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THE EFFECT OF CLIPPING AND WEED COMPETITION
UPON THE SPREAD OF PASTURE GRASS SEEDLINGS

being

A thesis presented to the Graduate Faculty
of the Fort Hays Kansas State College in
partial fulfillment of the requirements for
the Degree of Master of Science

by

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Date July 30, 1940

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Chmn. Graduate Council

A C K N O W L E D G M E N T

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I N T R O D U C T I O N

The drought of the last seven years with its disastrous dust storms has damaged vast areas of the native prairie as well as much of the cultivated land. Deficient rainfall has caused crop failures over large areas, leaving the fields without a protective covering. Due to these conditions, wind erosion started the dry, loose soil to drifting. Large amounts of the soil settled on the grassland and destroyed much of the native plant cover (10).

Where the native vegetation was weakened or destroyed, the soil was invaded by such weedy annuals as lamb's quarter (Chenopodium sp.), Russian thistle (Salsola pestifer), pig weed (Amaranthus sp.), and sunflower (Helianthus annuus). The severe competition of these ruderals further weakened the native vegetation to the point where, in many cases, it was completely destroyed.

These conditions have brought about an increased activity in the field of range research. Until recently there has been relatively little research work done on the revegetation of cultivated land. The greater part of the experimental work, prior to the drought, was carried out with the intention of using domestic forage plants to revegetate the depleted ranges (8).

The present needs in range research are more experimental data on native forage plants and the methods of handling them on revegetation areas. It is more practical to obtain this information on small experimental plots than on large revegetation areas where improper methods might prove too costly.

To provide a part of this needed information, an experiment was set up at Hays, Kansas, in the spring of 1939 to determine the effect of clipping and weed competition on the spread of pasture grass seedlings.

R E L A T E D S T U D I E S

Most of the experimental work relative to clipping has been done on the effect of clipping and fertilizing upon the yield and composition of the forage. Leukel, Camp, and Coleman (3) and Robinson, Pierre, and Ackerman (5) worked on the effect of clipping and nitrate fertilizing on the growth behavior and composition of pasture grasses. Richardson, Trumble, and Shapter in Australia (4) studied the influence of the growth stage and the frequency of cutting on the yield and composition of Phalaris tuberosa. They found that frequent cutting greatly reduced the yield of the tops and the extent of the root system. Two or three cuttings a year, however, had a tendency to increase the yield.

Nearly all the work on revegetation, until very recently, was done in the west and southwest with the use of imported and cultivated species (8). These studies were not very recent and for the most part did not prove successful because of the inability of these introduced plants to become adjusted to the arid climate of those regions.

To the author's knowledge, no detailed study has been made of the effects of clipping and weed competition on the increase of basal cover, which is so important on revegetation areas. Robertson (7) studied the effects of clipping on the yield of six range and pasture grasses, but his work was conducted entirely in the greenhouse where the environment is vastly different from that of the cultivated field.

ENVIRONMENTAL PROCEDURE

SELECTING THE SEED

The seed selected was secured near Hays, Kansas, and had been collected not earlier than 1938. The buffalo grass (Buchloe dactyloides) had a viability of 2 to 2.5 per cent. The burs were planted without any attempt to separate the caryopses because of the low germination rate.

The blue grama grass (Bouteloua gracilis) had a germination percentage of about 2 per cent. The spikes of the blue grama were separated into separate florets because of the

size of the spikes.

The side-oats grama grass (Bouteloua curtipendula) seed had a germination of 3 to 4 per cent. The spikes of this grass were not broken up before planting, except where they had broken apart in handling.

PREPARATION OF THE SEED BED

The experimental tract was located on good creek bottom soil which was well drained and equipped with an overhead irrigating system. Small dykes were put in where needed to prevent heavy rains from washing out the seedlings.

In preparing the seed bed, the weeds were removed with a hoe and only the surface of the soil was disturbed. The ground was then raked and wet down with the overhead irrigating system. After desirable moisture conditions were obtained, the ground was leveled by pulling a heavy plank over it.

