provided nutritious forage during the growing season and provided adequate standing forage for fall and winter grazing and protection against damage due to low temperature.

Big sacaton (*Sporobolus wrightii* Munro) is a robust perennial bunchgrass which occurs from Arizona to western Texas and south into Mexico (USFS 1937). The species grows mainly on low alluvial flats, bottomlands, and arroyos subject to flooding. Big sacaton will not generally grow on soils highly impregnated with alkali (Wootton and Standley 1912). Although it is a warm-season species, it begins growth early in the spring and may remain green throughout mild winters.

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Early spring growth is readily grazed by animals and big sacaton has been mowed during the growing season for hay (Humphrey 1960). Griffiths et al. (1915) reported big sacaton contained 9.25% crude protein when harvested at flowering to a stubble height of 10 cm. The plants produce a large volume of herbage which cures well and reportedly provide a source of good winter forage despite their coarseness (USFS 1937). However, Humphrey (1960) reported the mature foliage was rarely grazed. Rangelmen have long been aware that grazing, mowing, or burning can affect yield and quality of forage (Youngner 1972). The USFS (1937) reported the abundance of big sacaton had been reduced in many areas by overgrazing, but careful management would apparently allow full use of the species and maintain stands in a productive state. Sacaton flats can be used most effectively by grazing heavily early in the spring and then deferring until fall (Humphrey 1960). The Soil Conservation Service (1979) suggests grazing of big sacaton plants no closer than 20 to 25 cm stubble heights and then resting for 4 to 6 months. Coarse, unpalatable mature growth may be removed by burning every 3 or 4 years with less damage occurring to big sacaton plants burned in late winter or early spring before growth begins (Humphrey 1960). Bock and Bock (1978) reported that burning an ungrazed big sacaton community in the summer and winter in southeastern Arizona reduced the height and cover of big sacaton and stimulated the growth of other grasses and forbs. They found summer fires created more bare ground and encouraged a greater number and variety of annuals than did the winter fire.

Previous studies in Texas have shown forage quality of big sacaton to decrease with increasing plant maturity (Haferkamp-unpublished data). Quality, however, appeared to be maintained at a higher level with frequent defoliations. Specific responses to defoliation appear to vary by plant species due to intensity, frequency, and season of defoliation as associated with climate, soil fertility, and light. Many researchers have reported dry matter production of grasses to be affected by both frequency and height of defoliation (Holscher 1945; Jameson and Huss 1959; Peterson 1962; Auda et al. 1966; Burton et al. 1969). Total dry matter production can be reduced by close or frequent clipping, but digestible dry matter may be increased by an increased frequency of clipping (Burton et al. 1963). Increases in forage quality appear to result from maintaining plants and plant parts in a younger stage of development.

This study was designed to investigate the impact of defoliation on forage quality and quantity and stand vigor of established big sacaton, selection "PMT-820", growing on the South Texas Plains.

## Materials and Methods

### Site Description

Big sacaton "PMT-820" was drilled in 1968 on 197 cm centers on an Orelia clay loam (Typic Ochraqualfs, Fine-loamy, Mixed, Hyperthermic) soil in McMullen County, Texas. Average annual precipitation for the area is 58 to 61 cm with greatest amounts

**Table 1. Schedule of defoliation treatments applied in 1977 and 1978 to a big sacaton located in the South Texas Plains near Whitsett.**

Treatments	Sample seasons and dates						
	Spring		Summer			Fall	
	Mid	Late	Early	Mid	Late	Early	
	1977	June 8	July 7	August 3	September 3	October 1	
	1978	May 26	June 22	July 20	August 23	October 6	
Nonshredded	— <sup>1</sup>	—	—	—	—	—	—
Monthly (spring/fall)	x <sup>2</sup>	x	x	x	x	x	x
Spring/mid-summer	x	x	x	—	x	—	—
Spring/early summer	x	x	x	—	—	—	—
Spring	x	x	—	—	—	—	—
Spring-late summer/fall	x	x	—	—	x	x	x
Mid-summer/fall	—	—	—	x	x	—	x

<sup>1</sup>Standing crops were not estimated and plants were not shredded on these dates.  
<sup>2</sup>Standing crops were estimated and plants were shredded on these dates.

occurring during May, June, and September. Summers are generally hot and dry, and growing seasons are over 300 days in length. Rainfall has been above average every year since the planting was initiated, and the plants have formed essentially solid stands.

