THE EFFECT OF CUTTING HEIGHT ON SUDANGRASS, SORGHUM-SUDANGRASS HYBRIDS, AND PEARL MILLET

By

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CHAPTER I

INTRODUCTION

Sudangrass plays a very important economic role in the livestock industry, and may be employed profitably as an emergency hay or pasture crop, or as a crop in a long time program of the livestock producer. Economic returns from sudangrass can be expected to occur in the form of a cash hay crop marketed directly by the producer or indirectly in the form of beef, mutton, or milk in a sudangrass-livestock enterprise. Sudangrass is becoming a versatile crop and is even more adaptable to various soil and climatic conditions as new varieties and hybrids are being developed.

The names and seed sources of recommended varieties (standard and hybrids) have been readily available to producers for the past several years; however, recommendations pertaining to practical management and production of these new varieties have been of a limited nature. Very little information is available concerning the most desirable height for cutting sudangrass in order to obtain top forage yields in the Southern Great Plains.

The purpose of this study was to determine the optimum height to cut sudangrass, sorghum-sudangrass hybrids and pearl millet in order to obtain maximum recovery after clipping, and maximum forage yields per acre. Varieties include Lahoma Sweet sudangrass, Piper Common sudangrass,

a sorghum-sudangrass hybrid, variety SX-11, and a sorgo-sudangrass hybrid, variety Sweet Sioux. Piper sudangrass X Sorghum propinquum cross, variety PXP, was included along with the improved pearl millet, variety Gahi-1.

CHAPTER II

REVIEW OF LITERATURE

Management of forage crops has become more important during the past few years. However, a limited amount of research has been conducted on harvesting methods in sudangrass.

Adaptability of Sudangrass

In 1954, Carter (8) reported that sudangrass produced large plants capable of high yields per acre of pasture, hay, or silage in North Dakota. He also pointed out that sudangrass was first grown at the Chillicothe, Texas Experiment Station and was in general use by 1914 or 1915. Currently, ten million acres of sudangrass are grown in the United States. Gangstad (18) found that sudangrass was adapted in nearly every state of the United States over a wide range of soils and under various climatic conditions. Schoth and Rampton (29) observed that the place of sudangrass as a forage plant in Oregon was definitely established. Similar reports can be found from other sections of the country. Sudangrass is widely employed as a forage crop in Texas according to Holt and Vavra (23) who determined that broadcasting and drilling were both adequate methods of seeding if the sudangrass was harvested as hay. However, row seedings were apparently more dependable if the sudangrass was to be grazed throughout the season.

In a Wisconsin experiment, Ahlgren and Smith (2) discovered that sweet types of sudangrass contained more hydrocyanic acid, yielded less, and grew more slowly after planting than did the common types. As a result of a study in Kansas, Pickett (27) stated that the possibility of poisoning from hydrocyanic acid was increased if sudangrass was pastured at young stages.

Management of Other Forages

Although limited data are available concerning the clipping practices recommended for sudangrass, tests concerning clipping management of native grasses and tame pastures have been conducted. Some of these experiments may well be of value as a guide in selecting the correct clipping practices to use on sudangrass and other annual forage plants.

In 1897, Crozier (13) found that the yields of cultivated grasses were highest on those plots clipped less frequently. Aldous (3) concluded from a native grass experiment in Kansas that the vegetative yield varied inversely with the frequency of cutting. However, he believed that the deleterious influence of the more frequent clipping could be partially eliminated by increasing the height of clipping. In a Nebraska experiment, Biswell and Weaver (4) obtained interesting results from clipping seven native grasses at different intervals. They found that yields increased for three to five clippings after the first clipping. Then the yield decreased greatly.

Carter and Law (9) subjected grasses in the Pacific Northwest to 15- and 30-day clipping intervals. The results indicated that the yield was decreased by both cutting treatments but was more drastically reduced

by the 15-day cutting interval. Similar results were obtained by Wagner (31) and Leukel, et al. (25). Also, both studies revealed that root growth was greatly reduced by the frequent clipping with the greatest reduction occurring during the later stages of growth.

