SOME EFFECTS OF DIFFERENTIAL CLIPPING ON SIX NATIVE GRASSES AND ONE INTRODUCED SPECIES

By

GURMUKH SINGH

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Agra University

(U.P.) India

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Thesis Approved:

Jack R. Harlan
Thesis Adviser

H. J. Featherly

Robert Maclean
Dean of the Graduate School

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INTRODUCTION

Clipping vegetation at different heights and frequencies to imitate various methods or degrees of grazing has been rather commonly used to supplement actual grazing experiments. The clipping tests have been especially valuable in determining the effects of various treatments on the yield, succession, quality and vigor of the vegetation. Where these tests are conducted with actual grazing experiments, it is often possible to interpret better and to evaluate more closely the results secured from the grazing investigations.

The problem in most regions is to determine just how closely the forage plants can be grazed to obtain quality and at the same time maintain enough vigor to prevent degradation to less desirable species. Large areas of the native tall grass prairie have deteriorated to an alarming degree since the advent of the white man and his domestic animals. The studies reported here were initiated in order to learn more about the responses of several grasses to various clipping regimes.

REVIEW OF LITERATURE

Considerable amount of work has been done on clipping of grasses and its effect by many investigators. In this review, work on native grasses only is reported. It has been known for many years that excessive and continued close removal of the photosynthetic area of plants has deleterious effects on their growth. Sampson (20) [1], Weaver and Hongen (30) made a statement, after studying the effects of clippings very closely, that production and vigor of vegetation varies inversely with the frequency of clippings.

Working on clipping studies on several grass species at two week intervals for a period of 90 days, Biswell and Weaver (3) obtained top production varying from 16.4% to 47.5% of the control and root production from 3.1% to 20.6% of the control.

Aldous (2), Servis (21), Graber et. al. (9), Garnet (8), and Holscher (12) conducted several clipping experiments on native grass swards and found that the grasses clipped less frequently produced more forage throughout the year than those clipped more frequently.

Conducting the grazing trials in the Palose area of Eastern Washington, Daubenmire (4) found that overgrazing resulted in a considerable reduction in plant cover and the replacement of the tall dominant perennial Agropyron species by dwarf weeds.

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[1] Figures in parenthesis refer to Literature Cited.

Aldous (2) investigated the effect of clipping on composition of two prairie grass pastures and found the grass clipped at two week intervals deteriorated to the point that 50% of it was replaced by annuals while the grass clipped less frequently maintained the stand. Studying the botanical composition of native grass pastures as affected by clipping frequency, Smith (22), Weaver and Hansen (29), Voight and Weaver (25), Robocker and Miller (18), Neiland and Curtis (15) and Ellet (5) noticed that the big bluestem and switch grass sharply decreased in direct relation to an increase in clipping severity while Indian grass and little bluestem were less affected. Side-oats grama increased under certain clipping treatments.

Measuring the basal density of two prairie grass pastures, Aldous (2) found that the density of the fodder (grass) decreased about 60% on plots clipped at two week intervals for three seasons, while the plots clipped at three week intervals decreased 13% in density.

Some other workers, Albertson et. al. (1), Rummel (19), Robocker and Miller (18), Biswell and Weaver (3), also found that the grasses decreased in density in direct relation to increase in the intensity of grazing or clipping.

Working on the production of roots in native grasses, Weaver (28), Biswell and Weaver (3), Robertson (17), Harrison (10), and Garnet (8) found that frequent clippings were deleterious to root production.

Garnet (8), while studying the effect of clipping on root weight and root volume on native grasses, found that the lowest root weight and root volume was obtained from the plot clipped most frequently.

Various ecological methods have been used to determine the botanical

composition of native grass swards. An accurate estimate of species composition with a minimum expenditure is of primary concern for the agronomic research workers.

Working with the two point quadrat method, Timmey et. al. (23) found that it has the greatest merit for a rapid and reliable means of determining the composition of pasture.

Leasure (14) found that a combination of point quadrat and visual estimation method might well be used to effect a rather substantial saving in time without materially impairing the accuracy of observation.

Estimating the botanical composition of the native grass pasture, Hansen and Love (11) found that the chart method appears to be the best way of quadrating large and well defined mats or clumps and the count listing is the best for few or single stalked plants.

Wagner (26), while studying different methods of measuring botanical composition of grass sward, made a statement that inclined point or point quadrat method is the only current, strictly quantitative method for measuring crown coverage and its usefulness is limited to low grazing vegetation and windless days.

Numerous methods have been employed to study the root system of plants in soil. Pavlychenko (16) reviewed the methods used prior to 1937 and described the soil block washing method. Studying soil root relationships of native grasses in various soils, Weaver and Darland (27) developed a method of sampling root system of grasses by taking large soil monoliths of any desired depth and washing the roots contained therein free of soil.