**Defoliation Treatments**

Beginning in May 1977, the established stand of big sacaton was subjected to seven defoliation treatments (Table 1). Treatment plots (3.7 by 9.2 m) were arranged in a randomized complete block design with four replications. The area was fenced to preclude grazing by domestic livestock. Prior to fencing, the area had been grazed by cattle and forage harvested to a 15-cm stubble height was approximately 1,783 kg/ha.

Plots were shredded to approximately a 15-cm stubble height in 1977, and all plots were shredded to a 7.5-cm stubble height in February 1978 to remove the remaining standing dead material. With one exception, plots were shredded to the 7.5-cm stubble height during 1978 and again during April 1979. During April 1978 the treated plots were mistakenly shredded to a 15-cm stubble height. At each date, all shredded material was raked off the plots.

**Forage Harvested**

Samples used for estimation of the amount of forage harvested were collected before each plot was shredded. In 1977 forage samples were clipped to a 15-cm stubble height in three 1 x 0.5-m subplots located in each plot. If a plot was not scheduled for shredding, forage harvested was not estimated. The 1977 shredding and harvest dates were May 11, June 8, July 7, August 3, September 3, and October 1.

In 1978 the method for estimating the amount of forage harvested was modified. Ten randomly located plants per plot were clipped to a 7.5-cm stubble height, and forage harvests were derived by multiplying the average weight per plant by the average number of plants per plot. The average number of plants per plot was determined in June 1978 by counting the number of plants in each of five systematically placed 1 x 0.5 m subplots per main plot. The 1978 shredding and harvest dates were March 30, April 26, May 26, June 22, July 20, August 23, and October 6. Forage harvests were estimated on all plots in October and December 1977, and October 1978 to provide estimates of standing forage on undisturbed plots.

Average maximum foliage heights were measured with leaves extended on plots designated for shredding in 1977, and on all plots after April 1978. Measurements were taken at each clipping site or at five to ten random locations in the plots not scheduled for shredding. The plants heights provided an additional measure of plant response to defoliation.

Average maximum foliage heights were measured and all plots were shredded to a 7.5-cm stubble height on April 6, 1979. Plants were allowed to regrow until June 13, 1979, at which time plant heights were measured and standing forage was estimated to provide an index of plant vigor for comparing plant response to 2 consecutive years of defoliation.

**Forage Quality**

Forage samples for quality determinations were collected by clipping forage to the 15-cm and 7.5-cm stubble heights in the 1977 and 1978 sampling periods, respectively. Samples were collected on each shredding date and in January, February, and December 1978, and in February 1979. Approximately five samples were collected randomly across the plots scheduled for shredding, or from 1.2-m wide buffer zones on plots not scheduled for shredding. Workers were cautious to not resample previously clipped plants on the plots not shredded the previous month. Following harvesting, samples were sealed in plastic sacks, frozen on dry ice, transported to the laboratory, and stored at below 0°C. Prior to analysis, samples were placed in paper sacks, oven dried in a forced draft oven at 60°C for 48 hours, and then ground to pass a 1-mm screen.

Samples from two replications of each shredding treatment were analyzed for dry matter, organic matter, in vitro digestible organic matter (IVDOM), and total nitrogen content. Dry matter was determined by oven-drying at 105°C for at least 12 hours. Oven-dried samples were then placed in a muffle furnace at 550°C for 3 hours for organic matter determinations. All chemical constituents analyzed in the samples were expressed on an oven-dry, organic matter basis.

The Kjeldahl procedure (A.O.A.C. 1970) was used in determination of nitrogen content of the forage samples. Percent nitrogen was then multiplied by 6.25 and expressed as percent crude protein.

Digestible organic matter was determined employing a 48-hour fermentation of samples with rumen liquor (Tilly and Terry 1963) followed by neutral detergent fiber extraction (Van Soest and Wine 1967). Data were presented as percent IVDOM corrected by a standard forage of known in vivo digestibility.