Different conclusions were drawn by Gay (19) from a one-year clipping, burning, and fertilizing study of native grass in north central Oklahoma. The results showed that the plots clipped twice during the season produced more forage than plots clipped only once during the year.

Several experiments have been conducted in order to determine the optimum height for cutting forage grasses. The results of these studies have not been in complete agreement. Some experiments revealed that height of clipping had little, if any, effect on forage production while other studies indicated height of clipping greatly influenced yield.

Harrison (21) in an experiment with bluegrass and a fescue concluded that the shorter the grass was cut, the more the leaf area was reduced and the more the quantity of roots was reduced. Also, he found that grasses with different growth characteristics responded differently since the fescue tillered more when cut at a short clipping height than at a taller clipping height. However, the reverse was true for the bluegrass.

At the Miles City, Montana Experiment Station, Holsher (24) found that each clipping height used decreased the vigor of wheatgrass and blue grama. In a similar clipping experiment Wright (33) reported that yields were highest for grass clipped at the stage of early seed-head emergence and that yields increased with each increment in cutting

height from three to twelve inches. Similarly, Ahlgren (1) concluded that cutting bluegrass in the pre-boot stage favored productivity over cutting at the boot stage or when fully headed.

Cooper (12) found that two-, four-, or six-inch clipping heights had no effect on forage production in a native flood meadow of Oregon. Similar results were reported by Blood (5) from an experiment in Britain in which plots were clipped to a one-inch height with no harmful effect on forage yield. Wolf et al. (32) found the reverse was true when results from an experiment involving a mixture of tame grasses indicated that highest yields were from plots in which the highest stubble was left. The same was true in a sudangrass-alfalfa mixture clipping study. Yield was directly associated with cutting heights (15).

Management of Sudangrass and Millet

Cutting management experiments involving sudangrass and millets have produced variable results. Broyles and Fribourg (6) after conducting a clipping experiment with millet and sudangrass, stated that cutting at early bloom stage to a four-inch stubble produced highest yields, followed by cutting when the forage was 30 inches high to a ten- or six-inch stubble and at a 20-inch height to a six-inch stubble. Also, Elder and Lynd (17) concluded from the results of a clipping study on Lahoma sweet sudangrass that yields from the four-inch cutting height were significantly higher than those from the eight-inch cutting height. In an experiment with Lahoma sweet sudangrass, Daniel (14) reported that the highest yield was obtained at the eight-inch stubble as opposed to cutting heights of two, four, and six inches.

Mays and Washko (26) conducted a clipping experiment using pearl millet, common sudangrass and sweet sudangrass varieties. They pointed out that the yields from plots clipped at two and four inches out-yielded plots that were clipped at six and eight-inch heights.

Apparently, yield differences from sudangrass have resulted from different management practices as demonstrated by Cook and Palmer (11) from their results of a clipping frequency study. Results of the three-year study indicated that clipping twice a year as contrasted to three times a year increased yield.

According to Holt (22), maximum dry matter production was obtained when sudangrass was harvested in the milk to soft-dough stage. Harvesting in the pre-boot stage reduced dry matter production 40-50% as compared to the yield at the soft-dough stage. An extra cutting was obtained by harvesting in the pre-boot stage, but total dry matter production for the season was less than that harvested at the soft-dough stage.

Ramsey et al. (28) recommended that sudangrass in Mississippi should be cut for silage when one-third of the heads achieved a mature color. Dudley (16) stated that the stage of growth and development at the time of the first harvest affected the amount of regrowth of sudangrass obtained during the rest of the growing season and pointed out that maximum yields were obtained by the latest initial harvest.

In another stage of maturity test involving Wheeler, Greenleaf, Piper, and sweet sudangrass, Burger et al. (7) pointed out that all varieties produced much less dry matter when cut under the pasture system as compared to the hay system.

