Yield Responses to Time of Burning in the Kansas Flint Hills[1]

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Highlight

The effect of time of spring burning on herbage yields in pastures grazed throughout the growing season was investigated. Early and mid-spring burning reduced forage yields but late-spring burning caused no reduction. Weed yield was significantly reduced by late-spring burning. Differences in grazing distribution apparently affected treatment responses in ordinary upland and limestone breaks range sites.

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Grazing management in the Kansas Flint Hills has traditionally included spring burning of ranges. Studies there have indicated that burning ungrazed plots reduces herbage yield. This study was to determine the effect of time of spring burning on herbage yields in pastures grazed by steers throughout the growing season.

The literature indicates that yields of herbage on burned range vary widely. A primary factor in this variability is time of burning.

In the True Prairie near Manhattan, Kansas, yields of herbage were reduced by burning at all dates tested (Aldous, 1934; McMurphy and Anderson, 1965). Their trials showed that as time between burning and resumption of spring growth lengthened, forage yields diminished. Duvall (1962) studied burning on slender bluestem range of central Louisiana and, in contrast to the work reported in Kansas, found no difference in 8-year tests in herbage yield between areas burned in January and those burned in March. The disagreement may be explained by differences in when rapid growth starts and in precipitation in the two areas, about 58 inches annually in central Louisiana and about 32 inches in the Flint Hills. McMurphy and Anderson (1963) stated that differences in soil moisture brought about by burning appear to be the major cause of herbage yield reductions.

Fall burning near Guthrie, Oklahoma, reduced herbage yields as much as 59% during an 8-year period (Elwell et al., 1941). In the Trelease Prairie of Illinois, Hadley and Kieckhefer (1963) found that with almost pure stands of protected indiangrass *(Sorghastrum nutans* (L.) Nash) and big bluestem *(Andropogon gerardi* Vitman), living shoot biomass was greater after spring burning than after protection from fire, apparently from excessive accumulation of mulch in protected areas. Large accumulations of herbaceous litter can cause yield reductions.

Duvall (1962) concluded that a key to high herbage production in the slender bluestem area of central Louisiana was preventing large accumulations of herbaceous litter. Burning accomplishes that. Litter on protected native pastures of Iowa also retarded plant growth (Ehrenreich, 1959).

However, livestock gains, another indicator of the impact of range burning, have provided a major incentive for range burning in the Flint Hills. Smith et al. (1965) have reported the 15-year average of beef gains in mid and late spring burned pastures to be 20 and 23 lb/steer higher than gains on an adjacent, unburned pasture. Increased gains from burning are attested to by numerous lease arrangements for transient steer grazing requiring that Flint Hills pastures be burned (Kollmorgen and Simonett, 1965).

Time of burning affects many factors which, in turn, affect herbage yield. Hanks and Anderson (1957) indicated reduced infiltration and increased evaporation, which decreased water use efficiency in ungrazed fall and spring-burned plots in the Flint Hills, Higher soil temperatures and concurrent increased evaporation and transpiration caused soil water supplies to be depleted more rapidly in burned areas in the Hayden Prairie of Iowa (Ehrenreich and Aikman, 1963).

A summary of the literature cited indicates that moisture relations, influenced mainly by time of burning, are a primary factor affecting herbage yield. Removing excess herbaceous litter from the soil surface by burning can, in some instances, increase herbage yields. To determine effects of burning on herbage yield, one should investigate time and frequency of burning. Some data indicate that ungrazed and grazed areas may respond differently to time of burning. Duvall (1962) found that grazed paddocks in slender bluestem range of central Louisiana produced significantly more herbage than ungrazed ones.

Materials and Methods

The study area is 5 miles northwest of Manhattan, Kansas, in the Flint Hills region of the True Prairie. It is occupied largely by warm-season perennial grasses, i.e., big bluestem, little bluestem *(Andropogon scoparius Michx.)*, indiangrass, switchgrass *(Panicum obtusum* L.) and sideoats grama *(Bouteloua curtipendula* (Michx.) Torre.). Numerous other grasses and forbs also present make up only a small portion of the total vegetation.

