THE EFFECT OF HEIGHT AND FREQUENCY OF DEFOLIATION ON FORAGE PRODUCTION OF LAHOMA SUDANGRASS

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INTRODUCTION

One of the major problems of livestock production in Oklahoma is the midsummer decline in daily gain of beef cattle. Rapid spring gains are usually followed by mere maintenance or, in many cases, actual loss in body weight during the hot summer months. A reduction in forage quantity and quality no doubt is a contributing factor to this general decline in production. Supplemental pastures have long been used in an attempt to minimize this sharp drop in animal gain.

The production of large quantities of green, succulent forage of a high nutritive value would appear to be a possible solution for the maintenance of beef gains in midsummer on a plane nearer those obtained in the spring. Sudangrass can be grown successfully in Oklahoma through the hot, dry months and has gained widespread popularity, especially the improved varieties.

The availability alone of an improved forage plant does not necessarily assure the livestock producer adequate pasturage through midsummer as management can alter total production completely. Knowledge of management practices for sustained production of high quality abundant forage would be of considerable benefit to the livestock growers of Oklahoma.

In an attempt to determine the proper management practices to employ in the production of maximum forage yields, irrigated Lahoma sudangrass was subjected to various degrees and frequencies of defoliation. Plants

were clipped at a height of two, four, six and eight inches above the soil surface on 10, 20 and 30 day intervals simulating different intensities and cycles of utilization.

The objectives of this study were to determine at what frequency and height of clip, maximum forage yields could be obtained.

REVIEW OF LITERATURE

Though widely used as a supplemental pasture for a number of years, management data for sudangrass is somewhat limited. Denman (14) [1] in describing "Lahoma", a variety of sweet sudan, placed its yield from 500 to 6000 pounds of oven dry forage per acre, the variation in yield being primarily due to soil type and fertility. In describing forage quality, average protein content was placed between 10 and 12 percent, the variation again being in direct relation to the soil fertility level.

Elder (18) in a management study with Lahoma using two heights and three dates of clipping, found no significant difference in yield at the five percent level for time of cutting at either height. However, forage yields from the four inch height of clip were significantly higher than those from the eight inch cuttings on all harvest dates. In a similar study conducted in Illinois over a two year period, Burger et. al. (7) investigated the influence of various cutting dates on the total and aftermath yields of early, intermediate and late maturing sudangrass varieties grown under similar pasture and hay systems of management. All four varieties produced much less dry matter when harvested under the pasture system than when harvested under the hay system.

While studying the effect of clipping on the seedling development of four range and two cultivated grass species, Robertson (31) received as much as 96 percent reduction in growth when clipped four times as compared to end of season clipping. However, with sudan the results

[1] Figures in parenthesis refer to Literature Cited.

were not as exaggerated in that when clipped to a height of three centimeters, survival fell to 83 percent after the second clipping and 75 percent after the fourth.

Hoveland and McCloud (25) in an experiment conducted in Florida found that with proper management, Starr pearl millet forage yields could be greatly increased at a small expense. The highest yields obtained were from plants clipped when 54 inches tall. However, protein content of the tall plants was only 15 percent as compared to 25 percent on plants 12 inches high.

In a study of range grasses, Lang and Barnes (27) found by clipping blue grama and buffalo grass every three weeks or four times during the growing season that 48.4 and 51.0 percent more forage was received in two successive years than from one harvest at the end of the season.

Albertson et. al. (3) again using blue grama and buffalo, received approximately the same results as did Canfield (8) with black grama and tobosa grass. They found from frequent clippings that production fell below normal after the first year and continued to do so through the duration of the experiment. Holscher (24) in a four year study conducted at the United States Range and Livestock Experiment Station, Miles City, Montana, found that bluestem and wheatgrass decreased in numbers under any clipping frequency other than at the end of the season. The percent damage decreased in proportion to the reduction in frequency of cutting and increases in height of clipping. With a few minor exceptions, Biswell and Weaver (5) and Aldous (4) emphasized that any form of clipping during the growing season reduced root and top growth. Biswell and Weaver stated that yield varied inversely with frequency of clipping.

As a consolation, they concluded that protein was higher when clipped more frequently.

From a greenhouse study for evaluating clipping frequencies on cool season perennials, Carter and Law (9) found that both fifteen and thirty day clipping treatments greatly retarded root and top growth. They concluded that only a thirty day rotation period was worth considering and then only under optimum conditions.

In a field experiment on native flood meadow in eastern Oregon, Cooper (10) concluded that raising the height of cut from two, to four to six inches materially reduced yield. However, over a four year period yields were inversely affected in that higher clips produced the higher yields.

Field studies conducted on bluegrass have produced varied results. Ahlgren (1) in comparing four to five inch, early head and full head cutting frequencies, found no significant difference between treatments the first year. Though as the experiment progressed, there was a definite trend in productivity favoring the four to five inch cutting level on both fertilized and unfertilized plots even though yearly differences were not significant. Harrison (23) in a similar study reported the shorter the plant was cut and the more the leaf area was reduced, the smaller the quantity of roots produced. Eventually, this resulted in the death of the plants due to carbohydrate starvation.

In Virginia, Ellett and Carrier (19) in comparing clipping of bluegrass at different time intervals with a yearly clipping, received higher yields at the yearly clipping interval. However, considerably more protein was produced under the more intensive clipping. They concluded

that the decrease in percentage of protein when the grass was allowed to mature was of greater significance than the increase in weight of dry matter.

In studying the influence of various top cutting treatments on the root stocks of Johnson grass, Sturkie (35) found that frequent and close clipping reduced the weight of roots, the amount of reduction being in proportion to the severity of cutting. Prine and Burton (30) found that hay yields, stem length, leaf length, plant height, internode length and number could be increased on bermuda grass by extending the clipping interval from one to eight weeks, with the opposite effect on protein content. With tall fescue, Decker and Teemont (13) found that competitiveness of tall fescue was affected more by height than frequency of cutting. Crozier (12) in comparing several cuttings to one, on orchardgrass and timothy, obtained the larger yields of forage and crude protein with one cutting. Thaine (37) received higher forage and crude protein yields with Russian wild rye from three to five clippings per season than from one or two. He also found that root development greatly diminished after two clippings.