The results of a Mississippi experiment involving millet and sudangrass indicated that most millet varieties produced more forage than the best varieties of sudangrass regardless of seeding method, date of planting, or time and frequency of harvest (10). However, conflicting results were obtained by Griffith (20) in an Oklahoma experiment involving Lahoma sweet sudangrass, Piper common sudangrass, SX-11, Sweet Sioux, PXP, and Gahi-1 improved pearl millet. The yield data obtained from this study showed that Sweet Sioux out-yielded all other varieties in total dry weight per acre.

CHAPTER III

METHODS AND MATERIALS

In 1963 and 1964 a harvesting management study was conducted using six varieties of annual forage grasses (Table 1) grown on a Vanoss silt loam soil on the 2800 series of the Agronomy Research Station, Perkins, Oklahoma. The experiment consisted of a randomized block design with four replications. Each plot contained five rows, twelve inches apart and 20 feet long. Only the three inside rows of each plot were harvested.

Each variety was seeded with a one-row hand-operated Planet Junior garden planter on June 5, 1963 and on May 26, 1964. SX-11, Sweet Sioux, and PXP were seeded at the rate of 30 pounds per acre while Piper and Lahoma were seeded with 20 pounds of seed per acre and Gahi-1 pearl millet was planted at the 15 pound per acre rate. In 1963, 100 pounds of ammonium nitrate per acre was applied on June 24. This fertilizer treatment was repeated on July 27, one week after the first harvest. In 1964, the same fertilizer rates were used on July 15, August 20, and September 12. In all cases, the fertilizer was applied with a Gandy spreader.

Supplemental water was applied with a sprinkler irrigation system at the rate of one inch per day on July 11, and August 28, in 1963 and on June 23, July 6, 18, 23 and August 6, 1964. Signs of moisture stress in the plant leaves was the criterion used to determine the time of application.

TABLE 1

VARIETIES OF SIX ANNUAL FORAGE GRASSES USED IN A CLIPPING STUDY

PERKINS, OKLAHOMA, 1963-64

Variety		Type
Piper	Sorghum sudanense, Hitchc.	Common Sudangrass
PXP	Sorghum sudanense, Hitchc. x Sorghum propinquum	Piper x Sorghum propinquum
Lahoma	Sorghum sudanense, Hitchc.	Sweet Sudangrass
SX-11	Sorghum vulgare, Pers. x Sorghum sudanense, Hitchc.	Sorghum-Sudan Hybrid
Sweet Sioux	Sorghum vulgare, Pers. x Sorghum sudanense, Hitchc.	Hybrid Pearl Millet
Gahi-1	Pennisetum glaucum, R. Br.	Hybrid Pearl Millet

The forage was harvested twice at the hay stage in 1963 with the first harvest occurring on July 19 and the second harvest on August 19. In 1964, harvests were performed on July 10, August 5, and September 10. Each variety was clipped at two-inch, four-inch, and six-inch heights with a Jari mower. Green weight measurements of the forage were recorded from each plot. Random samples from each plot were selected for dry weight measurements and oven-dried in a forced air oven at 148° F. for 72 hours. The dry samples were then weighed and the weight was recorded. The percent dry matter was determined as well as the pounds of oven dry forage per acre. Statistical analyses of the data collected were conducted according to procedures outlined by Steel and Torrie (30).

CHAPTER IV

RESULTS AND DISCUSSION

A multiple range test (Table 2) for the yield data for 1963 indicated that greatest yield of forage per acre could be obtained by clipping at the two-inch clipping height. However, this was true for only some of the varieties.