Three 44-acre pastures have been burned annually at three different dates from 1950 to the present: early spring (March 20), mid-spring (April 10), and late spring (May 1). A 60-acre unburned pasture served as a check. The pastures consist primarily of two range sites 1) ordinary upland and 2) limestone breaks. Botanical composition within Flint Hills range varies within any given area due to topographic and edaphic features, and that variation significantly influences herbage yield. Anderson and Fly (1955) categorized areas with like vegetation into range sites to permit segregation of effects of site as such from those of grazing management practices.

Each pasture was stocked at 1 animal unit to 5 acres for the growing season. Steers (500-550 lb) were placed in the pastures at the start of each growing season (approximately May 1) and removed in early October weighing 700-750 lb each.

Ten wire cages, 1 meter square and approximately 75 cm high, were randomly placed in the ordinary upland and limestone breaks range sites within each of the four pastures to prevent grazing on sampling areas. At the close of the grazing season, herbage in a plot (area = 4.36 ft^2) in each of the caged areas was clipped to ground level. A like plot was also clipped in an adjacent unprotected area. In each case, the herbage was separated into forage, weeds, and mulch (no mulch remained in the burned pastures). Forage consisted of grasses, grass-like plants, and perennial forbs.[2] Weeds consisted of forbs not found in climax; mulch was the plant residue that had accumulated from season to season. Differences between caged and grazed areas were termed disappearance and considered an index of grazing use.

Plant census data were obtained by measuring the basal area along 20 to 30 randomly placed 5-m line transects in each range site within the four pastures. Data thus obtained were used to estimate range condition on the basis of original vegetation remaining.

Results and Discussion

Forage.—In ordinary upland bluestem range late spring burning did not reduce herbage yields significantly while mid-and early-spring burning did (Table 1). Forage yields from limestone breaks range showed that only early-spring burning reduced yield significantly. Ordinary upland range produced significantly more forage than limestone breaks range in all burning dates and in the unburned check.

Table 1. Forage and weed yields in lb/acre airdry for indicated times of burning (8-year average) on ordinary upland (OU) and limestone breaks (LB) sites.

Time of burning	Forage yield OU	Forage yield LB	Weed yield OU	Weed yield LB
Early	2612a*	2114a	335b	430c
Mid	3238b	2440ab	289b	269b
Late	3529bc	2681b	161a	106a
Check	3919c	2562ab	300b	337bc

* Yields within each range site followed by the same letter are not significantly different at the .05 level.

[2] *Perennial forbs included in forage are those found in climax and grazed by livestock.*

Forage disappearance (an index of grazing pressure) did not differ significantly in response to time of burning. That was expected, because the areas were stocked at the same rate. However, disappearance was greater on ordinary upland, a gently sloping area, than on limestone breaks, a steep, rocky area (Table 2). That explains the apparent difference between range sites in yield response to time of burning (Table 1). Differences in yield response between the two range sites were probably a consequence of lighter grazing on the limestone breaks range.

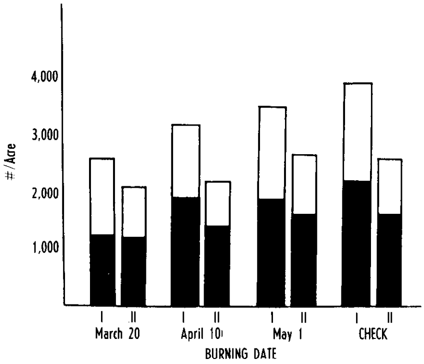

FIG. 1. Forage yields, lbs/A air-dry weight, with residual after grazing represented by blackened portion of bar for indicated times of burning (8-year average). I = ordinary upland range site and II = limestone breaks range site.

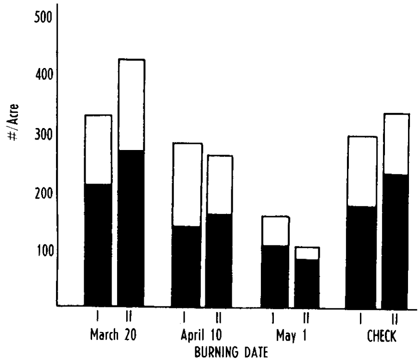

FIG. 2. Weed yields, lbs/A air-dry weight, with residual after grazing represented by blackened portion of bar for indicated times of burning (8-year average). I = ordinary upland range site and II = limestone breaks range site.