In studies conducted on the effect of height and frequency of clipping on the yield of some El Salvador forages, Lablab, pigeon pea, tropical kudzu, engorda caballo, Napier grass, guinea grass, jaragua grass, molasses grass and Rhodes grass, Watkins and Severen (41) found 30 days to be the ideal cutting frequency but that height varied with the individual crop.

In grass-legume mixtures as with grass alone, the effects of clipping are quite varied. Nelson and Robins (28) using a ladino clover-orchardgrass sward, received higher yields from a seven to eleven day

clipping frequency at a 12 inch height as compared to a longer frequency and closer clip. Sprague and Garber (34) also using a Ladino clover and orchardgrass pasture mixture to compare three heights and three frequencies of clipping, found that regardless of the frequency, two inches was the more favorable height for clipping the forage. They also found with regard to frequency of cutting under the eight inch height of clip, lowering the height of cut from one to three inches markedly increased the amount of clover harvested whereas, at the early head and full bloom stage, only slight increases occurred. When bromegrass was the principal grass, cutting it after it had reached a height of eight inches appeared not only to decrease the total dry forage produced but also reduced the stand of bromegrass.

Wagner (39) using a four grass-legume combination clipping at six and twelve inches, found that the frequency of cutting reduced the yield only when started in April. In general, little difference was found in forage production; however, in all cases more forage was produced when the clipping continued into October due to a longer growing season. Wagner (40) in studying the effect of clipping on seedlings, concluded that clipping affected top and root growth as well as tiller, rhizome and leaf development of seedling grass plants. Taylor et. al. (36) found no significant difference in orchardgrass-ladino clover yields under clipping versus grazing conditions. However, the yield from the clipped plots was 9.4 percent greater than from grazed plots. Plots harvested when the herbage reached a height of eight to ten inches produced significantly more dry matter than plots harvested when the herbage was four to six inches high. Dotzenko and Ahlgren (15) using an alfalfa

and bromegrass mixture, concluded that frequent and early cuttings reduced yields, as did delaying alfalfa harvest beyond the one half bloom stage, even though bromegrass produced its largest total yield when cut while in full bloom. Using mixtures of oats, ryegrass and crimson clover, Crowder et. al. (11) concluded that dry matter yields were greatest with the longer interval between clippings such as an eight week treatment. In addition, they reported a four week clipping treatment produced more forage during the winter and spring than a two week interval.

Robinson et. al. (32) in studies conducted with bluegrass and clover mixtures, concluded that the average stands of clover were higher on plots clipped to one half inch but that the treatment was too severe for the growth of grass, as it resulted in weakened plants and a thinner sod. The highest average yield for the four year period was obtained from a one-half inch treatment. Vicente and associates (38) conducted clipping studies on kudzu and molasses grass in Puerto Rico and found that high cutting (10 inches) favored the kudzu but did not significantly affect the yield of grass over a four inch height of clip. The difference in yield amounting to about 500 pounds of protein yearly. Brown and Munsell (6) received their best yields from timothy and ladino clover when a combination of either six two-inch or eight four-inch clippings was made. They reported that no clipping after September resulted in poor stands of ladino clover.

In a study of legumes planted alone, Duell and Gausman (16) received higher yields from birdsfoot trefoil when cut at the 1/10 bloom stage at one inch as compared to a three inch height and a twenty day harvest interval. Also, the protein percent, though declining with maturity, stayed relatively high. In studies conducted by Pierre and Bertham

(29) using kudzu, and by Harrison (22) using alfalfa, on the effect of clipping on root growth, found a decrease in proportion to the number of cuttings. Gross et. al. (21) while studying the response of some alfalfa varieties to fertilization and grazing management practices, found that frequent cutting depressed the yield of all varieties but that some were more severely affected than others. Jackobs and Oldemeyer (26), in a study of alfalfa clipping frequencies using 25, 30 and 40 day intervals, received significant reductions in yield from the more frequent clipping. In Wisconsin, Graber and Sprague (20) studied alfalfa cutting treatments and found they not only affected the immediate productivity of alfalfa but also subsequent productivity and survival, the basis for this decision being primarily due to root reserve depletion. Albert (2) in earlier studies with alfalfa in Wisconsin concluded that high protein and a more palatable forage could be obtained by frequent cuttings; however, at the risk of limiting the longevity of the field and obtaining a slightly smaller total yield.

METHODS AND MATERIALS

A forage yield study of Lahoma sudangrass was conducted at the Oklahoma Agricultural Experiment Station Agronomy Farm in the summer of 1957 on a Port silt loam soil.

The objective of this study was to determine at which of three cutting frequencies (10, 20 and 30 days) and four cutting heights (two, four, six and eight inches) as shown in Table I, the larger amount of forage could be produced. Crude protein determinations were made by the Department of Biochemistry for use as a guide in quality determination and nitrogen recovery.

The field layout consisted of a randomized block design with four replications. Each plot consisted of five rows, 12 inches apart and 20 feet long. The center three rows were harvested for forage yield determination. A border was planted around the perimeter of the plots to eliminate outside effect.

The sudan was seeded with a Planet Junior one-row, push-type planter at the rate of 25 pounds per acre on June 8, 1957. Soil treatment consisted of a broadcast application of 300 pounds of 10-20-20 commercial fertilizer per acre at the time of seedbed preparation. Additional nitrogen was applied with a Gandy spreader on July 3 and August 2 immediately after harvest in the form of 33 percent ammonium nitrate at a rate of 100 pounds of actual nitrogen per acre per application.