Soil core for sampling roots has been used previously by Laird (13)

and Fitspatrick and Rose (7). They, however, used steel cylinders or steel pipe driven into the soil and had no convenient way of relating root development to soil profile characteristics.

Devising a core sampling method for root studies in soil, Fehrenbacker and Alexander (6) eliminated the need for large samples and gave more complete sampling at various distances. They have also invented a shaker type of washer to remove most of the soil from roots under a stream of water. The final separation was made by small hand screen and tweezers.

Upchurch (24), working with root washing, developed a soil elution method of washing roots which avoided the loss of roots caused by directing a stream of water under pressure on a soil-root matrix resting on a screen.

METHODS AND MATERIALS

The site for the study was selected at the Carl Blackwell lake area where the grazing studies of the Animal Husbandry Department of Oklahoma State University were conducted. Experimental plots were located at a distance of one mile north of the prairie bridge at 87 highway.

Pure stands of El Reno and Tucson side-oats grama (Bouteloua curtipendula (Michx.) Torr.), big bluestem (Andropogon gerardi Vitman), Indian grass (Sorghastrum nutans (L.) Nash), switch grass (Panicum virgatum L.), little bluestem (Andropogon scoparius (Michx.)), and King Ranch bluestem (Bothriochloa ischaemum (L.) King) were planted in 30' X 96' plots by Roy Chessmore, Assistant Professor of Agronomy, in 1949. The soil of the plots was of low fertility and belongs to Norge loam soil series. There was a 1-3% slope from west to east throughout the whole field where the experimental plots were laid out.

Source of seed: Little bluestem, big bluestem and switch grass seeds were obtained from the Oklahoma State University Agricultural Experiment Station, Stillwater, whereas the Indian grass seed was collected from the Blackwell area. El Reno and K. R. bluestem were obtained from commercial sources while seed of the Tucson variety was obtained from the U. S. Southern Great Plains Field Station, Woodward, Oklahoma.

Since 1952, a few cattle were turned into the area from time to time to study the palatability of the individual grass species. In the

spring of 1955 clipping plots were set up on the old plantings that were well established. Each grass plot was divided into 8 (12' X 30') plots with 4 plots in each replication. Plots (12' X 30') within each replicate and grass species were then clipped at 2 and 4 inch heights at different intervals (treatment). The treatments were as follows:

A = Clipped in January or February each year.

B = Clipped in the latter part of July each year.

C = Clipped every 60 days commencing from latter part of May until early September of each year.

D = Clipped every 30 days (same period as in C treatment).

The object of this study was to determine the effect of the different treatments upon the stand, botanical composition, yield and value of the several species or strains of grasses.

The study was divided into four different parts to obtain the desired information.

Hand separations of the forage were made from herbage clipped from one foot square quadrats and weighed to determine the botanical composition and yield of forage in each component. For this study a one foot square quadrat made of 3/8 inch iron round was used and placed at random at three places in each plot. The contents of the quadrats were then clipped in each case and kept in air tight plastic bags to avoid loss of moisture. The stems of each species were separated, counted and weighed in the laboratory.

The second part of the study was conducted to find out botanical composition and percent basal density by the line transect method.

A one meter long 3/8 inch iron round graduated wire was used. The

line transect was placed at random at three places in each plot and the readings were recorded. One plant stem was considered to be equal to 1 cm. Larger crowns were measured to the nearest centimeter.

The use of one foot square quadrat (subdivided into square inches) was used to determine the percent basal density of grass species by the chart quadrat method.

A foot square quadrat 3/8 inch iron round divided into 144 square inches with thin wire was used in this study. Three readings were taken per plot. For example, if grass species occupy 80 square inches in the quadrat and the quadrat had 144 square inches, then the percent basal density for the grass species would be $\frac{80 \times 100}{144} = 55.56\%$ and the rest would be other plant materials and bare ground.

Soil core sampling method to determine the root weight and volume within each plot, replication and grass species was used. For this study an iron soil plugger with sharp edges was used to draw soil cores from the plots. The size of the core was $1\frac{1}{2}$" X $1\frac{1}{2}$" X 3 3/4". Three cores were drawn from each plot within each replication and grass species at random. The soil cores were then kept in air tight plastic bags until they could be washed and the roots and soil separated. Each core was washed under a continuous fine stream of water placed on a fine screen. The final separation of other inert material or organic matter was done with the help of tweezers.

The final product of roots obtained after washing and cleaning was then immersedin a graduated cylinder containing water to find out the volume of the roots. Roots were then kept in plastic dishes for a period of three to four days and then air dried samples of the roots were weighed to determine the root weights in a soil core.

RESULTS AND CONCLUSIONS

In the first part of the study, the species of plants were separated by hand and weighed to determine the botanical composition and yield.

As shown in Table I, the greatest number of plant units were contributed by the annual brome (Bromus tectorum and commutatus) and six week fescue (Festuca octiflora). The highest number was 585 in the case of Tucson side-oats grama under treatment A at the 4" clipping height. The next species in abundance were Plantago species.

