Effects of Fire on Grasses of the Texas High Plains[1]

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Highlight

Fall, spring, and summer burning significantly reduced total forage production on a Texas High Plains range. Although herbage yields were less on burned plots, the vigor of the desirable blue grama (*Bouteloua gracilis* Willd. ex HBK) appeared to be benefited by fires while the vigor of two less desirable grasses appeared to be decreased. Spring burning is recommended over fall burning when moisture accumulation and erosion potential are considered. Recovery from fire was quickest after a summer burn.

Fire has been an important factor in shaping vegetation patterns for thousands of years (Sauer, 1950; Cooper, 1961; and Humphrey, 1962). It influences the growth, reproduction, and distribution of many plants species (Ahlgren, 1960) by affecting such factors as soil temperature, moisture, and nutrients.

There are many accounts of the influences of accidental or planned fires upon vigor, production, and composition of plant communities. Fire apparently favors some species while detrimentally affecting others. This usually results in a change in composition of the plant community. The extent of the change depends upon many factors such as the environmental conditions at the time of burn, plant morphology, phenological development of the individual plants, ability of plants to respond after fire damage, fire intensity, and environmental conditions after the burn.

The voluminous literature concerning fire and its use shows the importance placed upon fire as an ecologic and economic factor. Fire can be as beneficial as it is destructive. This is pointed out by the approximately equal number of published documents on the use of fire as a tool and on its control. An extensive search of the literature on fire revealed few reports concerning the influence of fire on the native vegetation on the High Plains of Texas (Trlica, 1967). Consequently this study was initiated in 1965 to study the effects of burning upon the community and individual plants on a deep hardland site in the Texas High Plains. The findings should be useful in planning the use of burning as a range practice when similar environments are involved.

Experimental Area and Procedure

The study was conducted on the Texas Technological College Research Farm near Amarillo. Climatic conditions in this area of the Texas High Plains are quite variable. Summer temperatures may exceed 100F, whereas readings of below zero are sometimes recorded during the winter.

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The 69-year average annual precipitation recorded at the Amarillo weather station is 20.76 inches (Jensen and Hildreth, 1962). Most precipitation comes during the growing season from May through October. Rainfall generally occurs as thunderstorms of short duration. Pattern of rainfall, high wind velocities, and high evaporation rates tend to reduce the amount of effective precipitation (Lotspeich and Everhart, 1962). Total annual precipitation was below normal during the years of this study.

Vegetation on the experimental area is similar to that found on fair to good condition deep hardland range sites of the Texas High Plains. The grass cover was made up of blue grama, sand dropseed (*Sporobolus crytandrus* (Torr.) Gray), tumble windmillgrass (*Chloris verticillata* Nutt.), buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.), red threeawn (*Aristida longiseta* Stead.) and tumblegrass (*Schedonnardus paniculatus* (Nutt.) Trel.). Important annual forbs were kochia (*Kochia scoparia* (L) Schrad.), and dyssodia (*Dyssodia papposa* (Vent.) Hitchc.). Blue grama, buffalograss, western wheatgrass (*Agropyron smithii* Rydb.), and sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) are considered climax for this site (Jacquot, 1962).

The soil, a Pullman silty clay loam, is described by Jacquot (1962) as a dark, grayish-brown, deep, loamy, slowly permeable soil that has a dark brown clay subsoil. Soils of this type are highly productive, most of them being under cultivation. The experimental area has a gentle 1 to 3 percent southerly slope.

During the summer of 1965, six adjacent 100 × 50 ft plots were established. Fire lanes were constructed around the periphery of each plot and the area fenced to exclude livestock. Ten 9.6 sq ft permanent quadrats were located along a transect through the center of each treatment plot. Twenty-five individual plants per plot of four grass species were selected from the quadrats for individual study. Measurements of maximum height, basal area, and number of seedstalks were taken on 25 plants of blue grama, sand dropseed, and red threeawn per plot. Measurements of basal area and 10 leaf lengths were taken on 25 plants of tumble windmillgrass per plot. All measurements were made during the early fall of 1965 prior to burning and again at the end of the 1966 and 1967 growing seasons. Herbage yield for each treatment was determined at the end of the 1966 and 1967 growing seasons.

Each of the six plots under study constituted a burning treatment. Two plots were burned in the fall of 1965; one with and the other against the wind, and two plots were burned in the spring of 1966; one with and the other against the wind. One plot was burned with the wind in the summer of 1966. The remaining plot was not burned and served as the control. Those plots burned with the wind during the fall and spring of 1965 and 1966 were burned again at the same time in the fall and spring of 1966 and 1967.