**Table 2. Rainfall (cm) for January 1976 through June 1979 for the big sacaton site located on the South Texas Plains near Whitsett, Texas.**

Month	Years			
	1976	1977	1978	1979
January	0.9	12.1	1.9	8.1
February	0.0	5.8	3.2	3.7
March	2.2	2.2	0.0	2.5
April	13.2	21.2	1.5	11.8
May	20.7	4.4	10.0	5.2
June	1.1	11.4	14.1	16.5
July	17.6	1.1	10.7	
August	4.2	0.2	12.4	
September	9.0	10.5	8.2	
October	27.6	19.6	1.6	
November	8.8	7.2	8.6	
December	6.6	0.2	7.7	
Total	111.9	95.9	79.9	

Statistical analysis of the data consisted of an analysis of variance for IVDOM and crude protein within months, within years, and pooled over years. The interaction of treatment and year was tested and Duncan's multiple range test was performed as indicated to test differences between treatments.

## Results

Approximately 96 and 80 cm of rainfall fell on the study site during 1977 and 1978, respectively (Table 2). An additional 48 cm fell prior to mid-June 1979. The rainfall pattern was characterized by relatively dry periods during the early spring, summer, and winter of 1977 and the winter and spring of 1978. In addition, only 0.25 cm of rainfall occurred from June 8 to July 22, 1978.

### Forage Harvests and Plant Heights in 1977 and 1978

Approximately 1,783 kg/ha of big sacaton were removed when plots were defoliated in mid spring of 1977 (Table 3). In late spring an average of 1,192 kg/ha was harvested from the defoliated plots. The rate of regrowth progressively declined with defoliations in early and midsummer. Defoliation of plots shredded the previous month removed an average of 830 kg/ha big sacaton forage in July, 527 kg/ha in August, and 117 kg/ha in September. The initial harvest of the midsummer/fall plots in 1977 removed 3,386 kg/ha. However, regrowth was slow, and the depressed growth was attributed to the lack of rainfall and soil moisture, when only 1.3 cm of rainfall occurred in July and August.

During the May to October 1977 harvest period, over 4,000 kg/ha of forage were removed by the monthly, spring/midsummer, spring/late-summer/fall and midsummer/fall treatments. Plots in each of these treatments were defoliated three times or more during the season and three of the treatments included fall harvests. Approximately 2,900 and 3,800 kg/ha of forage were harvested from the spring and spring/midsummer plots, respectively. By early winter the nonshredded and spring treatments supported the most forage of 4,610 and 1,406 kg/ha, respectively. Standing forage on the other treatments ranged from 551 to 743 kg/ha. Accumulated forage harvests including the residue remaining on the plots not shredded in the fall ranged from 5,694 to 4,295 kg/ha for 1977 treatments (Table 3).

Heights of early spring defoliated plants ranged from 64 to 75 cm in late spring. Maximum heights of 106 and 115 cm were recorded in midsummer for plants defoliated in late summer/fall and in early fall for plants in the nonshredded plots, respectively. Min-

imum heights of 14 to 25 cm were recorded for the spring/mid-summer treatment in August and the midsummer/fall plots in September, respectively.

In mid-spring 1978, approximately 500 kg/ha of forage were removed by all except the spring treatment (Table 4). Replication one of this treatment was consistently more productive than other plots of this block. The cause of the greater productivity was not determined. The relatively small amounts of forage, 640 kg/ha and 410 kg/ha harvested in mid and late spring of 1978, respectively, resulted from a previous dry winter and a total rainfall of 4.7 cm during February, March, and April (Table 2). By early summer, forage harvested from the monthly, spring/midsummer and spring/early-summer plots averaged 1,302 kg/ha. Growth was undoubtedly enhanced by the increase in soil moisture from 24.1 cm rainfall received in May and June. Forage harvested from the plots treated monthly was less than 300 kg/ha and 600 kg/ha in midsummer and late summer, respectively. The midsummer harvest of previously defoliated plots was the only one to yield less than 300 kg/ha in 1978. Lack of rainfall had reduced plant regrowth when only 0.25 cm rain fell from June 8 to July 22, 1978. The initial harvest of the midsummer/fall plots removed 3,054 kg/ha. The regrowth after the initial harvest was greater than in 1977 and was in part due to increased rainfall and improved growing conditions.