There was no definite trend of increase and decrease in number of plants either of native grass species or of other plant species in direct relation to the increase in frequency and intensity of clipping. However, treatment C in all cases had the highest number of the grass species in question under both 2" and 4" clipping heights.

The highest number of plants (22 plants) per quadrat were found in the case of El Reno side-oats grama under C treatment at the 4" clipping height. While the lowest number was noticed in little bluestem and K. R. bluestem under all treatments irrespective of clipping intensity. The individual plants of the above two grass species were in large clumps and occupied more space than the plants of other grass species. No definite conclusion was reached for the above study but in all cases treatment C had the greatest number of plants. Annual brome grass and six week fescue were the main species responsible for the tremendous increase in total number of plants and also change in botanical composi-

TABLE I

AVERAGE NUMBER OF STEMS PER ONE FOOT QUADRAT

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
El Reno side-oats grama	2"	A	8	95	3	1	2	109
		B	6	181	1	7	2	197
		C	21	316	1	23	6	347
		D	14	141	5	6	3	169
	4"	A	7	246	1	2	4	260
		B	5	282	-	3	2	292
		C	22	177	2	10	8	219
		D	9	118	6	2	4	139
Tucson side-oats grama	2"	A	2	320	2	2	8	334
		B	2	224	1	4	10	241
		C	9	213	2	9	5	238
		D	4	132	6	3	9	154
	4"	A	2	585	-	-	5	592
		B	2	275	-	4	7	288
		C	7	449	-	5	6	467
		D	3	252	4	1	6	266
Big bluestem	2"	A	4	47	-	3	9	63
		B	4	70	1	7	6	88
		C	9	101	-	10	9	129
		D	4	134	2	2	3	145

TABLE I (continued)

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
Big bluestem	4"	A	4	25	1	-	4	34
		B	3	74	1	13	5	96
		C	9	44	1	14	3	71
		D	6	43	2	1	2	54
Indian grass	2"	A	5	166	-	8	5	184
		B	4	43	1	7	3	58
		C	13	89	2	60	1	165
		D	15	100	2	20	2	139
	4"	A	4	18	-	3	4	29
		B	3	36	-	21	1	61
		C	14	84	-	19	3	120
		D	13	61	1	7	1	83
Switch grass	2"	A	5	34	-	10	7	56
		B	4	92	1	23	4	124
		C	6	40	-	61	3	118
		D	3	122	1	39	2	167
	4"	A	5	50	-	4	6	65
		B	4	211	-	17	3	235
		C	9	295	-	22	2	328
		D	5	243	1	10	5	264

TABLE I (continued)

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
Little bluestem	2"	A	2	33	-	2	3	40
		B	1	106	-	29	1	137
		C	4	159	-	35	1	199
		D	2	122	1	5	2	132
	4"	Plots infested with weeds, hence not included in studies.						
K. R. bluestem	2"	A	1	52	-	1	1	55
		B	2	148	-	15	3	168
		C	3	353	-	43	3	402
		D	2	235	-	10	1	248
	4"	A	2	51	-	1	1	55
		B	1	138	-	6	1	146
		C	2	417	-	5	2	426
		D	2	329	-	5	1	337

tion of forage. Plantago species were also in abundance next to annual brome and six week fescue but Daisy fleabane and other weeds and grasses affected the composition but little.

As shown in Table II, the species in question contributed the major part of total forage weight as compared to annual grasses and weeds. Annual brome grass and six week fescue were the next highest forage contributors in each treatment of each grass species.

It was also noticed that approximately 34.13% of the forage was composed of undesirable grass species and weeds which reduces the value of the pasture both in quality and quantity of forage. Hence the yield of desirable forage was actually 65.87% of the total production in all grass species.

In the second part of the study, the line transect method was used to determine percent basal cover and botanical composition of the grasses.

This study was conducted approximately one month after the previous one, and by this time the annual brome grass, six week fescue and Plantago species were disappearing. Daisy fleabane was also at the verge of drying. Another plant species, Partridge pea (Cassia fasciculata) was in full bloom in its yellow flower and so it was taken into account. Panicum scribnerianum was also in abundance. Only those grasses and weeds were recorded other than the grass species in question which were in abundance. The weeds and grasses which were seldom found were recorded under other weeds and grasses. Table III shows no abrupt increase or decrease in percent basal density with the increase of frequency and intensity of clipping in any plant species except K. R. bluestem. This