PLANTING THE SEED

The seed was planted on May 30 in meter-sized quadrats. The seed was scattered by hand and then covered by sifting soil over it to the depth of about one-fourth inch.

The plot was wet down again after the planting was completed and kept moist thereafter until the seedlings appeared.

Water deficiency was never allowed to become a limiting factor throughout this experiment.

ARRANGEMENT OF EXPERIMENTAL PLOTS

There were twelve quadrats for each species, arranged in three series of four quadrats each. The plots were spaced eighteen inches apart and oriented along a north and south line (Figs. 1 and 2). The quadrats in each series were numbered consecutively from the north side of the experimental area. The three series were numbered in order from left to right for each species. The series of buffalo grass were assigned 1, 2, and 3; those of blue grama grass, A-1, A-2, and A-3; and those of side-oats grama, B-1, B-2, and B-3.

TREATMENT OF EXPERIMENTAL PLOTS

Series 1 of each species was kept free of weeds but was not clipped until the end of the growing season. Series 2 did not have the weeds removed but both weeds and grass were clipped to the same height at two to three week intervals. In clipping, the grass was cut at a height of one inch in order to simulate overgrazing as nearly as possible (Fig. 3).

Equal numbers of plants were staked and numbered for tiller counts in the blue grama and side-oats grama quadrats.

Fig. 1. The general arrangement of the experimental plot.

Fig. 2. A general view of the experimental plot.

Fig. 3. A view showing the height of clipping of buffalo grass (above) and blue grama grass (below). The small stakes shown are about two inches high.

The tillers on these plants were counted four times during the season. It was impossible to keep the same type of record on the buffalo grass because of its stoloniferous habit of growth. The solid mat which this grass formed made it impossible to identify individual plants.

Pantograph records were made of all the quadrats, with the exception of quadrat number 4 in each series, which was used for root study. Photographic records were made of quadrat number 3 in each series, both before and after clipping. Yield determinations were made on all except the buffalo grass series. The depth and spread of the root systems were determined and photographed.

The root systems were studied by digging a trench (bisect) seven feet deep along the end of the plot (Fig. 1). The soil was removed from the roots by working it loose with an ice pick and carefully washing it away with water under pressure (Fig. 4).

R E S U L T S

The three grasses used responded to the various types of treatment as follows.

BUFFALO GRASS

Buffalo grass was the last to germinate of the three grasses used in this study; the first seedlings appeared

Fig. 4. Trench in which the roots of the different species were removed.

on June 12. They were all vigorous plants and were well distributed over the quadrats.

The grass in Series 1 produced an average basal cover of 75 per cent at the close of the season. The vigorously growing leaf blades often held the stolons so high above the soil that rooting at the nodes was impossible (3).

The excessive weed competition in Series 2 greatly affected the growth of buffalo grass. The basal cover remained near zero during the entire season. There was no stolon growth until August, and only a few were longer than one inch. Each time the quadrat was clipped, a new crop of fast growing annual weeds (Table I) would spring up and soon was tall enough to shade the buffalo grass. The average basal cover at the end of the season was only 0.33 per cent (Fig. 5).

The cover in Series 3, which was weeded and clipped at regular intervals throughout the season, averaged 86.9 per cent. The clipping permitted the stolons to grow on the surface of the soil where they took root quickly and greatly increased the cover. In these quadrats it was necessary to cut off the stolons at the edge of the quadrat to keep them from spreading across the alleys to the other quadrats (Fig. 6).

The heaviest basal cover did not indicate the most extensive root systems. The root system of Series 3, which

TABLE I. List of ruderals growing in the clipped quadrats with weed competition.