Table 2. Forage and weed disappearance in lb/acre airdry for indicated times of burning (8-year average) on ordinary upland and limestone breaks sites.

Time of burning	Forage OU	Forage LB	Weed OU	Weed LB
Early	1304a*	870a	121ab	156b
Mid	1278a	993a	143b	101b
Late	1628a	1009a	53a	18a
Check	1670a	863a	125ab	106b

* Yields within each range site followed by the same letter are not significantly different at the .05 level.

Long-term effects of overgrazing, in this case a result of reduced forage yields due to time of burning, limit the productive potential of vegetation. Therefore, ordinary upland range appeared to show more response to time of burning than did limestone breaks range (Fig. 1 and 2) because grazing pressure was greater on the former.

Year-by-year forage yields are shown in Fig. 3. Over the 8 years, early spring burning consistently gave the lowest forage yield; and, with few exceptions, yield on the unburned area was highest. In 1958-1959 and 1964-1965 the unburned check yielded less than pastures burned in mid and late spring. Those years followed drought periods. A several-year drought preceded 1958-1959 and a severe 1-year drought (precipitation only about half the average) preceded 1964-1965. Anderson (1965) has indicated that range burning reduced soil moisture, and the yields in this experiment were lower than the check in the burned areas in 1963. However, the following

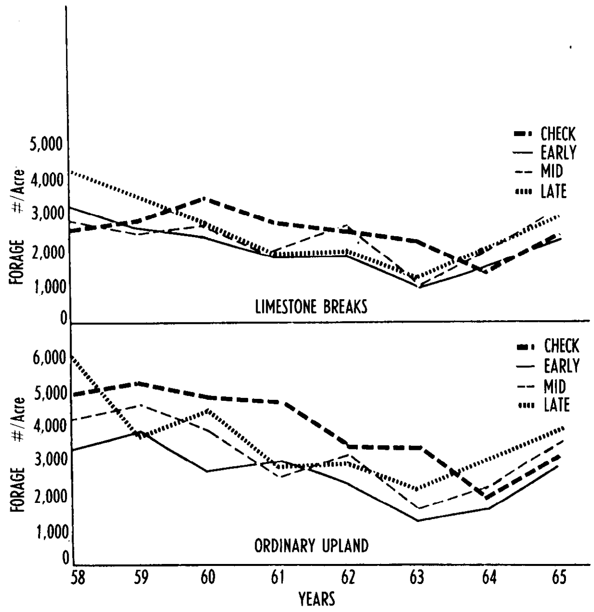

FIG. 3. Forage yield, lbs/A air-dry weight, over 8 years for indicated times of burning.

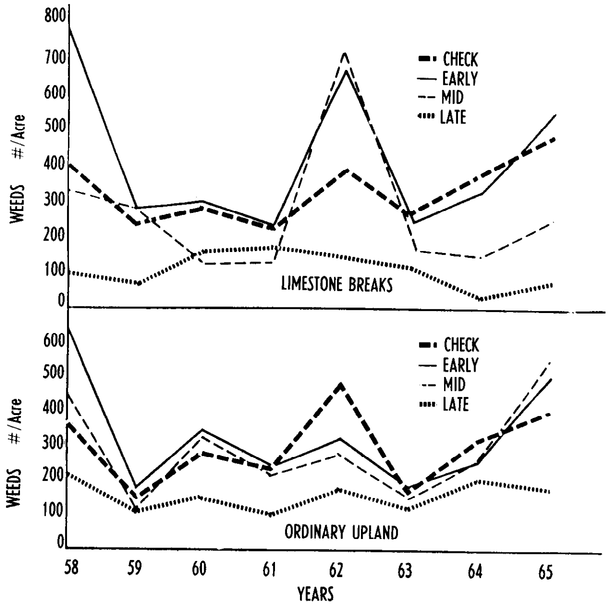

FIG. 4. Weed yields, lbs/A air-dry weight, over 8 years for indicated times of burning.

