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Reproduction and Life Span of Some Perennial Grasses of Southern Arizona

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Reproduction and longevity are important measures of the dependability of a range forage grass. Information on these characteristics of the principal forage grasses helps in planning management for native perennial grass ranges.

An unusual opportunity for evaluating some life history characteristics of several important perennial grasses of the semi-desert grassland type of southern Arizona was offered by a 17-year chartograph record on the Santa Rita Experimental Range, a unit of the Rocky Mountain Forest and Range Experiment Station, located about 35 miles south of Tucson, Arizona. Detailed measurements and chart records were kept of individual plants, which permitted the determination of longevity and reproductive rate.

Procedure and Methods

Meter-square quadrats were established at numerous sites on rangelands subject to yearlong grazing. Quadrat locations were representative of a great variety of soils and plant compositions. Approximately half of the quadrats were protected from grazing by permanent panel exclosures. The grazed quadrats were subjected to wide differences in utilization because they varied in distance to water, slope, accessibility, and other factors. No record of the grazing history of individual quadrats was maintained.

Early chartings of quadrats were made by hand tracings. Later the "Hill Chartograph" was used to save time, to increase accuracy of mapping, and to establish the location of individual plants. This instrument traces the perimeters of individual grass clumps and is based on the principle of the pantograph commonly used by draftsmen in duplicating maps.

The life span of each individual grass plant appearing on a quadrat was determined. Seedlings were identified when they first became established on a quadrat and were

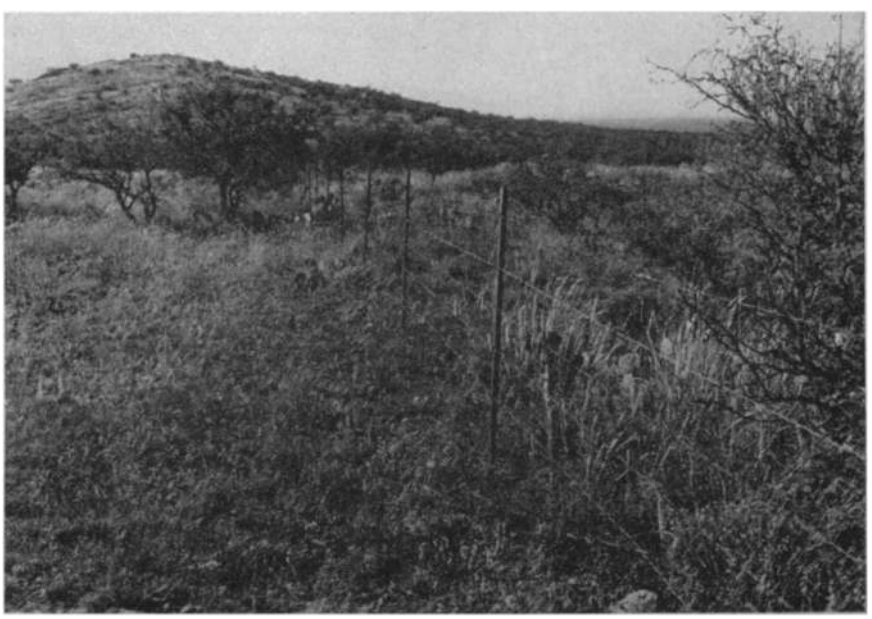

FIGURE 1. The effects of grazing on the species composition of perennial grasses are evident in this fence-line picture taken at an elevation of 4,000 feet in an 18-inch rainfall zone on the Santa Rita Experimental Range in southern Arizona. The area to the left of the fence is grazed yearlong and supports cover composed mostly of "short" grasses including slender grama *(Bouteloua filiformis)* sprucetop grama *(B. chondrosioidies)*, and curlymesquite *(Hilaria belangeri)*. To the right of the fence livestock grazing has been excluded for over 30 years. Here the taller grasses including Arizona cottongrass (*Trichachne california*), sideoats grama (*B. curtipendula*), and sprangletop (*Leptochloa dubia*) predominate.

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[2]*The research reported in this paper was conducted in cooperation with the University of Arizona at Tucson, Arizona.*

studied until they disappeared. Only those plants that began and completed their lives during the period of charting were included in the calculations of life span and mortality. In spite of the elimination of many plants with incomplete records, about 48,000 plants with complete records remained for analysis.

The perennial grasses studied included black grama (*Bouteloua eriopoda*), hairy grama (*B. hirsuta*), side-oats grama (*B. curtipendula*), Arizona cottongrass (*Trichachne californica*), mesa threeawn (*Aristida hamulosa*), tanglehead (*Heteropogon contortus*), Texas timothy (*Lycurus phleoides*), Rothrock grama (*B. rothrockii*), slender grama (*B. filiformis*), sprucetop grama (*B. chondrosioides*), and curlymesquite (*Hilaria belangeri*).