SX-11 clipped at two inches yielded significantly more than when clipped at four or six inches. Plots clipped at four inches yielded significantly more than those clipped at six inches. There was no significant difference in total yield from the two-inch clip and the four-inch clip of Sweet Sioux. However, plots from both the two- and four-inch clip yielded significantly more than the plots clipped at six inches. PXP clipped at two inches yielded significantly more than that clipped at four inches which, in turn, yielded significantly more than the same variety clipped at six inches. Yield from Lahoma did not follow the same pattern in that the plots clipped at two inches produced significantly more forage than the plots clipped at six inches. The six-inch clip resulted in significantly more forage than did the four-inch clip. Results indicated that a higher clipping height should be employed when harvesting pearl millet. Even though there was no significant difference between yields from plots clipped at six and four inches, both treatments resulted in yields significantly greater than those of the plots clipped at two inches. Piper was the only variety to produce

TABLE 2

TOTAL YIELD IN POUNDS OF OVEN-DRY FORAGE PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA. 1963

DUNCAN'S MULTIPLE RANGE TEST

Variety	Clipping height in inches	Average yield in pounds of oven-dry forage per acre
SX-11	2	6757 a[1]
Sweet Sioux	2	6610 a
Sweet Sioux	4	6528 a
Sweet Sioux	6	5742 b
SX-11	4	5481 bc
Gahi-1	6	5352 cd
Gahi-1	4	5303 cd
PXP	2	5094 de
Piper	6	5021 de
SX-11	6	5016 de
Piper	2	4906 ef
Gahi-1	2	4779 efg
Lahoma	2	4766 efg
Piper	4	4599 fg
PXP	4	4458 g
PXP	6	4054 h
Lahoma	6	3884 h
Lahoma	4	3252 i

[1] Numbers followed by the same letter are not significantly different at the 0.05 level of probability.

significantly more forage at the six-inch clipping than at the other two clipping heights. Again the yields did not occur in descending order according to clipping height, as the plots clipped at the two-inch height yielded significantly more than the plots clipped at four inches.

Since the forage was harvested twice, the second harvest yield and consequently the average yield, depended to some degree on the variety's ability to recover after the first harvest. The recovery data recorded two weeks after first and second harvests in 1963 are presented in Tables 3, 4, and 5. The recovery data were based on visual estimates only and the number of plants varied from plot to plot so no definite statements or conclusions can be drawn from the recovery data. However, apparent trends and differences may be pointed out. Percentage recovery for varieties Lahoma, SX-11, and Gahi-1 was greater at the six-inch clipping height followed by the four-inch and two-inch clipping heights in that order. Piper's greatest percentage recovery was at the four-inch cutting height followed by the two-inch and six-inch heights respectively. The four-inch height proved best for PXP with no difference occurring between the two-inch and six-inch heights. No appreciable difference was apparent in the variety Sweet Sioux although recovery was favored by the four-inch cutting over either the six-inch or two-inch clipping heights.

The forage grasses were harvested three times in 1964 and produced different results than those of the previous year. A multiple range test (Table 6) for the 1964 yield data indicated that no particular clipping height proved best for all varieties.

Yields from plots of Sweet Sioux clipped at two and six inches were not significantly different, but both treatments resulted in significantly

TABLE 3

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT TWO-INCH HEIGHT, PERKINS, OKLAHOMA, 1963.

Variety	1st Cutting % Stand	2nd Cutting % Stand	Ave. % Stand
Piper	80	40	60
PXP	80	30	55
Lahoma	30	5	17.5
SX-11	60	25	42.5
Sweet Sioux	75	30	52.5
Gahi-1 pearl millet	35	5	20

TABLE 4

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT FOUR-INCH HEIGHT, PERKINS, OKLAHOMA, 1963.

Variety	1st Cutting % Stand	2nd Cutting % Stand	Ave. % Stand
Piper	90	40	65
PXP	85	55	70
Lahoma	85	15	50
SX-11	65	50	57.5
Sweet Sioux	85	30	57.5
Gahi-1 pearl millet	85	40	67.5

TABLE 5

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT SIX-INCH HEIGHT, PERKINS, OKLAHOMA, 1963.