TABLE I

HEIGHT AND FREQUENCY OF DEFOLIATION OF LAHOMA SUDANGRASS

Treatment	Defoliation	
	Height	Frequency
1	2 inches	10 Days
2	4 inches	10 Days
3	6 inches	10 Days
4	8 inches	10 Days
5	2 inches	20 Days
6	4 inches	20 Days
7	6 inches	20 Days
8	8 inches	20 Days
9	2 inches	30 Days
10	4 inches	30 Days
11	6 inches	30 Days
12	8 inches	30 Days

Supplemental water was applied by sprinkler irrigation (Table II) throughout the season as needed as determined by taking soil probe samples.

Seedlings began to emerge on June 11; however, they were greatly handicapped by an excess of torrential rains soon after planting which packed the soil. In order to obtain adequate stands, some replanting was done. The soil was cultivated as often as deemed necessary.

On each designated harvest period, the forage was clipped with a Jari mower. The harvested forage from the inside three rows of each plot was then weighed and a representative moisture sample taken. The sample was weighed, then oven-dried in a forced air oven at 140 degrees Fahrenheit for 48 hours after which it was weighed immediately. After the weights were recorded, a random sample of each treatment was taken to the Department of Biochemistry for protein determination.

Statistical analyses of the data was conducted as outlined by Snedecor (33) and Duncan (17).

TABLE II

TOTAL QUANTITY OF WATER RECEIVED IN INCHES FROM SPRINKLER IRRIGATION AND RECORDED RAINFALL FOR THE PERIOD OF JUNE 1 TO SEPTEMBER 1, 1957 IN THE EXPERIMENTAL AREA ON THE AGRONOMY FARM STILLWATER, OKLAHOMA

Days	June		July		August	
	Rainfall inches	Sprinkler inches	Rainfall inches	Sprinkler inches	Rainfall inches	Sprinkler inches
1	.35		.89			
2						
3	.65					
4	.41				1.27	
5	.39					
6						
7						
8				2.0		
9	1.61					
10						2.0
11	.53					
12						
13						
14				1.0		
15					.27	
16						
17					.12	
18	2.75					
19				2.0		
20						
21			T			
22	.36					
23	1.68		T			
24						2.0
25						
26	1.05			2.0		
27	.18					
28						
29						
30				1.5		
31						
Total	9.96		.89	8.5	1.66	4.0

RESULTS AND DISCUSSION

When analyzed statistically, the total forage yield of Lahoma sudangrass when clipped at any height at 30 day intervals was significantly higher than any height of clip at either the ten or twenty day frequency of harvest. The treatment which resulted in the lowest yields though not statistically significant at the five percent level of confidence, was the two inch height of clip at 10 day intervals. This is shown by the analysis of variance and multiple range test in Tables III and IV.

As shown in Figure 1, forage yields varied with height of clip as with frequency; however, frequency proved to be the dominant factor. Differences in treatments can be seen in Figures 2 and 3. In all cases, though the differences were not great, higher forage yields were obtained from the six and eight inch heights of clip at any frequency of harvest with the exception of the eight inch at thirty day intervals. Perhaps this can be explained on the basis of sufficient time for the plants which were defoliated to a four inch height to attain approximate maximum growth, as did those clipped to a height of six to eight inches. When harvested, more forage was removed from the four inch height than the eight, purely as a result of the lower height of defoliation. The higher clipped plots apparently were penalized in yield by the material remaining below the clipping height. Another example of this is the eight inch height of clip at the 10 day frequency where, due to the persistant clip-

TABLE III

ANALYSIS OF VARIANCE OF LAHOMA SUDANGRASS FORAGE YIELDS PRODUCED UNDER DIFFERENT MANAGEMENT SYSTEMS

Source of Variation	D. F.	Sum of squares	Mean square	F value
Total	47	116,703,069		
Replications	3	3,509,685		
Treatments	11	99,171,699	9,015,609	21.21**
Error	33	14,020,685	424,869	

** Indicates significance at the 1% level of confidence

C.V. = 12.77

TABLE IV

MULTIPLE RANGE TEST OF LAHOMA SUDANGRASS FORAGE YIELDS PRODUCED UNDER DIFFERENT MANAGEMENT SYSTEMS

Treatment No.	Height of Clip	Frequency	Mean Forage Yield	Multiple Range /x 5%
1	2 "	10 Days	3274.25	
5	2 "	20 Days	3473.50	
2	4 "	10 Days	3744.75	
4	8 "	10 Days	4033.50	
6	4 "	20 Days	4464.75	
3	6 "	10 Days	4570.50	
7	6 "	20 Days	4578.75	
8	8 "	20 Days	5045.25	
9	2 "	30 Days	6654.00	
12	8 "	30 Days	6915.25	
10	4 "	30 Days	7134.50	
11	6 "	30 Days	7343.25	

/x Any two means underscored by the same line are not significantly different.