Each species did not occur on every quadrat, and the interaction between species was not segregated. However, the data are representative of wide variety of species' interactions. Reactions of individual species must be considered in refence to the general plant composition. Responses of species growing in pure stands might be quite different. Range managers of the desert grassland seek to maintain a diversity of perennial grasses; therefore, conclusion referred to the general plant composition are applicable.

The 11 grasses studied can be divided roughly into two groups designated as "primary grasses" and "secondary grasses." Primary grasses tend to predominate on lands that have been protected from grazing for a long period or that have been maintained in good condition by proper management. Species included in this group are black, hairy, and side-oats gramas, Arizona cottongrass, mesa threeawn, tanglehead, and Texas timothy. Secondary grasses are those that usually are more abundant on ranges or protected areas. This group includes Rothrock, slender, and sprucetop gramas, and curlymesquite.

Seedling Production

Seedling or set production is essential to the maintenance or increase of a species on the range. To maintain a grass population, seedling or set establishment must equal plant losses. Improvement in range condition is likewise dependent upon a favorable rate of seedling establishment of the better forage plants. Black grama and curlymesquite reproduce by sets from stolons; all other species reproduce from seed.

Some seedlings or sets of every species studied were found each year. For example, average production on ungrazed black grama quadrats varied from 0.4 new plants per quadrat in the poorest year to 8.0 in the best year. Slender grama varied from 1.0 to 32.7 seedlings per quadrat under the poorest and best growing conditions, respectively. The number of seedlings produced, however, differed by species. Secondary grasses usually produced more seedlings than the primary grasses (Table 1). Rothrock grama, a heavy seed producer, produced the most seedlings of any grass on both the grazed and ungrazed plots, followed closely by curlymesquite.

On grazed range, the average number of new plants per meter-square quadrat produced annually by secondary grasses exceeded primary grasses, without exception. In fact, the most prolific producer of the primary grasses, Texas timothy, produced an average annual number of seedlings which was only about one-half that of the least prolific secondary species, slender grama.

On ungrazed range there were some species exceptions to the general superiority of seedling production of the secondary grasses. Tanglehead and black grama both produced a slightly greater number of new plants per unit area than did slender grama.

Arizona cottongrass produced the fewest seedlings of all species studied.

All secondary grasses studied produced more seedlings on grazed range than on ungrazed range. In contrast, primary grasses showed a variable response to grazing but tended to produce the most seedlings when ungrazed. The average numbers of seedlings or sets per quadrat of hairy grama, tanglehead, black grama, and side-oats grama were all greater on ungrazed plots than on grazed range. Mesa threeawn and Arizona cottongrass produced a slightly greater number of seedlings when grazed. Seedling production of Texas timothy was markedly greater under grazing. In this respect, the species tended to exhibit the characteristics of the secondary grasses.

Based on the number of seedlings or sets observed each year,

Table 1. Average seedling production of some desert grassland perennial grasses.

Species	Annual number of new plants per meter-square quadrat (17-year average)	
	Grazed No.	Ungrazed No.
	Primary grasses	
Tanglehead	2.3	6.9
Black grama	2.8	6.4
Side-oats grama	3.9	5.0
Texas timothy	6.2	3.1
Hairy grama	2.9	3.1
Mesa threeawn	2.6	2.4
Arizona cottongrass	0.9	0.5
	Secondary grasses	
Rothrock grama	29.0	15.7
Curlymesquite	23.6	11.2
Sprucetop grama	12.6	7.8
Slender grama	11.9	5.2

the reproduction potential of all the perennial grasses studied appears adequate. Populations of these particular perennial grasses are apparently limited mostly by survival and longevity.

Seedling Survival

Mortality of seedlings and sets was highest before plants reached 1 year (Table 2). Of all species on all quadrats, an average of only about one-third survived the first growing season. Young plants were especially susceptible to drying winds and drought. Clipping of the tops by livestock or roots by rodents killed many seedlings. Competition apparently was severe both with other seedlings and with stronger, more mature plants.

Average percentage survival of seedlings was about the same for primary and secondary species. However, there was considerable variation among different species, irrespective of group.

Among the secondary species, about the same proportion of Rothrock grama and a greater percentage of curlymesquite and slender grama seedlings survived on grazed areas than on ungrazed areas. The reverse was true of sprucetop grama.

With the exception of side-oats grama, seedling survival of primary grasses was higher on ungrazed quadrats than on those open to grazing. Mesa threeawn exhibited the greatest differential in seedling survival between grazed and ungrazed conditions. Next in rank was hairy grama, with about twice as many seedlings surviving under ungrazed conditions. Tanglehead had the lowest rate of seedling survival and exhibited the least differential between grazed and ungrazed conditions. This characteristic combined with the low rate of seedling production gives tanglehead the lowest reproductive potential among the perennial grasses studied. Although Arizona cottongrass produced only few seedlings, its survival rate was relatively high, even under grazing.