TABLE II

AVERAGE WEIGHT OF STEMS PER ONE FOOT QUADRAT IN GRAMS

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
El Reno side-oats grama	2"	A	10.66	3.50	3.56	.04	1.16	18.92
		B	8.39	4.80	.73	.54	.86	15.32
		C	12.90	6.64	1.18	.37	2.47	23.56
		D	9.42	4.60	2.49	.12	.48	17.11
	4"	A	11.18	5.55	2.11	.30	2.72	21.86
		B	8.89	5.80	----	.25	.95	15.89
		C	16.53	4.38	1.26	.21	.62	23.00
		D	9.73	2.68	3.14	.13	.30	15.98
Tucson side-oats grama	2"	A	7.54	5.59	1.84	.03	3.73	18.73
		B	4.49	5.29	1.06	.28	3.60	14.72
		C	4.45	6.63	1.31	.22	.75	13.36
		D	3.31	3.95	2.66	.13	1.27	11.32
	4"	A	3.89	9.81	.42	--	1.49	15.61
		B	3.39	4.76	.52	.12	4.56	13.33
		C	4.52	8.96	.07	.08	1.00	14.61
		D	2.57	4.52	2.96	.03	.77	10.85
Big bluestem	2"	A	23.32	2.75	----	.24	2.26	28.57
		B	23.66	2.37	----	.62	2.41	29.06
		C	16.99	4.76	.15	.22	2.23	24.34
		D	13.02	4.42	1.23	.08	.40	19.15

TABLE II (continued)

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
Big bluestem	4"	A	30.28	1.24	.73	---	1.01	33.26
		B	27.70	3.53	1.34	1.01	1.30	34.88
		C	34.53	3.08	4.05	.39	.92	42.97
		D	14.20	2.72	2.21	---	.27	19.40
Indian grass	2"	A	17.47	3.72	.27	.42	1.11	22.99
		B	18.70	1.42	.46	.29	2.41	23.28
		C	15.03	4.13	1.56	1.44	.34	22.50
		D	14.03	3.41	1.17	.35	.18	19.14
	4"	A	25.84	1.26	---	.30	1.45	28.85
		B	13.29	1.33	---	.87	.63	16.12
		C	15.84	3.53	---	.47	.03	19.87
		D	13.99	3.57	1.09	.17	.05	18.87
Switch grass	2"	A	30.69	1.77	---	.63	2.17	35.26
		B	13.82	2.77	---	1.13	1.15	18.87
		C	13.44	4.40	.40	1.99	1.26	21.49
		D	12.23	2.74	.40	1.11	.12	16.60
	4"	A	23.32	2.50	.41	.23	1.61	27.87
		B	13.21	3.30	---	.98	.81	18.30
		C	13.99	6.07	---	1.07	1.67	22.80
		D	11.75	5.36	.41	.37	.59	18.48

TABLE II (continued)

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Other grasses & weeds	Total
Little bluestem	2"	A	12.43	1.52	.08	.22	3.27	17.52
		B	8.83	2.83	---	.63	.47	12.76
		C	9.37	3.92	---	.66	.72	14.67
		D	5.72	3.09	.26	.11	.16	9.34
	4"	Readings were not taken as the plots were very heavily infested with weeds.						
K. R. bluestem	2"	A	14.00	2.38	---	.02	.76	17.16
		B	5.84	5.52	---	.81	.91	13.07
		C	5.83	5.61	---	2.00	.78	14.22
		D	4.41	4.53	.07	.39	.36	9.76
	4"	A	12.93	2.95	---	.02	.65	16.55
		B	8.13	5.07	---	.20	1.92	15.32
		C	5.93	9.89	---	.21	.84	16.87
		D	4.81	8.02	.07	.25	.12	13.27

grass showed a slight trend towards the increase of percent basal density with the increase in frequency of clipping under both the 2" and 4" clipping heights.

Grass species in question contribute most of the basal density and the next highest contributors were annual brome grasses and six week fescue. Panicum scribnerianum was in third place. An average of approximately 51.43% of the ground cover was composed of undesirable grasses and weeds in every grass species except in the case of K. R. bluestem where the undesirable species were 33.79% of the total basal cover.

In other words, it can be stated that 51.43 plants out of 100 plants were composed of undesirable grasses and weeds which were indirectly lowering the value of the pasture and also replacing the desired grasses by competition in space, moisture and nutrition.

Data in Table IV (a) show that treatment A and C of K. R. bluestem had the greatest percent basal density (43.5% and 51.35%) under 4" and 2" clipping heights respectively. There was a marked increase in percent basal density in K. R. bluestem as a whole with the increase in frequency and intensity of clipping. The grass species which exhibited the next greatest percent basal density in all treatments was El Reno side-oats grama. The increase in intensity of clipping decreased the density in El Reno side-oats grama.

The lowest percent basal density was obtained from Tucson side-oats grama, but the density was increased with the frequency and intensity of clipping within the treatments.