Technical Name	Common Name
<i>Amaranthus retroflexus</i>	pig weed
<i>Carex praxida</i>	sedge
<i>Cenchrus pauciflorus</i>	sandbur
<i>Chamaesyce glyptosperma</i>	mat spurge
<i>Chenopodium album</i>	lamb's quarter
<i>Chloris verticillata</i>	windmill grass
<i>Digitaria sanguinalis</i>	crabgrass
<i>Eragrostis cilianensis</i>	love grass
<i>Helianthus annuus</i>	sunflower
<i>Lactuca ludoviciana</i>	western lettuce
<i>Panicum capillare</i>	witchgrass
<i>Salsola pestifer</i>	Russian thistle
<i>Setaria lutescens</i>	yellow foxtail
<i>Setaria viridis</i>	green foxtail
<i>Sporobolus cryptandrus</i>	sand dropseed
<i>Tribulus terrestris</i>	Texas sandbur

Fig. 5. Typical buffalo grass quadrats. Quadrat 1-3, weeded but not clipped, 2-3 clipped plus weed competition, and 3-3 weeded and clipped.

Fig. 6. Typical quadrats of buffalo grass showing the effects of the various types of treatment. In 1-3 (weeded but not clipped) the leaves are long and heavy, holding the stolons above the soil where they cannot take root. In 2-3 (not weeded but clipped) the cover is very sparse and mostly of weeds. In 3-3 (weeded and clipped) the cover is heavy and the stolons grow close to soil where they take root readily and have spread outside the quadrat.

had produced the heaviest ground cover, had a depth of four and one-half feet and a spread of fourteen inches (Table II). The root system of Series 1 was the heaviest, having a depth of five feet and a spread of twenty inches. The least extensive root system was produced in Series 2. This series, under seed competition and clipping, produced a root system only thirty inches deep with a spread of four inches (Fig. 7).

BLUE GRAMA GRASS

Twenty-five blue grama grass plants per quadrat were staked for yield determinations. These yields were computed on the basis of grams for twenty-five plants per quadrat. These plants were staked in order to have the same number of representative plants for each area.

The total seasonal yield for the twenty-five plants in Series A-1 (weeded but not clipped) was 173 grams of forage per quadrat (Table III). The same number of plants in Series A-2 (not weeded but clipped) produced only 27.8 grams during the same length of time. The twenty-five plants in Series 3 (weeded and clipped) yielded 123.4 grams during the season.

The last clipping was delayed to allow for seed production under all types. Heads were produced under each treatment, but no caryopses were developed in any of the

TABLE II. Basal cover made by buffalo grass under the various types of treatment during 1939.
 (1) Weeded but not clipped, (2) weed competition and clipped, and (3) clipped and weeded.

Series	1	2	3
Average basal cover	75.65%	0.33%	86.87%

Fig. 7. The root systems of the various species used. From left to right are: buffalo grass, blue grama, and side-oats grama. The various types of treatment represented in each photograph are, beginning at the left: unclipped, clipped plus weed competition, and clipped. Each dot represents 12 inches.

TABLE III. The root and top growth made by blue grama grass during the growing season of 1939. (A-1) Weeded and not clipped, (A-2) not weeded but clipped, and (A-3) weeded and clipped.

	Tillers		Average yield (gms.)	Average basal cover	Root system	
	Produced	Number survived			Length	Spread
A-1	68.3	68.3	178	13%	4'2"	20"
A-2	30.5	19.6	27.8	6%	2'6"	6"
A-3	102.5	64.6	128.4	11%	3'6"	12"

spikelets. The first heads were found on the weeded and unclipped quadrats on July 21. They first appeared on the weeded and clipped quadrats August 10, and five days later on the clipped but not weeded series.

The total number of tillers produced per plant was determined at the end of the season. The living tillers were separated from the dead ones to determine the effect of clipping upon tiller growth.

The grass plants of Series 1 produced an average of 68 tillers per plant, all of which were alive at the end of the season. Those of Series 2 produced an average of 30 tillers per plant but an average of only 19 of them remained alive at the end of the season. The average number of tillers in Series 3 was 102 per plant, 64 of which survived the season.

The weeded and unclipped series of blue grama had an average basal cover of 13 per cent at the close of the season. This was only slightly greater than that of Series A-3, which averaged 11 per cent. A combination of weed competition and clipping had a retarding effect on the blue grama in Series 2. The average cover here was only 6.4 per cent at the close of the season (Figs. 8 and 9).