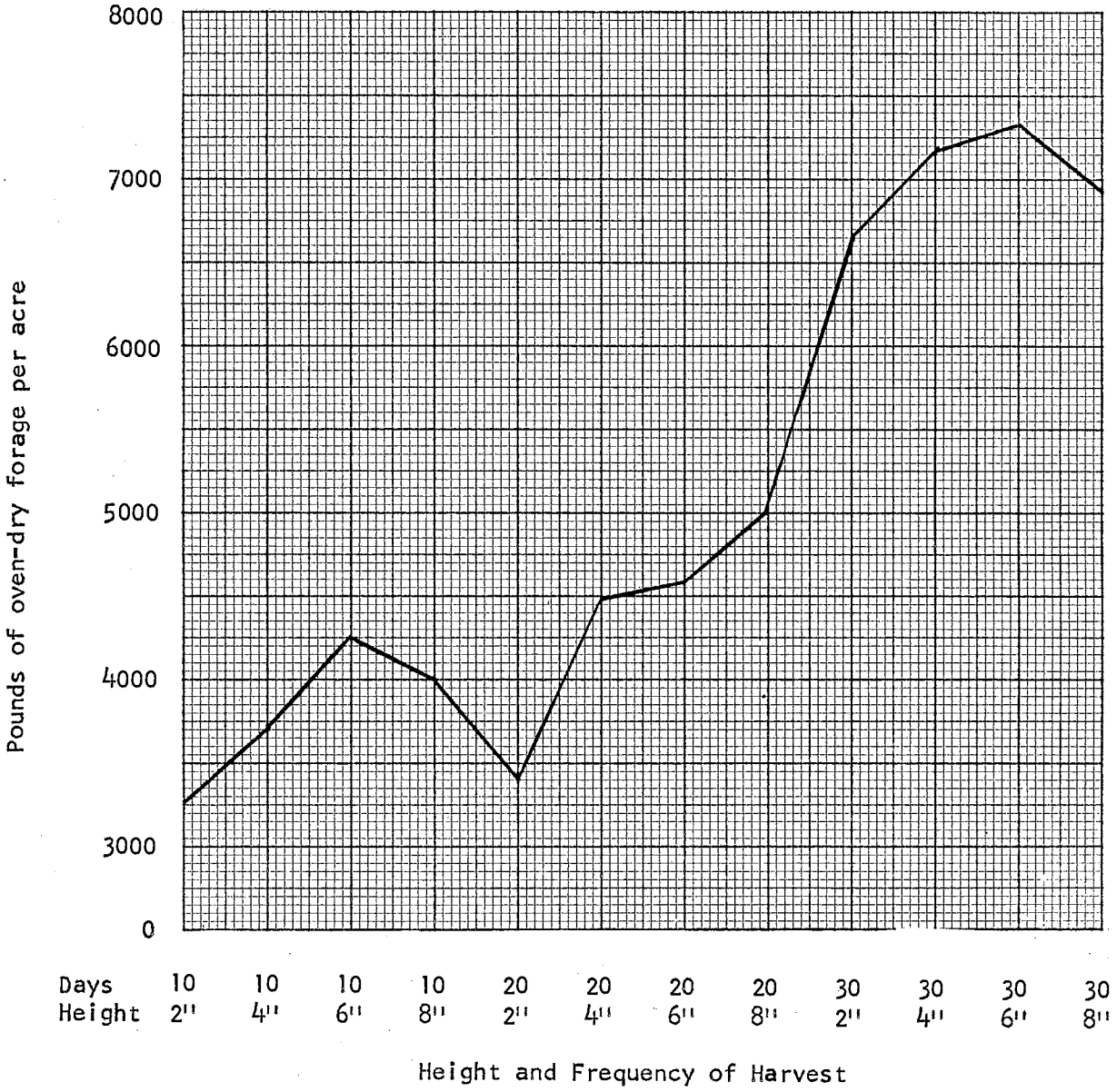

Figure 1. Pounds of Forage Produced by Lahoma Sudangrass Under Different Management Systems

Figure 2. Plots of Lahoma Sudangrass 10 Days After Harvest on Left and Center and After 20 Days of Rest on Right

Figure 3. Plots of Lahoma Sudangrass 10 Days After Harvest

ping and height of defoliation, the treatment is somewhat lower in yield than might be expected. The six inch clipping treatment yielded more forage at the ten and thirty day harvest periods whereas the eight inch clipping height gave the highest yield for the 20 day frequency of clip. The reason for the irregularity at 20 days possibly can be explained by the fact that defoliation to an eight inch height left apparently more photosynthetic area which permitted the plant to resume growth faster and, as a consequence, produced more forage than other heights of clip at this harvest frequency.

Another factor to be considered in yield is stand. Though no stand counts were made other than visual observation, the lower clipping heights appeared to result in a higher mortality rate of the plants than at the other clipping heights, thus possibly lowering the yield somewhat. At no time did the stand of sudan in any plot approach an undesirable level.

The amount of protein in pounds per acre produced followed a trend similar to the total forage yields as indicated by Table V and Figure 4. In total protein production, again frequency played a very important part in that all treatments at the 30 day harvest frequency were the higher producers. All 20 day clippings dropped below the six inch cutting height at ten days. Perhaps this can be explained on the basis of an inverse relationship between frequency of harvest (stage of maturity) and crude protein content. Although 10 days difference between harvest dates is not an appreciable length of time, this still results in greater crude protein production from the 10 day cutting frequency as compared to 20 days. Apparently the percent crude protein content is sufficiently greater in the forage clipped at 10 days as shown in Table VI to more than

TABLE V

AVERAGE PERCENT PROTEIN AND POUNDS OF PROTEIN PRODUCED PER ACRE FROM VARIOUS TREATMENTS ON LAHOMA SUDANGRASS

No.	Treatment		Average % Protein	Lbs. Protein Produced/Acre
	Height of Clip	Frequency		
1	2 "	10 Days	16.01	524.20
2	4 "	10 Days	16.24	608.14
3	6 "	10 Days	14.99	685.11
4	8 "	10 Days	14.23	573.96
5	2 "	20 Days	13.90	482.81
6	4 "	20 Days	13.53	604.08
7	6 "	20 Days	12.81	586.53
8	8 "	20 Days	12.95	653.35
9	2 "	30 Days	11.52	766.54
10	4 "	30 Days	11.75	838.30
11	6 "	30 Days	11.75	862.83
12	8 "	30 Days	11.98	828.44