There was no marked increase or decrease in percent basal density in the case of big bluestem, little bluestem, switchgrass and Indian

TABLE III

PERCENT COVER AND BOTANICAL COMPOSITION OF THE PLOTS
AS MEASURED BY THE LINE TRANSECT METHOD

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Panicum scribnerianum	Cassia sp.	Other grasses & weeds	Total Cover P.C.
El Reno side-oats grama	2"	A	26.85	16.17	.33	1.00	1.83	3.33	2.00	51.51
		B	38.35	19.19	1.66	3.00	.50	.83	3.17	66.60
		C	31.67	15.17	1.33	0.34	.50	.17	2.34	59.52
		D	43.35	16.67	1.34	3.50	.67	—	.67	66.20
	4"	A	32.50	19.50	1.50	.67	—	3.00	1.83	54.00
		B	44.17	20.83	1.67	2.00	.33	.67	2.50	72.17
		C	32.00	14.17	2.17	3.00	.50	.17	.33	52.34
		D	26.00	17.17	2.50	3.17	.50	.17	1.83	51.34
Tucson side-oats grama	2"	A	13.17	14.17	2.00	3.17	16.00	1.67	6.50	56.68
		B	30.00	15.00	1.67	3.33	8.50	1.34	4.33	64.17
		C	28.33	16.50	3.17	.33	6.17	.50	3.50	58.50
		D	23.67	4.34	1.67	.50	12.50	.34	6.50	49.52
	4"	A	13.17	13.34	1.50	.83	13.50	5.33	5.84	53.51
		B	26.17	15.00	3.34	1.00	10.17	1.83	6.67	64.18
		C	15.67	22.17	1.67	2.34	7.67	.84	10.50	60.86
		D	15.17	10.34	.34	2.17	26.00	2.00	5.67	61.69
Big bluestem	2"	A	28.67	17.34	.67	2.34	3.00	1.00	1.67	54.69
		B	25.17	11.50	2.34	7.17	3.50	—	.67	50.35
		C	34.34	9.00	.67	3.17	4.17	—	5.00	56.35
		D	21.00	4.50	.67	.67	1.50	.67	14.00	43.01

TABLE III (continued)

Variety		No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Panicum scribnerianum	Cassia sp.	Other grasses & weeds	Total Cover P.C.
Big bluestem	4"	A	38.67	11.83	2.10	1.17	1.17	2.17	1.84	58.85
		B	31.17	13.00	1.50	5.84	4.67	.34	3.33	59.85
		C	31.67	9.50	1.83	6.10	3.83	.50	3.50	56.83
		D	35.33	7.17	2.17	1.50	1.50	.17	3.67	51.51
Indian grass	2"	A	28.67	11.50	1.83	6.33	1.67	2.50	.50	53.00
		B	37.50	11.50	4.33	7.33	—	.17	.67	61.50
		C	24.00	8.83	.67	4.33	3.00	—	1.33	42.16
		D	32.67	4.00	2.00	—	1.50	—	8.83	49.00
	4"	A	32.83	12.17	2.67	4.50	.50	1.00	1.67	55.34
		B	27.00	11.50	1.50	13.00	.34	.17	2.17	55.68
		C	26.67	14.67	3.00	5.50	1.17	.34	1.83	53.18
		D	42.34	6.34	.34	2.34	1.33	—	4.67	57.36
Switch grass	2"	A	11.83	12.50	2.50	5.00	1.34	2.00	11.34	46.51
		B	24.33	15.83	.83	15.67	4.17	.34	3.17	64.34
		C	17.83	11.00	.67	3.83	5.67	—	5.67	44.67
		D	19.00	5.33	.67	.67	5.67	—	7.83	39.17
	4"	A	19.67	13.00	.67	3.50	2.83	2.50	3.50	45.67
		B	18.17	18.50	.17	18.00	9.83	2.00	2.34	69.01
		C	18.00	16.83	—	7.83	8.67	—	1.83	53.16
		D	18.67	10.83	.17	5.00	12.67	.34	1.00	48.68

TABLE III (continued)

Variety	No. of Treat.	Native Grass	Bromus & Festuca sp.	Daisy fleabane	Plantago sp.	Panicum scribnerianum	Cassia sp.	Other grasses & weeds	Total Cover P.C.
Little bluestem 2"	A	31.83	23.67	--	12.67	.36	.36	2.82	71.68
	B	28.50	17.50	.50	11.50	.17	.17	3.17	61.51
	C	23.17	11.50	.17	4.34	2.50	--	12.50	54.18
	D	30.83	6.83	--	--	6.00	--	5.84	49.50
4"	Readings were not taken as the plots were very heavily infested with weeds.								
K. R. bluestem 2"	A	64.00	12.50	--	4.00	--	.17	.33	80.83
	B	49.67	21.67	--	13.50	--	--	2.17	87.00
	C	50.17	15.00	--	5.00	1.00	--	1.33	72.50
	D	52.34	8.84	--	3.67	--	--	.33	65.17
4"	A	49.34	16.17	--	3.34	.67	.17	.67	70.34
	B	41.62	22.84	--	13.33	.67	--	7.50	86.00
	C	55.34	19.00	--	6.67	--	--	1.67	82.67
	D	58.50	17.17	--	4.33	.17	--	1.67	81.67