Soil moisture conditions at the time of the fall and spring burns (1965 and 1966) were determined gravimetrically for depths of 0–1, 1–2, 2–3, 12 and 24 inches. These depths were also sampled at the beginning of the 1966 growing season in a fall burned plot and adjacent unburned plot to determine if fall burning had affected winter moisture accumulation. Soil moisture was traced throughout the 1966 growing season using Bouyoucos moisture blocks installed at a six inch depth in adjacent fall burned plot and unburned control plot.

Maximum temperatures during the burns were measured using a modification of the technique developed by Bently and Fenner (1958). Pyrometric crayon marks ranging from 125F to 1800F were placed on rectangular pieces of asbestos housing shingles to form fusion pyrometers. The pyrometers were placed at ground level within and between grass clumps before each burn.

FIG. 1. Winter snowfall was blown from fall burned plots, but was retained on unburned plots. Winter moisture accumulations in the unburned plot resulted in earlier spring growth and greater forage production.

Results and Discussion

Fusion pyrometers placed within clumps of blue grama indicated that plots burned with the wind attained the highest temperatures. The highest temperature recorded was during the 1966 spring burn with the wind. The highest wind velocity recorded (18 mph) and extremely dry conditions were the primary factors causing the high temperature. Although plots burned with the wind attained high temperatures, the time required to completely burn the plots was considerably less than when burning was against the wind.

Soil Moisture

There were no significant differences ($P > 0.05$) in soil moisture between the plots at the time of the fall (1965) and spring (1966) burns. Therefore, the differential responses of the vegetation to the season of burnings must be attributed to factors other than soil moisture at the time of burning.

It was noted, however, that winter snowfall was blown from fall burned plots. The adjacent unburned plots had dormant plants and litter on them that accumulated the snow (Figures 1 and 2). Snow accumulations during the winter of 1965 and 1966 resulted in unburned plots having higher ($P < .01$) spring moisture than an adjacent fall burned plot. The more favorable soil moisture conditions resulting from snow accumulations may have caused the earlier spring growth of plants within unburned plots than on burned plots. Additionally, soil moisture at a six inch depth as indicated by

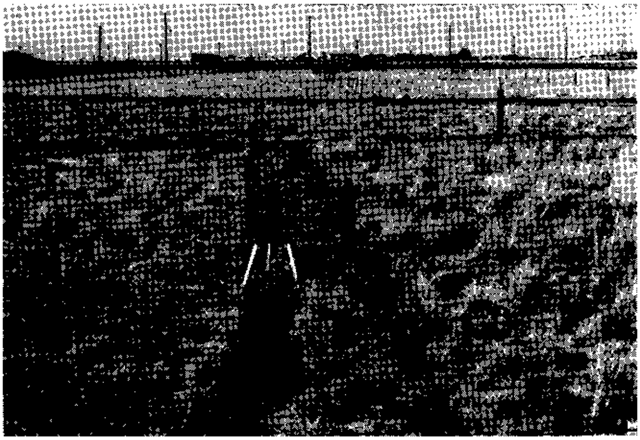

Fig. 2. Visual differences in the amount of total forage produced by the spring burned plot against the wind in 1966 on the left, and the unburned control plot, on the right. The unburned control plot produced more forage than any burned plot. Photograph was taken at the end of the 1966 growing season.

Bouyoucos moisture blocks was significantly greater in the unburned control plot than in the fall burned plot until plants began active growth in June.

Forage Production

All burning reduced forage yields both the first and second year after the fire. Reductions in yields ranged from 15 to 35 percent (Table 1). The plot burned against the wind in the spring 1966 produced more total herbage at the end of the first growing season than the plot burned with the wind. The reverse was true for fall burns; the plot being burned with the wind produced more than the plot burned against the wind. Although statistically significant, these differences were not great. Therefore, we do not believe that the direction of burn contributed significantly to differences in herbage yields.

Spring burned plots produced only slightly more herbage than the fall burned plots during the first growing season. During the second growing season (1967), however, the fall burned plots produced slightly more total herbage than did spring burned plots. Therefore, no distinct advantage was shown in spring burns over fall burns when total herbage yields was the only criterion used for comparison.

Previous studies indicate different responses when fall and spring burns were compared. Aldous (1934) and Anderson (1964) both reported greater yields after spring burns than after fall burns. Both reports concerned tall-grass ranges. On the other hand, Hopkins, Albertson, and Riegel (1948) reported greater herbage production following fall burning on short-grass ranges in West Central Kansas.

Unless distinct advantages such as increased herbage yields or favorable effects on desirable species are shown by fall burns, burning in the spring appears more acceptable. Removal of the protective plant cover by fall burning leaves the soil bare for wind and water erosion for a longer period before revegetation. This appears important enough to recommend spring burning over fall burning in regions of high winds as is generally experienced in the Texas High Plains.