The response of the root systems in the various quadrats to the different types of treatment was similar to that of buffalo grass. The roots of the weeded and unclipped

Fig. 8. Typical blue grama grass quadrats selected to show the effects of the various types of treatment. In A-1-3 (weeded but not clipped) the forage is heavy, dense, and about eight inches high. The flower stalks are about fourteen inches high. In A-2-3 (not weeded but clipped) the cover is sparse, short, and full of weeds. In A-3-3 (weeded and clipped) the leaves and flower stalks are much shorter than those in A-1-3.

Fig. 9. Typical blue grama quadrats. (A-1-3) weeded and not clipped, (A-2-3) not weeded but clipped, (A-3-3) weeded and clipped.

series penetrated the soil to a depth of fifty inches. The roots in the weeded and clipped series extended to a depth of forty-two inches. Weed competition and clipping greatly reduced the root system of the series. Its roots were only thirty inches long and the number of roots per plant was much less than that of the other two series (Fig. 7).

SIDE-OATS GRAMA GRASS

Representative plants were staked in the side-oats grama quadrats, similar to those in the blue grama series, but the yield was based upon thirty plants per quadrat.

The thirty plants in the weeded but unclipped series averaged 159 grams per quadrat during the season of 1939. The clipped but not weeded series produced about one-half as much, 82 grams, for the same season. The weeded and clipped series produced 111 grams during the same length of time.

Spikes were produced in the side-oats grama when the last clipping was delayed (Fig. 10) but, as in the former species, no caryopses were developed.

The total number of tillers was determined at the end of the season and the living tillers were separated from the dead ones. The greatest number of tillers, 143, was produced in the weeded but unclipped series. All of these were alive at the end of the season. Series B-2 produced an average of

Fig. 10. Typical side-oats grama grass quadrats subjected to the various types of treatment. In B-1-3 (weeded but not clipped) the forage is dense and the flower stalks are long and heavy. In B-2-3 (not weeded but clipped) the cover is sparse and weedy and the flower stalks are very short. In B-3-3 (weeded and clipped) the leaves are short and the flower stalks are not as long as those in B-1-3.

53 tillers per plant but only 25.8 survived to the end of the growing season. The weeded and clipped series lost nearly the same per cent of tillers, an average of 92.7 per cent being produced, but only 54.9 per cent surviving the season (Tables III and IV).

There was little difference in the basal cover between the weeded but not clipped and the weeded and clipped series. The cover averaged 8.39 per cent and 8.19 per cent, respectively. The basal cover on the clipped but not weeded series averaged only 2.76 per cent (Figure 11).

The response of the root systems in the various quadrats was similar to that of the other two species, but it was not as pronounced. The root system of the unclipped and weeded series penetrated the soil to a depth of seventy-six inches and had a spread of twenty-four inches. The depth of the root system of the clipped but not weeded series was only sixty inches and the spread was twelve inches. The weeded and clipped series had a root system seventy-two inches long with a spread of eighteen inches.

DISCUSSION

The following observations were made from a study of the experimental data.

TABLE IV. The root and top growth made by side-oats grama grass during the summer of 1939. (B-1) Weeded but not clipped, (B-2) not weeded but clipped, and (B-3) weeded and clipped.

	Tillers		Average yield (gms.)	Average basal cover	Root system	
	Produced	Number survived			Length	Spread
B-1	143.1	143.1	159.1	8.39	6'4"	24"
B-2	53.0	25.8	82.3	2.76	5'0"	12"
B-3	92.7	54.9	111.0	8.19	6'0"	18"

Fig. 11. Typical side-oats grama quadrats. (B-1-3) weeded but not clipped, (B-2-3) not weeded but clipped, and (B-3-3) weeded and clipped.