TABLE IV (a)

PERCENT BASAL DENSITY OF GRASS ESTIMATED BY THE ONE FOOT SQUARE QUADRAT METHOD

Variety	A		B		C		D	
	2"	4"	2"	4"	2"	4"	2"	4"
El Reno	32.8	37.5	36.5	42.7	31.3	31.0	31.8	32.9
Tucson	20.4	12.2	15.9	23.6	27.1	27.1	19.1	25.6
Big bluestem	32.0	29.7	27.7	39.4	22.2	26.2	28.0	22.9
Indian grass	17.9	33.4	23.1	24.2	20.7	26.2	29.2	28.2
Switch grass	29.0	26.5	17.3	20.5	36.6	28.0	25.0	32.9
Little bluestem	27.0	----	23.4	----	28.1	----	29.6	----
K. R. bluestem	31.1	43.5	37.7	30.0	51.35	39.2	36.23	33.9

grass on account of frequency and intensity of clipping.

Hence, it was concluded that the percent basal density of K. R. bluestem grass increases in relation to the increase in frequency and intensity of clipping while in the other grass the frequency did not show up any difference in density but the increase in intensity (height) of clipping decreases the percent basal density.

In Table IV (b) the analysis of variance is given for the above study and shows that the variety is very highly significant.

Variety interaction with time and variety interaction with time by level (height) are also significant.

There is no strong evidence for time and level being significant in the experiment.

In Table V (a), big bluestem showed the greatest root weight (.760 grams) per sample in treatment B under the 4" clipping height and the lowest root weight (.122 grams) per sample was found in the case of Tucson side-oats grama in treatment B under the 2" clipping.

In general, big bluestem had the greatest root weight per sample in all treatments as compared to other grasses. El Reno side-oats grama was considered next in root weight production under all treatments. The lowest root weight was produced by Tucson side-oats grama and little bluestem, irrespective of treatments.

There was a marked increase in the weight of roots per sample under the 4" clipping height within each treatment in all grass species except K. R. bluestem where there was no definite increase or decrease. Height of clipping had more effect than frequency on root production.

The analysis of variance was also run for the above study (as shown

TABLE IV (b)

ANALYSIS OF VARIANCE FOR PERCENT BASAL DENSITY OF GRASS ESTIMATED BY THE ONE FOOT SQUARE QUADRAT METHOD

Source of variation	D. F.	Sum of squares	Mean square	F value	P. L.
Total	287	46,128.31			
Replications	1	165.68			
Treatments	47	16,826.07	358.00		
Time	3	223.45	74.48		
Level	1	173.14	173.14	2.11	90.0
Variety	5	8,907.23	1,781.44	21.67	99.95
T x L	3	352.99	117.66	1.43	90.0
T x V	15	4,078.13	271.88	3.31	99.95
L x V	5	414.52	82.91	1.00	70.00
T x L x V	15	2,676.61	178.44	2.17	99.0
Exp. Error	47	3,863.03	82.19		
Sampling Error	192	25,273.53	131.63		

TABLE V (a)

AVERAGE WEIGHT OF ROOTS PER SAMPLE AND PER ACRE IN GRAMS AND POUNDS RESPECTIVELY AS DETERMINED BY THE SMALL PLUG METHOD

Variety	A		B		C		D	
	2"	4"	2"	4"	2"	4"	2"	4"
El Reno	.225 1372.94	.333 2031.95	.249 1519.38	.362 2208.90	.265 1617.01	.362 2208.90	.245 1494.97	.252 1537.69
Tucson	.168 1025.12	.204 1244.79	.122 744.44	.273 1665.83	.177 1080.04	.218 1330.22	.140 854.27	.213 1299.71
Big bluestem	.499 3044.87	.507 3093.68	.322 1964.82	.760 4637.47	.177 1080.04	.527 3215.72	.178 1086.14	.317 1934.31
Indian grass	.149 909.19	.421 2568.92	.259 1580.40	.346 2111.27	.108 659.00	.212 1293.61	.103 628.50	.225 1372.94
Switch grass	.178 1086.14	.382 2330.94	.165 1006.82	.356 2172.29	.162 988.51	.354 2160.09	.163 994.62	.211 1287.51
Little bluestem	.216 1318.02	--- ---	.232 1415.65	--- ---	.157 958.00	--- ---	.167 1019.02	--- ---
K. R. bluestem	.284 1732.95	.240 1464.46	.273 1665.83	.240 1464.46	.205 1250.90	.135 823.76	.170 1037.33	.153 933.60

in Table V (b)) and found that all treatment comparisons are highly significant except time X level and time X level X variety interaction.

In Table VI (a) it was noticed that the same results were obtained in volume determination studies as were found in the case of root weight in all grass species.

The grass with higher root weight production exhibited greater root volume. K. R. bluestem indicated different results than the rest of grasses.