During the 1978 treatment period, approximately 4,000 kg/ha were harvested from the monthly and spring/late-summer/fall defoliated plots and 5,200 kg/ha were harvested from the midsummer/fall plots. These plots were defoliated three or more times and all were defoliated in the fall. Approximately 2,000 kg/ha were removed from the other three treatments by harvesting during spring to midsummer. The nonshredded and spring defoliated plots supported 6,204 and 4,831 kg/ha of big sacaton forage in the fall and the plots defoliated in spring to early or midsummer supported approximately 1,500 kg/ha.

Plant heights in (March) 1978 indicated nonshredded plants (39 cm) were significantly taller than plants in the other treatments. Plants defoliated only in the spring averaged 35 cm, and those of other treatments ranged in height from 29 to 30 cm. These data suggest that at least a slight decrease in plant height occurred with any defoliation during the 1977 growing season.

Big sacaton plants averaged 30 to 40 cm in height by April 1978 regardless of defoliation treatment. Through early summer the plants in the nonshredded and midsummer/fall plots were not defoliated and were the tallest, averaging 99 and 83 cm, respec-

**Table 3. Forage harvested (kg/ha) from big sacaton stands defoliated to a 15 cm stubble height on the South Texas Plains near Whittsett, from May 11 to December 6, 1977.**

Treatments	Sample seasons and dates							Accumulated forage harvested and residue on plots
	Spring		Summer			Fall	Winter	
	Mid May 11	Late June 8	Early July 7	Mid Aug. 3	Late Sept. 3	Early Oct. 1	Early Dec. 6	
Nonshredded	—	—	—	—	—	2,992 <sup>2</sup> (560)	4,610 (1,155)	4,610
Monthly (spring/fall)	1,783	1,363 (576) <sup>1</sup>	805 (305)	579 (928)	117 (134)	345 (271)	702 (206)	5,694
Spring/mid-summer	1,783	1,280 (528)	756 (311)	475 (257)	—	459 <sup>2</sup> (192)	725 (187)	5,019
Spring/early summer	1,783	1,093 (443)	930 (273)	—	—	494 <sup>2</sup> (475)	743 (354)	4,549
Spring	1,783	1,106 (886)	—	—	—	1,691 <sup>2</sup> (1,112)	1,406 (968)	4,295
Spring-late summer/fall	1,783	1,118 (304)	—	—	1,157 (215)	588 (213)	551 (216)	5,197
Mid-summer/fall	—	—	—	3,386 (2,709)	13 (18)	660 (420)	715 (172)	4,774

<sup>1</sup>Standard Deviation

<sup>2</sup>These values were not included in the accumulated yields, because the plots were not defoliated in October.

**Table 4. Forage harvested (kg/ha) from big sacaton stands defoliated to a 7.5 cm stubble height on the South Texas Plains near Whitsett from April 26 to October 6, 1978.**

Treatments	Sample seasons and dates						Accumulated forage harvested and residue on plots
	Spring		Summer			Fall	
	Mid April 26	Late May 26	Early June 22	Mid July 20	Late Aug. 23	Early Oct. 6	
Nonshredded	—	—	—	—	—	1,630	1,630
Monthly (spring/fall)	574 (324) <sup>1</sup>	369 (195)	1,221 (351)	282 (187)	596 (334)	929 (361)	3,971 (1,677)
Spring/mid-summer	494 (154)	338 (117)	1,216 (203)	196 (67)	—	1,442 (334)	3,686 (802)
Spring/early summer	476 (249)	381 (131)	1,469 (490)	—	—	1,643 (692)	3,969 (1,493)
Spring	1,190 (962)	627 (352)	—	—	—	4,831 (3,040)	6,648 (4,250)
Spring-late summer/fall	466 (233)	333 (148)	—	—	2,189 (492)	1,142 (415)	4,130 (1,208)
Mid-summer/fall	—	—	—	3,054 (1,498)	892 (278)	1,283 (371)	5,229 (2,019)

<sup>1</sup>Standard Deviation

tively. Plants in the spring and spring/late-summer/fall treatments, averaged 66 and 69 cm, respectively, in early summer, and they were significantly taller than the 50 to 52 cm average height for plants defoliated monthly, or in spring/midsummer, and spring/early summer. The difference in June heights may have reflected the previous year's treatment. Minimum plant heights of 16 to 19 cm were recorded in midsummer for the monthly, spring, mid-summer, and spring/early-summer treatments.