Herbage production on the plot burned in July, 1966, was less at the end of the 1966 growing season than on plots burned the previous fall and spring. However, it was second only to the unburned control plot in herbage yields during the 1967 season. This indicates less damage to plants by summer fires than by fall or spring fires. It is possible that heat damage was not as severe in green plant crowns during summer burns as in dormant plant crowns in fall and spring burns.

Production on all plots, including the unburned control, was reduced considerably in 1967 due to the severe drought. Plots burned two years in succession produced only slightly less forage in 1967 than those plots that had been burned only once in 1965 or 1966. Successive fires do not appear to have a cumulative effect because total herbage yields were similar on plots burned only once and those burned two years in succession.

Table 1. Average oven-dry herbage yields (lbs/acre) from six burning treatments.[1]

	1966	1967
Unburned Control	1384a	962a
Burned Against Wind		
Fall 1965 only	938d	638c
Spring 1966 only	1078b	571cd
Burned With Wind		
Fall 1965 and 1966	1026bc	569cd
Spring 1966 and 1967	946cd	513d
Summer 1966 only	916d	759b

[1] For each column, means with the same letter are not significantly different from each other at the .05 level.

Plant Attribute Measurements

The average basal diameters of blue grama increased between 1965 and 1967 regardless of treatment. The basal diameters of red threeawn and sand dropseed decreased between 1966 and 1967 on the plots burned two years in succession, but either maintained or increased in size in the unburned control and plots burned only once the previous year. Blue grama continued to increase in basal diameter between 1966 and 1967 in all treatments except when burned in the spring with the wind two successive years. The average basal diameter of tumble windmillgrass decreased 44%

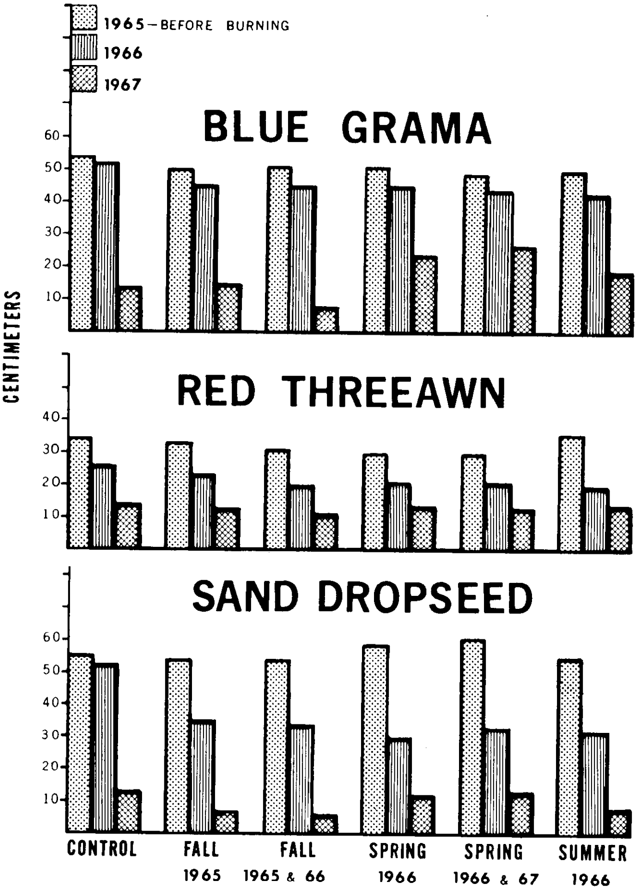

FIG. 3. Average maximum heights of 25 plants of each of three species within six burning treatments.