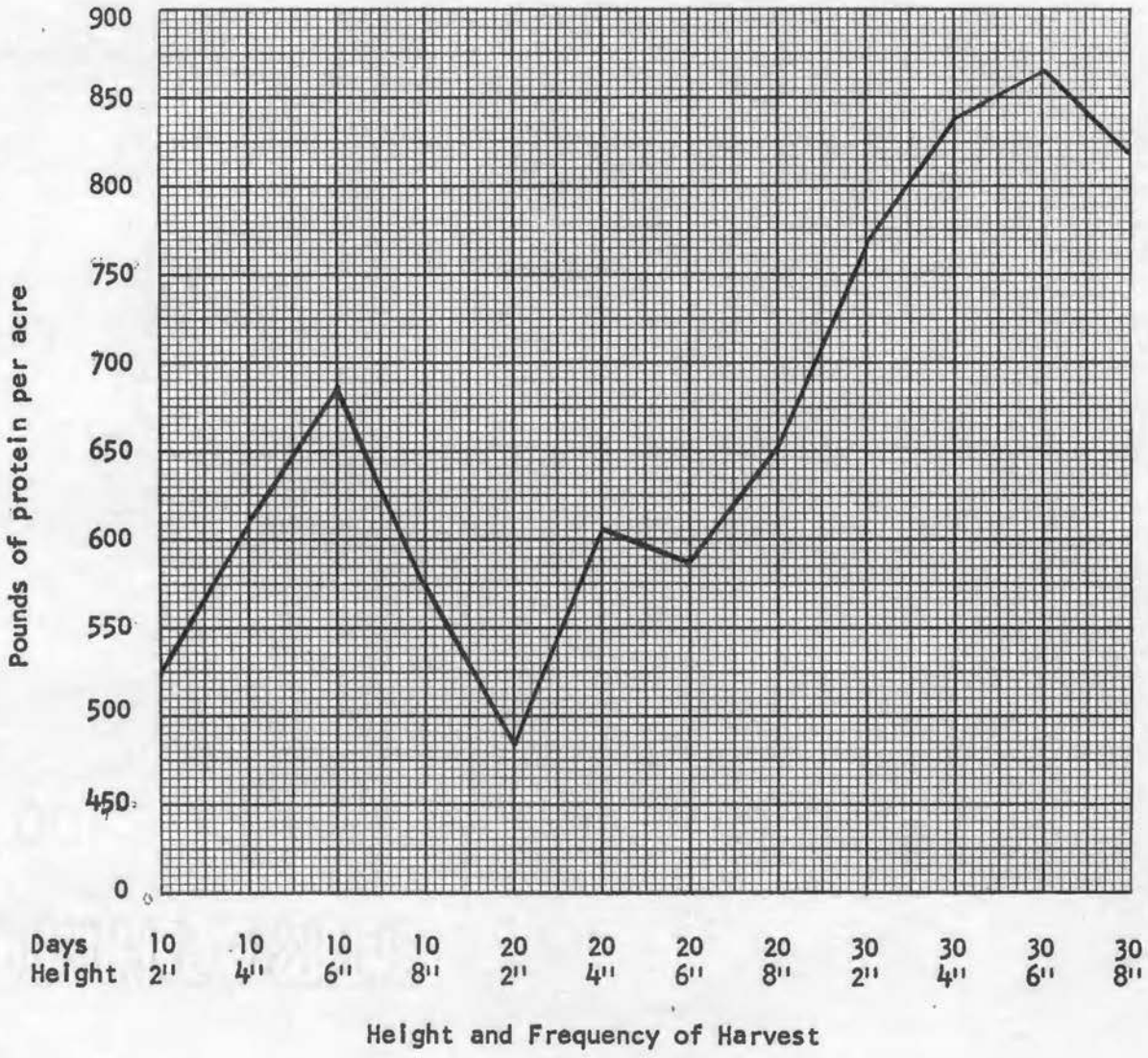

Figure 4. Pounds of Protein Produced by Lahoma Sudangrass Under Different Management Systems

TABLE VI

AVERAGE PERCENT OF CRUDE PROTEIN IN LAHOMA SUDANGRASS FORAGE HARVESTED AT THREE INTERVALS (10, 20 AND 30 DAYS) AND FOUR HEIGHTS (2, 4, 6 AND 8 INCHES)

Clipping Dates	Frequency and Height of Harvest											
	10 Days				20 Days				30 Days			
	2"	4"	6"	8"	2"	4"	6"	8"	2"	4"	6"	8"
3 July	18.38	17.81	19.63	18.13	18.38	18.63	16.94	17.81	18.50	18.00	18.13	16.13
13 July	20.81	20.25	18.00	16.44								
23 July	18.50	16.38	12.63	13.00	10.19	9.69	9.00	9.37				
2 August	8.69	12.75	9.94	7.94					5.87	6.69	6.19	6.75
12 August	14.56	16.06	15.44	14.81	14.06	13.00	13.00	12.81				
22 August	17.19	16.19	15.31	16.38								
30 August	13.94	14.25	14.00	12.96	13.00	12.81	12.31	11.81	10.19	10.56	10.94	13.06
Total	112.07	113.69	104.95	99.64	55.63	54.13	51.25	51.80	34.56	35.25	35.26	35.94
Mean	16.01	16.24	14.99	14.23	13.90	13.53	12.81	12.95	11.52	11.75	11.75	11.98

offset a slight increase in dry matter production from a 20 day harvest but lower protein content. The two inch height of defoliation at 20 day intervals produced the least amount of protein.

In total pounds and percent nitrogen recovered as indicated in Figures 5 and 6, the trend is the same as with protein produced. The higher amount of nitrogen recovered was from the six inch height of clip at 30 day intervals.

The quantity of aftermath left on the six and eight inch treatments at all frequencies was quite large and highly significant as indicated by Table VII. Also, when analyzed by the multiple range test (Table VIII and Figure 7) with the exception of 10 days at eight inches and 30 days at six inches, each treatment ranking from six inches at 10 days to eight inches at 30 days was significantly higher than the other.

Practical application of the results found in this investigation perhaps could be projected to any situation in which Lahoma sudangrass is used. It would appear from the results of this study that in any improved grazing system, intensive management and rotational grazing would be advantageous. This study indicates that by the use of a system whereby the grass was rested for 30 days after being grazed to a height no lower than six inches, maximum forage yields could be obtained.