Variety	1st Cutting % Stand	2nd Cutting % Stand	Ave. % Stand
Piper	70	30	50
PXP	70	40	55
Lahoma	75	35	55
SX-11	60	60	60
Sweet Sioux	75	35	55
Gahi-1 pearl millet	85	70	77.5

TABLE 6

TOTAL YIELD IN POUNDS OF OVEN-DRY FORAGE PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1964

DUNCAN'S MULTIPLE RANGE TEST

Variety	Clipping height in inches	Average yield in pounds of oven-dry forage per acre
Sweet Sioux	2	7704 a[1]
Sweet Sioux	6	7601 a
Piper	6	7355 ab
PXP	2	7285 ab
Gahi-1	4	7236 ab
Sweet Sioux	4	6995 bc
Piper	2	6977 bc
Piper	4	6924 bc
Lahoma	4	6604 cd
SX-11	4	6593 cd
SX-11	6	6319 de
Gahi-1	6	6035 ef
SX-11	2	5939 ef
PXP	4	5645 fg
Lahoma	2	5347 gh
PXP	6	5022 h
Gahi-1	2	4964 h
Lahoma	6	4080 i

[1] Numbers followed by the same letter are not significantly different at the 0.05 level of probability.

more forage than the four-inch clipping height. Piper was the only variety in the test to produce significantly more forage at the six-inch clipping height than at the two- and four-inch heights. However, there was no significant difference in yield between plots of Piper clipped at two and four inches. PXP reacted differently to the cutting treatments in that the plots clipped at two inches produced significantly more forage than plots clipped at four inches which, in turn, produced significantly more forage than plots clipped at six inches. The four-inch clipping height produced the best results for the three other varieties in the test with plots of Gahi-1 and SX-11 clipped at four inches producing significantly more forage than the plots clipped at either six or two inches. Yields of forage of both varieties from plots clipped at six inches were significantly greater than yields from plots clipped at the two-inch height. Also, the yield of Lahoma plots clipped at four inches produced significantly more forage than the other two treatments with the two-inch clipping resulting in significantly more forage than the six-inch clipping height.

The recovery data for 1964 (Tables 7, 8, and 9) varied greatly from those of 1963. These erratic results were probably partially due to extremely dry conditions at certain times throughout the summer. Even though supplemental water was applied in 1963 and 1964, the irrigation system was sometimes not available when it was badly needed. When the irrigation system was available, sometimes one to two weeks after supplemental water should have been applied, only limited amounts of water could be applied since only a short time was allotted for use of the irrigation system. As a result of this situation extremely dry periods occurred throughout the study. In 1964, height of clipping Piper and Lahoma apparently did not affect the recovery to any appreciable degree since recovery after clipping at all heights was approximately the same.

TABLE 7

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT TWO-INCH HEIGHT, PERKINS, OKLAHOMA, 1964.

Variety	1st Cutting % Stand	2nd Cutting % Stand	3rd Cutting % Stand	Ave. % Stand
Piper	65	63	48	59
PXP	75	66	14	52
Lahoma	65	60	85	71
SX-11	53	78	47	59
Sweet Sioux	75	60	27	54
Gahi-1	47	100	88	78

TABLE 8

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT FOUR-INCH HEIGHT, PERKINS, OKLAHOMA, 1964.

Variety	1st Cutting % Stand	2nd Cutting % Stand	3rd Cutting % Stand	Ave. % Stand
Piper	69	56	33	53
PXP	82	75	39	65
Lahoma	75	83	49	69
SX-11	76	80	67	77
Sweet Sioux	68	79	66	71
Gahi-1	88	86	54	76

TABLE 9

AVERAGE STAND OF SIX ANNUAL FORAGE GRASS VARIETIES CLIPPED AT SIX-INCH HEIGHT, PERKINS, OKLAHOMA, 1964.