Analysis of variance was also run for the above study (Table VI (b)) and found that all treatment comparisons are highly significant except for the time X level and time X level X variety interaction which is significant at the 2½% level.

TABLE V (b)

ANALYSIS OF VARIANCE FOR AVERAGE WEIGHT OF ROOTS PER SAMPLE AND PER ACRE AS DETERMINED BY THE SMALL PLUG METHOD

Source of variation	D. F.	Sum of squares	Mean square	F value	P. L.
Total	287	7.979			
Replications	1	0.0			
Treatments	47	4.506			
Time	3	0.599	.199	11.71	99.95
Level	1	0.856	.856	50.35	99.95
Variety	5	1.531	.306	18.00	99.95
T x L	3	0.088	.029	1.71	90.00
T x V	15	0.481	.032	1.88	95.00
L x V	5	0.527	.105	6.18	99.5
T x L x V	15	0.424	.028	1.65	90.00
Exp. Error	47	0.815	.017		
Sampling Error	192	2.658	.014		

TABLE VI (a)

AVERAGE VOLUME OF ROOTS PER SAMPLE AND PER ACRE IN MILLILITERS AND LITERS RESPECTIVELY AS ESTIMATED BY THE SMALL PLUG METHOD

Variety	A		B		C		D	
	2"	4"	2"	4"	2"	4"	2"	4"
El Reno	1.67	2.42	1.83	2.25	1.83	2.08	1.50	1.67
	5655.69	6746.57	5101.75	6272.64	5101.74	5798.71	4181.76	4655.69
Tucson	.92	1.42	.92	1.62	1.17	1.67	1.00	1.33
	2564.81	3958.73	2564.81	4516.30	3261.77	4655.69	2787.86	3707.83
Big bluestem	2.17	2.75	1.71	3.25	1.25	2.42	1.25	1.58
	6049.61	7666.56	4767.21	9060.48	3484.8	6746.57	3484.80	4404.78
Indian grass	1.17	2.50	1.71	2.29	.83	1.37	.75	1.21
	3261.77	6969.6	4767.21	6384.15	2313.90	3819.34	2090.88	3373.29
Switch grass	1.62	2.67	1.33	2.62	.87	2.67	1.08	1.79
	4516.30	7443.53	3707.83	7304.14	2425.62	7443.53	3010.87	4990.23
Little bluestem	1.42	----	.87	----	.92	----	.96	----
	3958.732	----	2425.42	----	2564.81	----	2676.32	----
K. R. bluestem	1.75	1.92	1.71	1.75	1.33	.96	1.11	.92
	4878.72	5352.65	4767.20	4878.72	3707.83	2676.33	3094.50	2564.81

TABLE VI (b)

ANALYSIS OF VARIANCE FOR AVERAGE VOLUME OF ROOTS PER SAMPLE AND PER ACRE AS ESTIMATED BY THE SMALL PLUG METHOD

Source of variation	D. F.	Sum of squares	Mean square	F value	P. L.
Total	287	168.66	.588		
Replications	1	.06	.060		
Treatments	47	100.36	2.135		
Time	3	21.52	7.173	28.69	99.95
Level	1	26.73	26.730	106.92	99.95
Variety	5	23.48	4.696	18.78	99.95
T x L	3	2.46	0.820	3.28	97.5
T x V	15	9.10	0.606	2.42	99.0
L x V	5	12.14	2.428	9.71	99.95
T x L x V	15	4.93	0.326	1.30	90.0
Exp. Error	47	11.77	0.250		
Sampling Error	192	56.47	0.294		

DISCUSSION

The object of the study was to determine the effect of clipping on the stand, density, botanical composition and yield of six native grasses and one introduced species, after being clipped for three years.

The detrimental effects of removal of the stem apex lie in part in the reduction of photosynthetic area. Such decrease in photosynthetic area has been directly related to reduction in development of root system and the storage of reserved carbohydrates.

Varying with the species, the time, frequency and degree of defoliation have been found of great importance and, in general, the most frequent and severe clipping result in the greatest injury.

The result of the present investigation on six native grass species and one introduced species support the above generalization.

Annual brome and six week fescue were the principal invading species in all grass plots clipped least frequently and where abundant litter had accumulated on soil. Plantago species and Panicum scribnerianum were the next occupants in abundance.

By hand separation of the plant species to determine the botanical composition, 34.13% of the forage was found to have been composed of undesirable annual and perennial plants.

Increase in the frequency of clipping had decreased the forage weight of grass species in question. The grasses clipped more frequently were small and thin in stand as compared to those clipped once a year.

K. R. bluestem was an exception to this general behavior.

In the case of K. R. bluestem, the density of grass increased with increase in intensity and frequency of clipping. Root weight and volume were also increased in K. R. bluestem under the 2" clipping height as compared to the 4" clipping height plots. Frequency of clipping did not show up marked difference within the treatments.

Results obtained from line transects also indicate that K. R. bluestem had the lowest number of weeds and undesirable annual grass as compared to other grass species.