**Forage Quality in 1977 and 1978**

Forage quality of big sacaton forage was significantly affected by defoliation and weather conditions in 1977 and 1978. Crude protein content was significantly different among treatments in 1978 in all except the late-summer sampling period. Similarly the IVDOM content was significantly different among treatments except for the mid- and late-summer harvests. These summer harvests followed very dry and hot periods and the weather conditions appeared to enhance maturation of forage as well as reduce regrowth on recently defoliated plants. The lack of regrowth prevented collection of a forage quality sample from replication two of the midsummer/fall treatment. Replications two and four were drier than one and three.

During the 1978 harvest crude protein and IVDOM contents differed significantly among treatments from midsummer 1978 to late winter 1979. In contrast to 1977, forage quality was not significantly different between treatments during spring and early summer 1978. Rainfall was greater during May through Sep-

tember of 1978 compared to 1977, although a dry period occurred during June and July which prevented regrowth in block two of the monthly and spring/early-summer treatments. The probable cause of lack of significant treatment effect in spring and early summer 1978, however, was a reduction in standing dead forage in samples collected from the nonshredded and midsummer/fall plots. In 1977 treatments were begun with 1,783 kg/ha standing forage above the 15 cm stubble height which contained some standing dead forage, but all plots were defoliated to 7.5-cm stubble height in February 1978 to remove the influence of standing dead.

Big sacaton forage contained 0.6 to 5.8% more crude protein during spring through late summer harvest in 1978 than in 1977. IVDOM content was 0.8 to 8.3% greater during the spring through early-fall harvest in 1978 than in 1977. The 1977 crude protein and IVDOM contents, however, averaged 1.7 to 1.1% and 7.5 to 8.2% greater, respectively, during the early and late winter collections. The improved quality during the spring, summer, and early fall of 1978 was due to decreased standing dead in some forage samples and the better growing conditions provided by the increased rainfall in 1978. Fall regrowth in response to 30.1 cm rainfall in September and October improved forage quality in the winter of 1977-78, and early hard freeze caused a decline in forage quality in the winter of 1978-79.

The 1977 and 1978 crude protein and IVDOM contents were pooled for ease of presentation of defoliation effects. Significant treatment-by-year interactions were found for crude protein content for all but the late-summer collection and for IVDOM content

**Table 5. Average percentage crude protein contained in big sacaton forage harvested from the South Texas Plains near Whitsett during May 1977 to February 1979.**

Treatments	Sample seasons and dates										Average
	Spring			Summer			Fall		Winter		
	Mid 1977-78 1978-79 April 26	Late June 8 May 26	Early July 7 June 22	Mid Aug. 3 July 20	Late Sept. 3 Aug. 23	Early Oct. 1 Oct. 6	Early Dec. 7 Dec. 26	Mid Jan. 26	Late Feb. 16 Feb. 9		
Nonshredded	10.1b <sup>1</sup>	9.5d	7.0d	5.8c	5.2d	6.4e	5.8d	5.4e	5.8e	6.8c	
Monthly (spring/fall)	12.3a	11.5ab	10.5a	10.3a	11.9a	12.1a	12.4a	10.9a	10.8a	11.4a	
Spring/mid-summer	12.0ab	10.4bcd	8.9c	9.7a	10.0b	10.9bc	9.6bc	9.1bcd	8.6c	9.8b	
Spring/early summer	12.3a	11.2bc	9.4abc	10.2a	10.3b	10.6c	8.5c	8.9cd	7.6d	9.9b	
Spring	12.9a	12.4a	10.1ab	7.5b	7.3c	8.6d	10.0bc	8.6d	7.7d	9.4b	
Spring/late-summer/fall	12.1a	10.3cd	9.3bc	7.2bc	6.6cd	10.9bc	10.9ab	10.0abc	10.2ab	9.7b	
Mid-summer/fall	12.8a	10.7bc	7.2d	6.4bc	10.9ab	11.5ab	11.3ab	10.1ab	9.8b	10.0b	

<sup>1</sup>Means within a column followed by the same letter are not significantly different at the 95% level according to Duncan's new multiple range test.