Variety	1st Cutting % Stand	2nd Cutting % Stand	3rd Cutting % Stand	Ave. % Stand
Piper	68	76	27	57
PXP	88	68	47	68
Lahoma	82	76	46	68
SX-11	73	66	65	68
Sweet Sioux	67	86	66	73
Gahi-1	92	78	85	85

Recovery was best when plots were clipped at two inches, intermediate at four inches, and poorest at six inches. Plots of Gahi-1 pearl millet recovered best from six-inch clipping height and little difference occurred between plots clipped at the two- and four-inch heights. SX-11 was the only variety that recovered best at the four-inch clipping height followed by the six- and two-inch heights respectively.

It has generally been assumed that sudangrass and pearl millet should be clipped six to eight inches above the ground level for maximum recovery and forage yields. Results of this experiment and of others elsewhere clearly indicate that there are varietal differences within the same species and the proper cutting height will have to be determined for each variety and type.

CHAPTER V

SUMMARY AND CONCLUSIONS

A cutting height study was conducted using six varieties of annual forage grasses grown on a Vanoss silt loam soil at the Agronomy Research Station, Perkins, Oklahoma, in 1963 and 1964. The purpose of the experiment was to determine the best height to harvest sudangrass, sorghum-sudangrass hybrids, and pearl millet for greatest recovery and yield.

In this two-year study, the forage grasses were planted in a randomized block design with four replications. Each plot consisted of five rows, twelve inches apart and twenty feet long. The inside three rows of each plot were employed to measure the effect of various treatments on forage production. The treatments were three heights of clip (2, 4, and 6 inches) above the soil surface when the forage was in the early boot stage of maturity. Two fertilizer applications of 33.5 pounds actual nitrogen per acre were made in 1963 and three applications of the same amounts were made in 1964. Rainfall was supplemented with two inches of irrigation water in 1963 and six inches in 1964 applied by a sprinkler system. Forage was harvested twice in 1963 and three times in 1964.

In 1963, Lahoma, PXP, SX-11 and Sweet Sioux yielded best when clipped at the two-inch height while Piper and Gahi-1 performed best at the six-inch height. Piper, PXP, and Sweet Sioux recovered best from the four-inch cutting while Lahoma, SX-11 and Gahi-1 recovered best from the six-inch cutting.

In 1964, the six-inch clipping height resulted in highest yield for Piper, while the four-inch clipping height was best for Gahi-1, Lahoma, and SX-11. Sweet Sioux and PXP yielded best when a two-inch clipping height was used. Lahoma recovered best following a two-inch cutting while PXP and SX-11 recovered best after the six-inch clipping. The percentage recovery was approximately the same for Piper following harvest at each clipping height.

Climatic conditions may have partially accounted for the varying results for the two-year study, but the results indicated that the type of management practices employed influenced the amount of forage produced. It can be concluded that some varieties perform differently under the same harvesting practices.

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Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF CUTTING HEIGHT ON SUDANGRASS, SORGHUM-SUDANGRASS HYBRIDS, AND PEARL MILLET

Major Field: Agronomy (Range Management)

Biographical:

Personal Data: Born near Alva, Oklahoma on March 4, 1941, the son of Louie and Ellen Thurman.

Education: Attended grade school at Greenleaf School, Woods County, Oklahoma; graduated from Alva High School, Alva, Oklahoma, in 1959; attended NSC at Alva from 1959 to 1962; transferred to Oklahoma State University and received Bachelor of Science degree from OSU, with a major in Agronomy (Field Crops) in May, 1963; graduate study at Oklahoma State University, 1963-1965.

Experience: Born and reared on a farm; employed as a farm and ranch worker for local farmers and cattlemen, 1953-1962; worked for Woods County SCS in summer of 1957 and for the Agronomy Department at Oklahoma State University, 1963-1965.

Member of: Agronomy Club, Alpha Zeta, Student National Education Association, Aggie Toastmasters, Stillwater Junior Chamber of Commerce, Aggie Club, Rodeo Club, Newspaper Staff, Livestock Judging Team, and Crops Judging Team.