TILLER GROWTH

The tiller growth of the blue grama grass and the side-oats grama grass did not give the same response to clipping (2). The greatest number of tillers in the blue grama was produced in the weeded and clipped series and the second largest number in those weeded but not clipped. The side-oats grama was opposite in tiller growth, the greatest number of tillers being produced on the weeded but not clipped series and the next largest on those weeded and clipped (Tables II and III). However, in the weeded and clipped quadrats only slightly over half of the tillers survived the season, while all tillers in the weeded but not clipped quadrats were alive at the end of the season. This difference was probably due to the variation in habit of growth, the tillers of the blue grama being fine and short while those of the side-oats grama were heavy and long.

The clipped but not weeded quadrats produced the fewest tillers of any of the quadrats and a large number of these did not survive the season. The severe competition for light and soil solutes, produced by the fast growing ruderals, retarded the normal tiller growth of these grasses to the extent that they were badly weakened.

YIELD

The weeded but unclipped series of both blue grama and side-oats grama grasses produced the heaviest yield of forage. The reduction of the number of live tillers in the clipped and weeded series was probably a factor that helped to keep the yield from these quadrats low. The spread between the two probably would have been greater had the last clipping not been delayed to permit seed production. Two or three cuttings a year would probably increase the yield on all the species (6).

GROUND COVER

The mat-forming buffalo grass was greatly damaged by clipping and weed competition. There were no stolons more than four inches long produced and where these had taken root there were no stolons sent out beyond the new plants. It may be said that the ground cover at the end of the season was the same as it was when the seedling had become established. The fact that buffalo grass is a very low-growing plant allowed the weeds to shade it more quickly than the other species, thus hindering its growth.

In Series 3 the ground cover was greatly increased by the clipping process which caused the runners to lie close to the ground where the nodes could readily take root. The

leaf blades were short and numerous, thus preventing an excessive reduction in leaf surface by clipping. The runners were very prolific, building up a mat which completely covered the ground. Series 1 did not produce as much ground cover because the stolons grew above the forage and did not take root as often as when they were next to the ground. Much of its growth resulted in forage production, instead of runners.

The basal cover of the grammas seemed to be greatest in the unclipped quadrats. The blue grama had 2.5 more ground cover on the unclipped quadrats than on the clipped, and the side-oats grama had only 0.20% more ground cover. Clipping, as has been shown above, killed many of the tillers, so the actual ground cover on the clipped quadrats was probably not as great as shown by the pantograph records.

Weed competition and clipping reduced the basal cover of blue grama to one-half that of the weeded but unclipped series; it reduced the side-oats grama to about one-fourth that of the corresponding series.

ROOT GROWTH

The greatest reduction in root growth accompanied the greatest reduction in top growth in buffalo grass. In each species the weed competition and clipping greatly reduced the root system. The side-oats grama was the least affected of all (11). Its root system was reduced the least of any,

being only about twelve inches less than the weeded but not clipped series. The roots of blue grama in Series A-2 were heavier and more numerous but no longer than those of buffalo grass in the corresponding series (Fig. 7).

Clipping alone reduced the root systems of all the species but not to a very great extent, the length being reduced from four to six inches and the spread from six to eight inches. A reduction of this amount probably would not be very detrimental to the grasses in becoming established.

A P P L I C A T I O N

This experiment indicates that weeds should be kept under control as nearly as possible on revegetation areas. On areas large enough to make pulling or hoeing weeds impractical, mowing would be a good method of controlling the weeds, if the mower is set high enough to cut above the grasses.

Light grazing on areas with a good stand might prove helpful, providing climatic conditions were favorable, but in very dry seasons no grazing should be practiced.

On areas where a thin stand of native grasses already exists, it would be advisable to keep the weeds under control and protect it from all but very light grazing. This method will bring about conditions favorable to the re-establishment of the native grasses.

S U M M A R Y

1. Clipping and weed competition were very detrimental to all the grasses used.
2. Clipping aided the spread of buffalo grass.
3. The yield was the greatest on the unclipped quadrats.
4. Clipping killed nearly half the tillers in the blue grama and side-oats grama.
5. The root systems of all grasses used were reduced somewhat by clipping.
6. The root systems were greatly reduced by clipping plus weed competition.

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