FIGURE 2. This area outside the experimental range is a striking example of differences brought about by grazing. The area to the left of the fence has been protected for 22 years. Vegetation is largely primary grasses including sideoats grama, cane bluestem (*Andropogon barbinodis*), and tall threeawns. The outside grazed range is composed mainly of curlymesquite, with a sprinkling of hairy, sprucetop, and sideoats gramas.

Table 2. Survival of seedlings of grasses on grazed and ungrazed sites during the first growing season.

Species	Survival of seedlings	
	Grazed Percent	Ungrazed Percent
	Primary grasses	
Hairy grama	32.5	64.5
Mesa threeawn	28.7	63.8
Texas timothy	30.7	50.0
Arizona cottongrass	38.8	45.5
Black grama	35.3	38.8
Side-oats grama	46.6	33.9
Tanglehead	10.5	11.4
	Secondary grasses	
Sprucetop grama	42.2	59.6
Curlymesquite	32.2	25.0
Rothrock grama	23.2	22.5
Slender grama	27.6	15.6

Longevity

All the perennial grasses proved to be relatively short lived on the average, although individual species varied greatly as to longevity (Table 3). Black grama, Arizona cottongrass, mesa threeawn, and sprucetop grama were among the most long lived. Some plants of black grama lived 14 years. Rothrock grama was the shortest lived; no plant of this species lived longer than 3 years, where protected, or longer than 4 years, where grazed. Texas timothy, hairy grama, tanglehead, and side-oats grama of the primary grass group and curlymesquite of the secondary group also appear to be relatively short-lived.

As previously mentioned, death of seedlings between the first and

second growing seasons was very high. Exceptions were Arizona cottongrass, sprucetop grama, tanglehead, and mesa threeawn. After the third year, mortality was fairly constant among all species until maximum age was reached. The primary grasses tended to be longer lived where protected from grazing than where grazed; whereas the opposite was true of the secondary grasses. An exception was Arizona cottongrass. This opposite reaction to grazing can be accounted for by differences in growth characteristics of the contrasted groups. The primary grasses are taller and have a greater percentage of leafage easily accessible for grazing by cattle. Moreover, they are ordinarily intensively utilized. This higher percentage of utilization leads to less plant survival. On the other hand, most of the secondary grasses have short leaves and much of their foliage is at the base of the plant. As a result, a smaller proportion of the leafage can be readily grazed.

All secondary grasses, except sprucetop grama, had a higher survival rate throughout their life spans when grazed than when protected from grazing. At 5 years of age, on the average, even this species falls into conformity with the other secondary grasses. With Rothrock grama, an extremely short-lived species for which survival was only slightly greater for grazed plants in the seedling stage, the difference in favor of grazing widened with age. The greater length of life apparently results both from Rothrock grama's good resistance to grazing and to a lessening of competition where the taller primary grasses were restricted by grazing.

Summary

A record of 17 years of annual chartograph records on meter-square quadrats located on the Santa Rita Experimental Range provided a basis for studying life history characteristics of 11 common perennial grasses of the desert grasslands of southern Arizona.

Seedling production, seedling survival, and longevity of grasses

Table 3. Survival of plants that originated on grazed and ungrazed quadrats.

Species and treatment	Age of plants by years														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Percent survival														
	Primary grasses														
Texas timothy															
Grazed	15.7	4.2	3.0	0.6	0										
Ungrazed	46.0	27.3	22.7	13.6	9.1	9.1	9.1	0							
Hairy grama															
Grazed	16.1	9.7	4.6	1.8	0										
Ungrazed	58.9	44.7	31.2	20.6	10.6	9.2	0								
Tanglehead															
Grazed	4.1	2.8	1.6	0.4	0										
Ungrazed	7.6	5.2	2.8	1.1	0.7	0.3	0								
Mesa threeawn															
Grazed	15.5	9.5	5.9	3.1	2.5	1.5	0.8	0.6	0.2	—	0.1	0			
Ungrazed	20.4	19.9	5.4	6.4	4.1	3.3	2.9	0.5	0.2	—	—	—	0.7	0	
Black grama															
Grazed	21.6	13.0	8.5	4.6	3.7	2.2	1.8	0.9	0.2	0.1	0				
Ungrazed	24.3	17.6	14.1	10.0	7.7	6.8	1.5	1.0	—	0.6	0.4	—	—	0.4	0
Arizona Cottongrass															
Grazed	25.7	23.5	20.2	16.9	10.9	9.3	5.5	5.3	1.6	1.1	0.5	0			
Ungrazed	36.4	33.3	—	21.2	12.1	9.1	—	3.0	—	0					
Side-oats grama															
Grazed	34.6	19.2	9.0	0											
Ungrazed	26.8	10.7	7.1	5.4	—	—	5.3	0							
	Secondary grasses														
Rothrock grama															
Grazed	7.5	2.4	0.8	0.3	0.1	0									
Ungrazed	3.5	0.8	0.2	0											
Curlymesquite															
Grazed	15.8	7.0	3.0	1.2	0.6	0.4	0.3	0.2	0						
Ungrazed	10.0	2.2	0.6	0.3	0										
Slender grama															
Grazed	12.6	6.7	4.1	2.1	1.0	0.5	0.2	—	0						
Ungrazed	5.9	2.2	1.1	0.3	0.3	0.1	0.1	0							
Sprucetop grama															
Grazed	30.4	24.8	21.6	16.1	12.2	10.2	6.6	4.2	2.5	0.1	0				
Ungrazed	47.5	43.3	42.6	26.0	12.0	9.1	0.8	0.3	0						