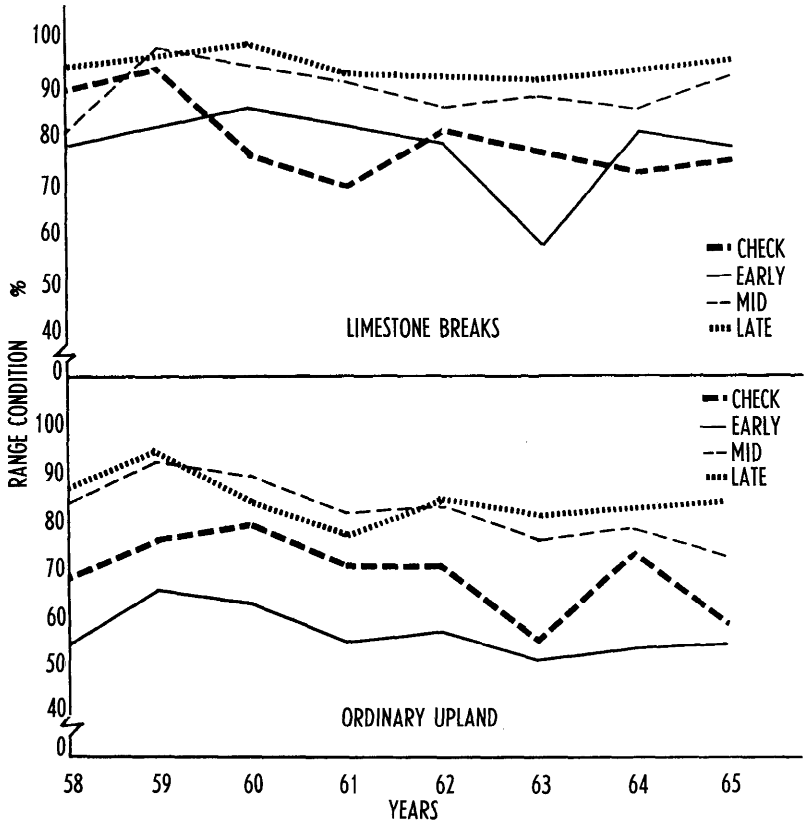

FIG. 5. Range condition as percentage of original vegetation over the 8-year period for indicated times of burning.

years, 1964-1965, the check yielded less forage than mid- and late-spring burned pastures. A possible explanation is fewer competing weeds in the mid- and late-spring burned pastures. Range condition in mid- and late-spring burned pastures is considerably higher (contain fewer weeds) than in unburned pastures.

Weeds.—Weed yields in both range sites were significantly lower in late-spring burned pastures than in any other treatments (Table 1). In ordinary upland range, differences in weed yields were not significant among early-spring burning, mid-spring burning, and the unburned check. However, yields in limestone breaks range for early- and mid-spring burning were different from each other but not from the check. No differences in weed yield between the two range sites within the various treatments occurred.

Throughout the 8 years, weed yields fluctuated widely in early- and mid-spring burned pastures as well as in the unburned check (Fig. 4). Late-spring burning kept weed yields rather uniformly low from year to year as late-spring burning comes when many weedy forbs are growing actively and are susceptible to fire injury. Plant census data indicated that weedy species definitely decreased in late-spring burned pastures.

Grazing use (disappearance) of weeds was lowest in the late-spring burned pasture, primarily from lack of quantity available for grazing. Disappearance of weeds was not significantly different in early- and mid-spring burned pastures and the unburned check (Table 2).

Range condition.—Range condition, as expressed by original vegetation present, is shown year by year in Fig. 5. The late-spring burned pasture was consistently high in range condition, while the unburned check and early-spring burned pastures were lower and varied more. However, mid- and late-spring burning did not eliminate all weeds. Smooth sumac (*Rhus glabra* L.), a woody increaser pest, increased significantly.

Summary

Time of burning in the Kansas Flint Hills markedly affected yields of forage. Late-spring burned pastures and unburned pastures gave equal forage yields in both ordinary upland and limestone breaks range. Early- and mid-spring burning reduced forage yields in ordinary upland range but not in limestone breaks.

Weed yields were considerably lower in the late-spring burned area than in the unburned check, while weed yields in early- and mid-spring burned pastures did not differ significantly from those in the unburned check.

Range condition was higher in mid- and late-spring burned pastures than in early-spring burned or unburned pastures.

Since there were no significant reductions in forage yield, and range condition was excellent with late-spring burning, it appears that burning, if practiced in the Flint Hills, should be done in late spring (May 1).

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