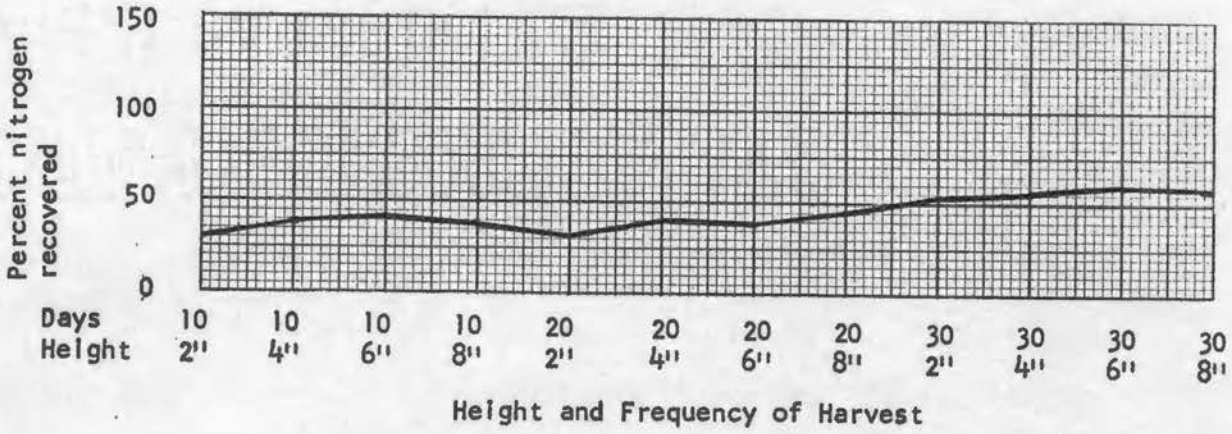

Figure 5. Percent Nitrogen Recovered by Lahoma Sudangrass Under Different Management Systems

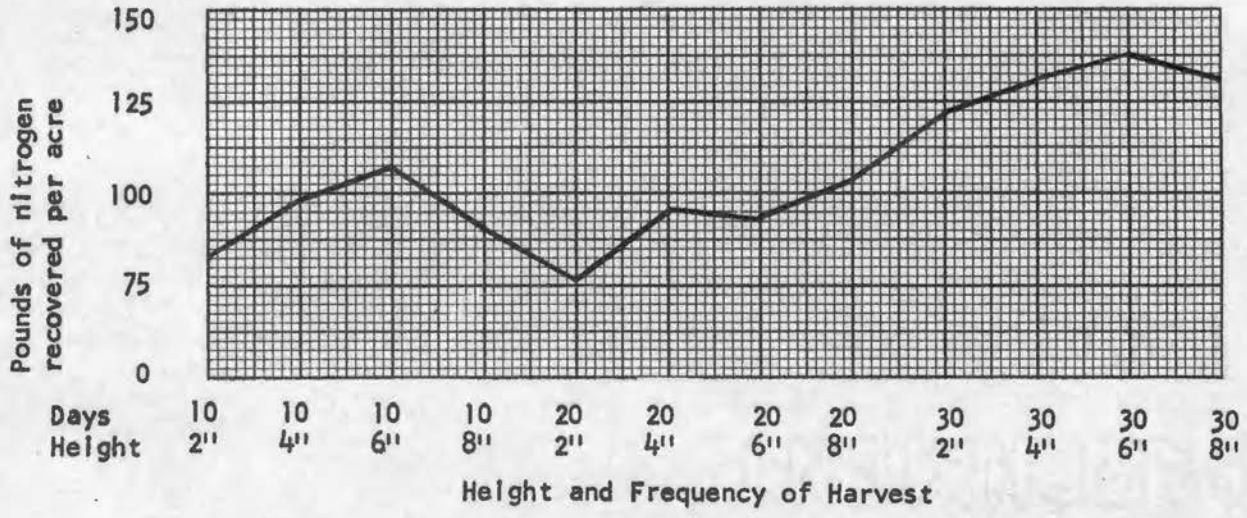

Figure 6. Pounds Nitrogen Recovered by Lahoma Sudangrass Under Different Management Systems

TABLE VII

ANALYSIS OF VARIANCE OF POUNDS OF AFTERMATH HARVESTED FOLLOWING THE LAST DEFOLIATION

Source of Variation	D. F.	Sum of squares	Mean square	F value
Total	23	3,104,908		
Replications	3	2,510,235	502,047	
Treatments	5	97,024	32,341	15.13**
Error	15	497,649	33,176	

** Indicates significance at the 1% level of confidence.

TABLE VIII

MULTIPLE RANGE TEST OF POUNDS OF AFTERMATH HARVESTED FOLLOWING THE LAST DEFOLIATION

Treatment		Mean Forage Yield	Multiple Range /x 5%
Height of Clip	Frequency		
6 inches	10 Days	477.00	
6 inches	20 Days	873.00	
6 inches	30 Days	1,060.00	
8 inches	10 Days	1,067.00	
8 inches	20 Days	1,219.00	
8 inches	30 Days	1,539.00	

/x Any two means underscored by the same line are not significantly different.