It gives encouragement to the research worker that such a variety of grass plant can be developed which can withstand close grazing without losing its vigor and stand.

While studying the underground parts of native grass species with the soil core sampling method, it was found that the root weight and volume decreases with the increase in intensity and frequency of clipping. Big bluestem exhibited largest production of root weight and volume in the top 4 inches of soil among the native grass and introduced grass species.

The evidence indicates that native grasses cannot withstand close and year round grazing. When underground parts become weak, annual grasses and weeds or other undesirable plants compete with them in nutrition, moisture and space and ultimately occupy their space. On the other hand, annual bromes seem to thrive where abundant litter is left on the ground. Moderate grazing is not likely to decrease these species.

Ranch managers should be very careful while grazing their native

grass pastures. Mere negligence and carelessness on the part of the rancher may result in a complete replacement of dense and thick stand of native grasses with undesirable annual and perennial grasses and weeds within a couple of years. The pastures not only suffer from an undesirable stand of plants but also become a victim of soil erosion.

Since the objective of range management is to produce the most valuable yield of forage and to harvest the crop through the medium of livestock in such a manner that the yield will be sustained from year to year, it is imperative to have methods whereby any forage improvement or deterioration can be accurately determined. Various quadrat and transect methods, devised by ecologists, have been adapted and modified for day to day practical use in recording changes in the character and density of forage vegetation resulting from different treatments employed in pasture and range management.

In this study, two ecological methods have been used to determine botanical composition of the grass species under study viz. hand separation and line transect.

Hand separation method to find out the botanical composition is a very time consuming method. The line transect method is a much faster method but the results obtained were somewhat different. In this study no attempt was made to check the accuracy of the two methods.

The time taken for each reading in hand separation and line transect was 30 minutes and 10 minutes respectively. Hence hand separation takes three times as much time as the line transect.

Basal density of grass species was determined with the help of line transect and chart quadrat method. Both methods appeared satis-

factory but the results were somewhat different. The line transect took 10 minutes for each reading while the chart quadrat took 2 to 3 minutes.

Studies with 1 foot square quadrat showed that it can be a very useful tool to the rancher to estimate the basal density of his grass with less time, and after taking a few readings with it, he can do visual estimates of his forage if he is quite confident.

Soil cores for sampling roots of the grass species were also tried to determine the root weight and volume resulting from different clipping treatments. A small soil plugger was used to draw soil cores from the grass plots (size $1\frac{1}{2}$" X $1\frac{1}{2}$" X 3 3/4") and gave good results in a short time.

Drawing of a soil core from the plot took two minutes and the washing of roots contained therein free of soil and other inert material under a specially devised washing technique took 12 to 15 minutes.

The main limitation to this method was the fact that cores could not be taken except when the soil was moist.

SUMMARY

A study was conducted at the Lake Carl Blackwell area. Six native grass species and one introduced species were selected for the research.

Different ecological methods were used to determine the botanical composition, basal density, yield and root weight and volume of the grass species in question resulting from various clipping treatments.

Annual brome and six week fescue were the principal invading species in all plots. In general these were most abundant in plots clipped least frequently and where abundant litter had accumulated on the soil.

Basal density of grass species decreases with the increase in intensity of clipping except in the case of K. R. bluestem where the density increased with the increase in frequency and intensity of clipping.

Root weight and volume was also larger under the 2" clipping height as compared to the 4" clipping height in K. R. bluestem.

The root weight and volume of native grass species decreased with the increase in intensity and frequency of clipping.

The line transect method was quicker than hand separation for finding out botanical composition.

The quadrat method was faster than the line transect in determining the basal density.

The soil core sampling method appeared to be a satisfactory method for determining root weight and volume of grass species in the top 4" of soil. It could be used, however, only when soil moisture was adequate.

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VITA

Gurmukh Singh

Candidate for the Degree of

Master of Science

Thesis: SOME EFFECTS OF DIFFERENTIAL CLIPPING ON SIX NATIVE GRASSES AND ONE INTRODUCED SPECIES

Major Field: Field Crops

Biographical:

Personal data: Born at Nawabganj, Kanpur, U.P. India, July 10, 1928, the son of Sardar Sahib, S. Hansraj Singh.

Education: Attended elementary and graduated from A.V.M. High School, Nawabganj, Kanpur, U.P. India in 1945. Received an intermediate diploma in agriculture from A.S. Jat. College, Lakhaoti, Bullundsher, U.P. India in 1947. Received the Bachelor of Science degree in agriculture from Agra University, U.P. India in 1949.

Experience: Employed by Deputy Director, Mechanised State Farms, U.P. India as cultivation-in-charge from 1949-1955. Also worked as assistant farm manager of the District Dairy Demonstration Farm in Mathura under Principal U.P. College of Veterinary Science and Animal Husbandry, U.P. India from 1955-1957.

Date of Final Examination: February, 1959