**Table 6. Average percentage IVDOM contained in big sacaton forage harvested from the South Texas Plains near Whitsett during May 1977 to February 1979.**

Treatments	Sample seasons and dates										Average
	Spring		Summer		Fall		Winter		—	Feb. 9	
	Mid	Late	Early	Mid	Late	Early	Early	Mid			
1977-78	—	June 8	July 7	Aug. 3	Sept. 3	Oct. 1	Dec. 6	Jan. 26	Feb. 16		
1978-79	April 26	May 26	June 22	July 20	Aug. 23	Oct. 6	Dec. 26	—	Feb. 9		
Nonshredded	56ab <sup>1</sup>	52a	47a	45c	41c	42d	38c	36c	34c	43c	
Monthly (spring/fall)	54ab	53a	53a	48a	46b	53ab	50a	45a	41a	49a	
Spring/mid-summer	54ab	55a	53a	47ab	45b	50bc	47ab	39bc	38b	48a	
Spring/early summer	58a	53a	53a	46bc	46b	49c	44ab	42ab	38ab	48a	
Spring	55ab	55a	50a	46bc	44b	44d	42bc	40bc	37b	46b	
Spring/late summer/fall	51b	53a	54a	46bc	44bc	52abc	47ab	41ab	40a	48a	
Mid-summer/fall	54ab	52a	48a	47ab	50a	55a	49a	46a	40ab	49a	

<sup>1</sup>Means within a column followed by the same letter are not significantly different at the 95% level according to Duncan's new multiple range test.

for the mid and late-summer and late-winter collections. The significant interactions were due to several factors: the standing dead forage contained in nonshredded samples in 1977, the difference in rainfall for the 2 years, and the missing data due to lack of plant regrowth during dry periods.

Crude protein contents were significantly increased by defoliation in 1977 and 1978 harvests (Table 5). Averaged across all dates the plants defoliated monthly contained the most crude protein and the nonshredded plants contained the least amount. Plants of all treatments contained over 9% crude protein in spring. By early summer, treatment effects became obvious and plants defoliated during the spring contained significantly more crude protein than plants which had not been defoliated. Midsummer quality was improved by the early summer shredding and the monthly, spring-/midsummer, and spring/early summer plants contained significantly greater crude protein content than other plants. By late summer all plots except the nonshredded had been defoliated at least once, and forage from the monthly, spring/midsummer, spring/early summer, and midsummer/fall treatments contained the most crude protein. Each of these plots had been defoliated during the previous 2 months. Plants defoliated in early summer or later contained over 10% crude protein in the fall, significantly more crude protein than in spring defoliated plants. Plants defoliated at any time during the harvest period contained significantly more crude protein than the nonshredded plants during the fall and winter. By late winter the plants defoliated in the fall contained significantly more crude protein than plants of all other treatments. Plants defoliated the last time in midsummer contained more crude protein than plants shredded last in spring or early summer.

IVDOM contents did not appear to change as rapidly with defoliation as the crude protein contents. Averaged across all dates the monthly and midsummer/fall plants contained the higher percentages of IVDOM and the nonshredded plants contained the least (Table 6). The IVDOM contents were similar among treat-

ments during spring and early summer. Digestibilities by early summer, however, decreased to below 50% in the plants that had not been previously shredded. By midsummer IVDOM contents of all treatments had decreased to below 50%, and differences due to defoliation were not obvious. The midsummer/fall plants contained approximately 50% IVDOM in late summer. The digestibility of these plants was significantly greater than for other plants shredded a month earlier, monthly and spring/midsummer treatments, but there was not an obvious explanation for this difference. Plants shredded in late summer were the only plants that contained over 50% IVDOM in the fall. All plants shredded in early summer or later, however, contained significantly more IVDOM in fall than nonshredded or spring treated plants. A similar trend in IVDOM occurred in winter collections. The plants shredded during the growing season consistently contained more IVDOM than the nonshredded plants, although consistent differences were not obvious among other treatments.