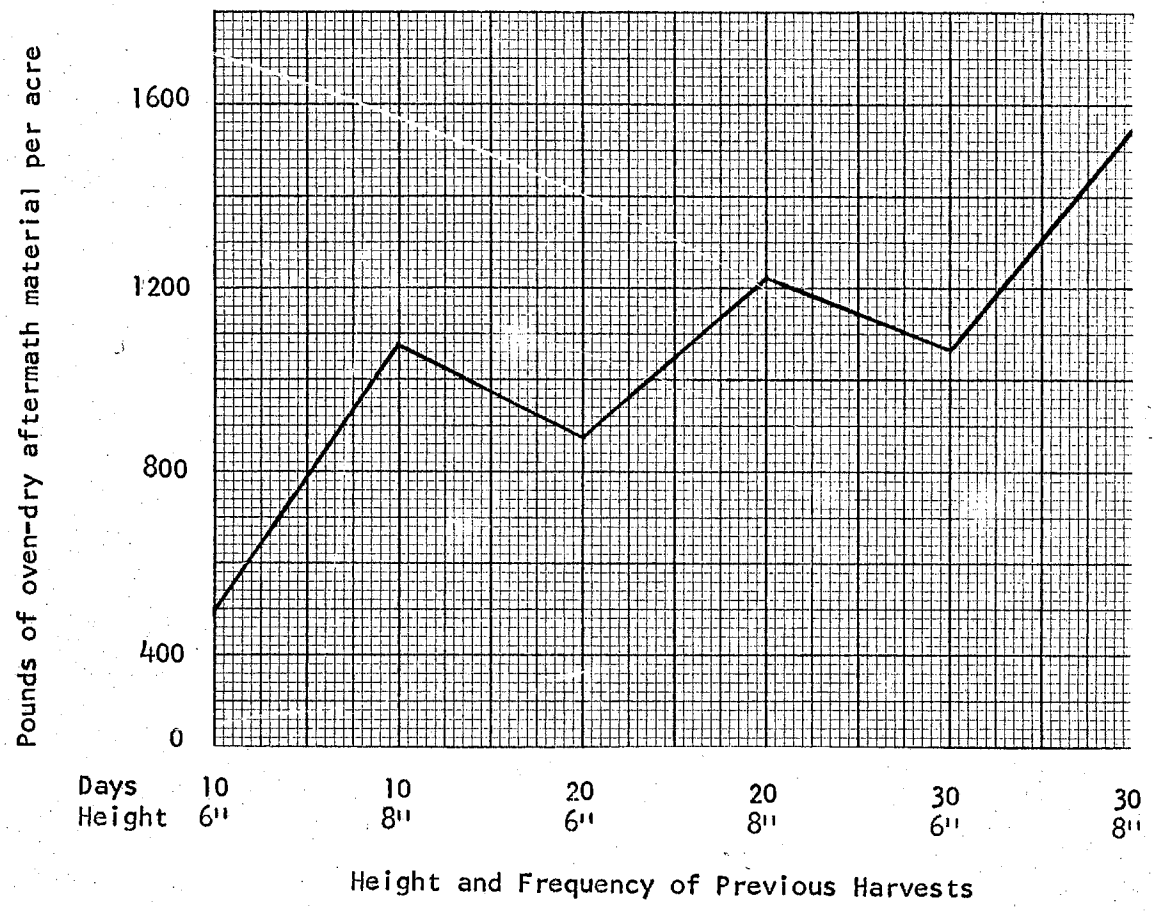

Figure 7. Pounds of Oven-dry Aftermath Produced by Lahoma Sudangrass After Final Clipping

SUMMARY AND CONCLUSIONS

A forage yield study with Lahoma sudangrass was conducted at the Oklahoma Agricultural Experiment Station Agronomy farm in the summer of 1957 on a Port silt loam soil.

The sudan was planted in a randomized block design with four replications. The treatments consisted of four heights of clip (2, 4, 6 and 8 inches) above the soil surface at intervals of 10, 20 or 30 days. Each plot consisted of five rows, twelve inches apart and twenty feet long with a border on either end. The inside three rows were used to measure the effect of various treatments on forage production. Fertilizer was applied in three applications which totaled 230 pounds of nitrogen, 60 pounds of phosphorus and 60 pounds of potassium per acre. Rainfall was supplemented with 12½ inches of water applied by a sprinkler irrigation system in an effort to minimize the effect of other factors on forage production of Lahoma sudangrass. Forage stubble or aftermath left at the end of this study was harvested from all plots following the last clipping for yield determination.

All treatments harvested at 30 day intervals produced significantly greater yields than either the 10 or 20 day frequency. The lower yields were produced from the more frequent harvests and the lower heights of clip. Aftermath yields following the last harvest were quite large from all six and eight inch clipping heights, the highest producer being eight inches at 30 days.

Protein production followed closely the pattern of forage yield when plots harvested at 30 day intervals produced more forage than those plots clipped at 10 and 20 day frequency; however, the lowest amount of protein produced was from a two inch height of clip harvested every 20 days. The results of this study indicate that the type of management employed will determine the amount of forage produced.

LITERATURE CITED

1. Ahlgren, H. L. Effect of fertilization, cutting treatments, and irrigation on yield of forage and chemical composition of the rhizomes of Kentucky bluegrass. Jour. Amer. Soc. Agron. 30: 683-698. 1938.

2. Albert, W. A. Studies on the growth of alfalfa and some perennial grasses. Jour. Amer. Soc. Agron. 19:624-654. 1927.

3. Albertson, F. W., A. Riegel and J. L. Launchbaugh, Jr. Effect of different intensity of clipping on short grasses in west-central Kansas. Ecology 34:1-20. 1953.

4. Aldous, A. E. Effect of different clipping treatments on the yield and vigor of prairie grass vegetation. Ecology 11:752-759. 1930.

5. Biswell, H. H. and J. E. Weaver. Effect of frequent clipping on the development of roots and tops of grass in prairie sod. Ecology 14:368-390. 1933.

6. Brown, B. A. and R. I. Munsell. Effects of cutting systems on ladino clover. Conn. Agr. Exp. Storrs Bul. 313. 1956.

7. Burger, A. W., J. A. Jackobs and C. N. Hittle. Yield of sudangrass varieties as affected by time and frequency of cutting. Agron. Jour. 50:37-39. 1958.

8. Canfield, R. H. The effect of intensity and frequency of clipping on density and yield of black grama and tobosa grass. U.S.D.A. Tech. Bul. 681. 1939.