in two groupings were compared: (1) primary grasses (black, sideoats, and hairy gramas, Arizona cottongrass, tanglehead, mesa threeawn, and Texas timothy) that tend to predominate on lands that receive light or no grazing or are maintained in good condition, and (2) secondary grasses (Rothrock, sprucetop, and slender gramas, and curlymesquite) that tend to occur sparingly on ungrazed ranges but are abundant on ranges in poor condition.

1. All grasses studied produced some seedlings or sets each year, but the number produced varied greatly by species. Secondary grasses usually produced more seedlings than the primary grasses. Rothrock grama and curlymesquite were the most prolific, followed by sprucetop and slender gramas. Arizona cottongrass produced the least seedlings.

2. All secondary grasses and Texas timothy produced more seedlings where grazed than where protected. Black, hairy, and sideoats gramas, and tanglehead produced more seedlings or sets where ungrazed than where grazed. Grazing seemed to have little effect on seedling production of Arizona cottongrass and mesa threeawn.

3. Mortality of seedlings and young plants was especially high during the first 2 years.

4. Black and sprucetop gramas, Arizona cottongrass, and mesa threeawn were the longest lived with some plants of black grama living 14 years. Rothrock grama was the shortest lived; no plant lived more than 3 years where protected or more than 4 years where grazed.

5. In general, the primary grasses tended to be longer lived where protected than where grazed; whereas the opposite was true of the secondary grasses.

Nineteen Years of Range Improvement on the Crystal Springs Range Demonstration Area in Nevada

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The Crystal Springs Range Demonstration area was established in 1937 by presidential order at the request of the Crystal Springs Soil Conservation Association. The object of establishing this "range study" area was to re-establish and maintain a vegetative cover of high forage value and to demonstrate methods of utilizing the range forage crop to the fullest extent possible consistent with sustained forage production.

The order withdrew 16,210 acres of federal range located on the northwest side of Pahranagat Valley, Lincoln County, Nevada. The area was assigned to the Soil Conservation Service for rancher-SCS cooperative range conservation practice study purposes.

The Crystal Springs range demonstration area is located in the transition zone between the southern desert shrub and the northern desert shrub belts in what is recognized as the hopsage-blackbrush plant association.

Shrubs and grasses, characteristic of both the northern and southern desert shrub belts grow there in association with each other. Indian rice grass (*Orzopsis hymenoides*) was probably the most abundant of the northern desert grasses present in the climax cover. Only remnants of this species exist in the present vegetation. Galleta grass (*Hilaria jamesii*) and bush muhly (*Muhlenbergia porteri*) were the most abundant of the southern desert grasses in the original cover. These grasses have increased greatly under controlled winter and early spring grazing.

Northern desert (cool-season) plants growing in association with southern desert (warm-season plants seriously complicate the grazing management necessary for simultaneous cool-season and warm-season range-forage improvement.

Two major vegetation sub-types of the desert shrub type occupy the fenced portion of the study area as follows:

1. The spiny hopsage-galleta grass sub-type occupies 4,670 acres in the southern part. Vegetation in this type consists mainly of such species as galleta grass, Indian ricegrass, bush muhly, Nevada jointfir (*Ephedra nevadensis*), spiny hopsage (*Grayia spinosa*), white burrobrush (*Hymenoclea salsola*), wolfberry (*Lycium andersoni*), four-wing saltbush (*Atriplex canescens*), and rabbitbrush (*Chrysothamnus spp.*) This type produces the usable forage.
2. The blackbrush sub-type occupies 3,180 acres in the northern and western portions of the area. Blackbrush (*Coleogyne ramosissima*) is by far the dominant species. Small amounts of Nevada jointfir, spiny hopsage, wolf-