#### 1979 Response

Standing forage and plant heights were again measured in spring and early summer 1979 to evaluate the effects of 2 consecutive years of shredding on big sacaton stands. Plant heights were measured and all plots were shred to a 7.5-cm stubble height on April 6, 1979. Plants were then allowed to regrow and stands were sampled for plant heights and standing forage on June 13, 1979.

By April 6, 1979, plants of the nonshredded treatment were the tallest (Table 7). Plants defoliated in spring through midsummer were intermediate in height and any plants that had been defoliated in the fall were the shortest. A similar trend was found for heights of regrowth measured in late spring 1979. Standing forage in late spring was also greatest for plants of the nonshredded treatment. The spring and spring/early summer defoliations appeared to have minimal effects on standing forage. Any treatment with a fall defoliation appeared to be the most detrimental to the vigor of big sacaton stands. With the exception of the spring-late summer/fall and midsummer/fall treatments there appeared to be a trend for a

**Table 7. Plant heights (cm), plant weights (g), and standing forage (kg/ha) at a clipping height of 7.5 cm on June 13, 1979, for big sacaton stands defoliated at different frequencies.**

Treatments	Height		Standing forage-June 1979	
	Mid spring	Late spring	Per plant (g)	Total (kg/ha)
	April 6, 1979	June 13, 1979		
Nonshredded	84a <sup>1</sup>	74a	111a	3,285a
Monthly (spring/fall)	48e	45c	30c	1,188de
Spring/mid-summer	56d	61b	40bc	1,852cd
Spring/early summer	70b	61b	52bc	2,265bc
Spring	69c	72ab	68b	2,769ab
Spring/late summer/fall	46e	46c	23c	876de
Mid-summer/fall	36f	49c	33c	1,090de

<sup>1</sup>Means in the column with the same letter are not significantly different at the 95% level according to Duncan's new multiple range test.

**Table 8. The total amount of big sacaton forage (kg/ha) harvested during the sampling periods, May to December 1977 and April to October 1978, and the total amount of forage (kg/ha) left as residual during the two winters.**

Treatments	Total	Harvested	Residual
Nonshredded	10,814	0	10,814
Monthly	9,665	8,963	702
Spring/mid-summer	8,705	6,538	2,167
Spring/early summer	8,518	6,132	2,386
Spring	10,943	4,706	6,237
Spring-late summer/fall	9,327	8,776	551
Mid-summer/fall	10,003	9,288	715

decreased plant weight and yield with an increase in the number of times plants were defoliated. The exposure of fall defoliated plants to low winter temperatures may have been a factor in reducing plant vigor during the winter of 1978. Several researchers reported die-out of some grass species following the cold winter. Greater death losses were observed on areas defoliated late in 1978, thus resulting in smaller standing crops during the winter.

### Management Implications

During the 1977 and 1978 growing seasons, the largest amounts of forage were harvested from plots that were defoliated three or more times and were defoliated in the fall (Table 8). The least amounts of forage were harvested from plots defoliated in spring, spring/early summer and spring/midsummer. In the fall and winter the nonshredded and spring defoliated plots supported relatively large amounts of forage and the spring/early summer and spring/midsummer plots supported intermediate amounts of forage that were available as roughage for grazing livestock.

Stand vigor was maintained best by brief periods of use in the spring or spring/early summer, followed by utilization of old forage in late winter. Harvesting to a stubble height of less than 7.5 cm may have been too severe and a taller stubble height needs to be maintained during the winter to provide some protection against low temperature winter die-off.

Maintenance of high quality big sacaton forage was related to plant maturity and rainfall. A higher level of forage quality was maintained by removing old growth before spring. With subsequent defoliations and adequate soil moisture plants regrew, producing new herbage which was higher in quality than the more mature forage remaining from earlier defoliations.

Based on these data the spring/early summer system provided large amounts of high quality forage and maintained stand vigor.

This system defoliated plants when soil moisture was usually adequate for plant regrowth, provided nutritious forage during the growing season, and provided adequate standing crop for fall and winter grazing and protection against damage due to low temperature.

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