9. Carter, J. F. and A. G. Law. The effect of clipping upon the vegetative development of some perennial grasses. Jour. Amer. Soc. Agron. 40:1084-1091. 1948.

10. Cooper, C. S. The effect of time and height of cutting on the yield, crude protein content and vegetative composition of a native flood meadow in eastern Oregon. Agron. Jour. 48:257-258. 1956.

11. Crowder, L. V., O. E. Sell and E. M. Parker. The effect of clipping, nitrogen application, and weather on the productivity of fall sown oats, ryegrass and crimson clover. Agron. Jour. 47:51-54. 1955.

12. Crozier, A. A. Forage crops and wheat. Mich. State Agri. Exp. Sta. Bul. 141:130-132. 1897.

13. Decker, M. A., Jr. and U. Teemont. Tall fescue management. Agron. Abst. 83. 1956.

14. Denman, C. E. Lahoma sweet sudangrass. Okla. Agr. Exp. Sta. Bul. 452. 1955.

15. Dotzenko, A. and G. H. Ahlgren. Effect of cutting treatments on the yield, botanical composition and chemical constituents of an alfalfa-bromegrass mixture. Agron. Jour. 43:15-17. 1951.

16. Duell, R. W. and H. W. Gausman. The effect of differential cutting on the yield, persistence, protein and mineral content of birdsfoot trefoil. Agron. Jour. 49:318-319. 1957.

17. Duncan, D. B. Multiple range and multiple F tests. Biometrics 11:1-42. 1955.

18. Elder, W. C. and J. Q. Lynd. Pasture management studies. Annual Report of Progress in Forage Crops Research in Oklahoma. 1956.

19. Ellett, W. B. and L. Carrier. The effect of frequent clipping on total yield and composition of grass. Jour. Amer. Soc. Agron. 7:85-87. 1915.

20. Graber, L. F. and V. G. Sprague. The productivity of alfalfa as related to management. Jour. Amer. Soc. Agron. 30:38-54. 1938.

21. Gross, D. H., C. P. Wilsie and J. Pesek. Some responses of alfalfa varieties to fertilization and cutting treatments. Agron. Jour. 50:161-164. 1958.

22. Harrison, C. M. Greenhouse studies of the effect of clipping the tops of alfalfa at various heights on the production of roots, reserve carbohydrates and top growth. Plant Physiology 14: 505-516. 1939.

23. _____. Effect of cutting and fertilizer applications on grass development. Plant Physiology 6:669-684. 1931.

24. Holscher, C. E. The effects of clipping bluestem, wheatgrass and blue grama at different heights and frequencies. Ecology 26: 148-156. 1945.

25. Hoveland, C. S. and D. E. McCloud. Manage millet for better yields. Fla. Res. Rep. 2:14. 1957.

26. Jackobs, J. A. and D. L. Oldemeyer. The response of four varieties of alfalfa to spring clipping, interval between clipping and fall clipping in the Yakima valley. Agron. Jour. 47:169-170. 1955.

27. Lang, R. and O. K. Barnes. Range forage production in relation to time and frequency of harvesting. Univ. Wyo. Agri. Exp. Sta. Bul. 253. 1942.

28. Nelson, C. E. and J. S. Robins. Nitrogen uptake by ladino clover-orchard grass pasture under irrigation as influenced by moisture, nitrogen fertilization and clipping treatments. Agron. Jour. 49:72-74. 1957.

29. Pierre, W. H. and F. E. Bertham. Kudzu production with special reference to the influence of frequency of cutting on yield and formation of root reserves. Jour. Amer. Soc. Agron. 21: 1079-1101. 1929.

30. Prine, G. M. and G. W. Burton. The effect of nitrogen rate and clipping frequency upon the yield protein content and certain morphological characteristics of bermuda grass. Agron. Jour. 48:296-301. 1956.

31. Robertson, J. H. Effect of frequency of clipping on the development of certain grass seedlings. Plant Physiology 8:425-447. 1933.

32. Robinson, R. R., V. G. Sprague and A. G. Lueck. The effect of irrigation, nitrogen fertilization and clipping treatments on persistence of clover and on total and seasonal distribution of yields in a Kentucky bluegrass sod. Agron. Jour. 44:239-244. 1952.

33. Snedecor, G. W. Statistical methods. 5th Ed. Ames, Iowa: Iowa State College Press. 1956.

34. Sprague, V. G. and R. J. Garber. Effect of time and height of cutting and nitrogen fertilization on the persistence of legume and production of orchard grass-ladino and bromegrass-ladino associations. Agron. Jour. 42:586-593. 1950.

35. Sturkie, D. G. The influence of various top-cutting treatments on rootstocks of Johnson grass. Jour. Amer. Soc. Agron. 22:82-93. 1930.

36. Taylor, T. H., R. E. Blaser, J. B. Washko and V. G. Sprague. The effect of different intensities of clipping and grazing on the yield and botanical composition of an orchard grass-ladino clover mixture. Agron. Abst. 85. 1956.

37. Thaine, R. The effect of clipping frequency on the productivity and root development of Russian wild rye in the field. Canadian Jour. Agri. Sci. 34:299-304. 1954.

38. Vicente-Chandler, J., R. Caro-costa, J. Figarella. The effect of two heights of cutting and three fertility levels on the yield, protein content and species composition of a tropical kudzu and molasses grass pasture. Agron. Jour. 45:397-400. 1953.

39. Wagner, R. E. Yield and botanical composition of four grass-legume mixtures under differential cutting. U.S.D.A. Tech. Bul. 1063. 1952.

40. _____. Effects of differential clipping on growth and development of seedling grasses and legumes. Agron. Jour. 44:578-584. 1952.

41. Watkins, J. M. and M. L. Severen. Effect of frequency and height of cutting on the yield, stand and protein content of some forages in El Salvador. Agron. Jour. 43:291-296. 1951.

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