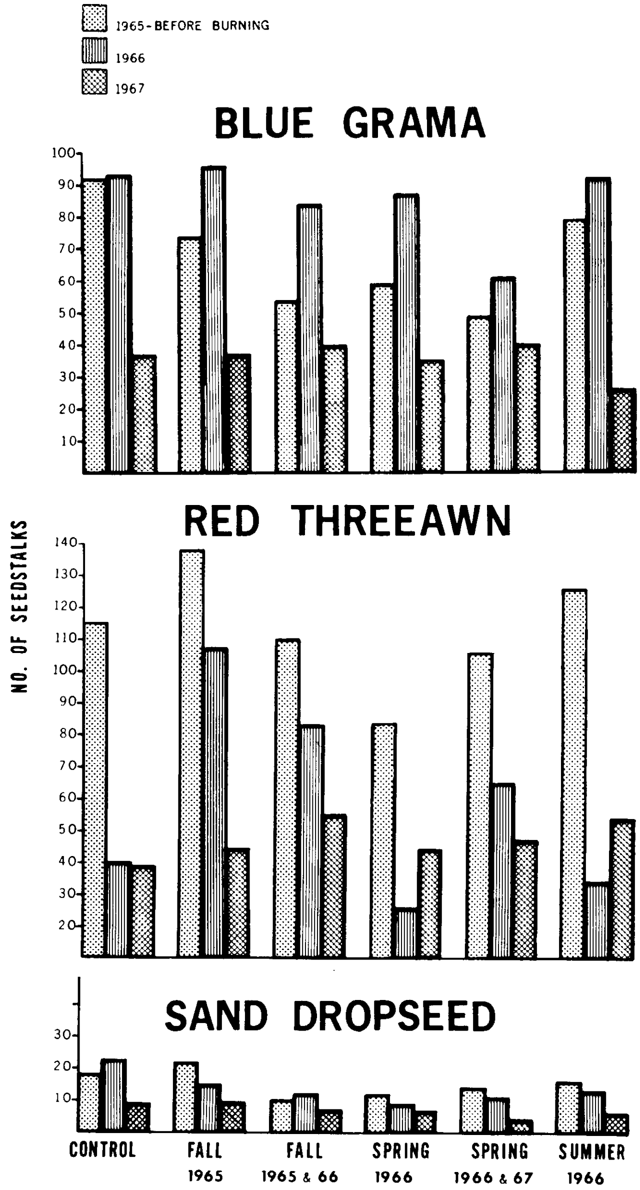

FIG. 4. Average seedstalk production of 25 plants of each of three grass species within six burning treatments.

between 1966 and 1967 in all treatments. However, basal diameters of tumble windmillgrass decreased 64% on the unburned plot and only 40% on the burned plots. Burning appeared to prevent natural decreases for tumble windmillgrass.

The maximum heights of red threeawn, blue grama, and sand dropseed decreased between 1965 and 1967 regardless of treatment, but burning reduced the heights of sand dropseed more than blue grama or red threeawn (Figure 3).

Height reduction following fire has been noted by other workers. Launchbaugh (1964) found that a spring burn in Kansas resulted in decreased heights of blue grama, buffalograss, and western wheatgrass. In our study height growth of blue grama was less in all burned plots than in the unburned control plot the first season (1966) after fire. There was apparent recovery of blue grama by the second season (1967) since height growth was greater in plots burned in spring and summer of 1966 than in the unburned control plot.

Seedstalk production was lower for the three species in 1967 than in 1965 (Figure 4). Blue grama produced more seedstalks in 1966 than in 1965 regardless of burning treatment. On the other hand, burning significantly reduced seedstalk production of sand dropseed during the first and second growing seasons after fire. Fire had little effect on seedstalk numbers of red threeawn the first growing season following burning. However, during the second growing season (1967) seedstalk numbers of red threeawn were greater in all burned plots. It appeared that burning stimulated seedstalk production of blue grama, but was detrimental to sand dropseed. Fall and spring burning two years in succession reduced seedstalk production more for sand dropseed than for blue grama and red threeawn.

Seedstalk production of blue grama in 1967 was greater in plots burned two years in succession than on the unburned control. The reason for this increase is not known. Several researchers have reported increases in seedstalk production after burning (Ehrenreich, 1959; Ehrenreich and Aikman, 1963; and Dix and Butler, 1954). Ehrenreich and Aikman (1963) believed that an increase of height and number of flower stalks after burning was probably due to the increased growth rate of plants in the spring, which would allow the plants to produce more carbohydrates. The greater supply of carbohydrates possibly induced the differentiation and growth of flowering stalks. But in our study, spring growth of plants was retarded by burning. Also, height growth on burned plots was less than on the unburned plot. Therefore, greater carbohydrate production probably was not the cause for the greater number of seedstalks produced by blue grama after burning. Significant ($P < .05$) three factor interactions between species, burning treatments, and years for most plant attribute data indicated that under different environmental conditions results might have been different.

The average leaf length of tumble windmillgrass was less in 1966 and 1967 in all treatments regardless of burning treatment. It appeared that burning had little influence on leaf lengths of tumble windmillgrass. Burning retarded natural decreases in basal cover for this species. It therefore appears to be resistant to fire.

In conclusion, it appears that periodic burning may have a definite position in the management of Texas High Plains ranges similar to the range in this study. The reduction in herbage yields may be compensated for by the favorable response of the more desirable species such as blue grama. In this case, burning would reduce the time required for the range to reach its productive potential by favoring the fire tolerant species.

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