Soil Fertility
Fire consumes an average of 1,000 to 2,000 pounds of plant material on bluestem range. Nutrient losses are primarily from nitrogen and organic matter. Wyrill (1971) and Aldous (1994) reported no differences in organic matter and nitrogen in the soil on Aldous plots after 5 and 48 years between burned and unburned plots. No differences in soil potassium (K), phosphorus (P), calcium (Ca), pH, or magnesium (Mg) were shown between late-spring burned plots and unburned ones. Winter-, early-, and mid-spring burned plots had higher soil K, Ca, and Mg than late-spring burned and unburned plots. Less water infiltration probably reduced leaching of those cations on the earlier burned plots.

Livestock Performance
Steers gained more on late-spring burned pastures than early-summer burned or unburned pastures (Table 2). Higher early-season gains on burned pastures than on unburned accounted for the difference. Aldous (1934) and Smith and Young (1959) found that burning increased protein and ash content of bluestem forage. Smith et al. (1960) found bluestem dry matter and crude fiber digestibility to be higher on burned than on unburned range.

LITERATURE CITED

Table 2. Steer gains on range burned at different spring dates (17 yr avg., 1950-1966).

<table>
<thead>
<tr>
<th>Burning date</th>
<th>Average daily gain (lb/head/day)</th>
<th>Grazing season gain (lb/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May</td>
<td>June</td>
</tr>
<tr>
<td>Unburned</td>
<td>1.83</td>
<td>1.74</td>
</tr>
<tr>
<td>March 20</td>
<td>2.42</td>
<td>2.10</td>
</tr>
<tr>
<td>April 10</td>
<td>2.50</td>
<td>2.01</td>
</tr>
<tr>
<td>May 1</td>
<td>2.36</td>
<td>2.06</td>
</tr>
</tbody>
</table>

INFLUENCE OF FIRE AND MOWING ON VEGETATION OF THE BLACKLAND PRAIRIE OF TEXAS

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Dept. of Range Science, Texas A & M University,
College Station, Texas 77843

Abstract. Influence of spring burning and semiannual mowing was investigated on a native hay meadow in the Blackland Prairie of Texas. The study was initiated in 1970 on communities dominated by Indiangrass (Sorghastrum nutans), little bluestem (Schizachyrium scoparium) and big bluestem (Andropogon gerardii). Soils were calcareous clays and clay loams of the Houston Black-Heiden-Ferris Association characterized by shrink-swell properties with the resultant development of gilgai (hog-wallow) microtopography. Average annual precipitation was 85 cm. All sites had been mowed annually or semiannually for at least 30 years prior to treatment. None had ever been cultivated.

Periodic samples were collected for total green herbage production, production of major species, mulch accumulation and density of several abundant forbs. Results from 1971 showed all treatments to have significantly less total green herbage production than controls for the months June-October while end-of-season production (November) was significantly less only on burn-mow plots. During the 1971 growing season a drought existed after the burn until August. This may have caused a severe micro-environment on exposed, treated plots and hence lowered their production. When above normal fall precipitation occurred nearly all sites except the burn-mow recovered. In 1972 total production on all treated sites was essentially the same as the controls throughout the growing season. By 1972 all sites had the same amount of mulch as the controls except the continuously semiannually mowed sites. It appears that approximately three years are needed for mulch to reach an equilibrium. A noticeable reaction to burning and release from mowing was a decrease in density of certain abundant forbs. Semiannual mowing enhanced forb numbers.
INTRODUCTION

The influence of fire (Daubenmire 1968) and mowing (Merrill and Young 1959, Jameson and Huss 1959, Ehrenreich and Aikman 1963, Vogel and Bjugstad 1968) on native grassland species composition and production has been widely investigated. However, one area that has received little attention in relation to these factors is the Blackland Prairie of Texas. This grassland, which is the southern extension of the True Prairie (Dodd 1968), exists in an environment with generally higher temperatures and a longer growing season than the rest of the True Prairie. As a result, it may respond differently to fire and mowing treatments than similar grasslands in Iowa (Ehrenreich and Aikman 1963), Missouri (Kucera and Koelling 1984), Kansas (Owensby and Anderson 1967) and other portions of the True Prairie.

Little of the original vegetation of the Blackland Prairie remains today since most of the land is cultivated. There is a tendency, however, for some cropland to be returned to permanent grass and in some situations native grass mixtures may be utilized. Also, of the existing remnants, a few are being considered as nature preserves and some have already been purchased by the Nature Conservancy. Many of the remnants are being destroyed and it seems desirable to document their vegetational characteristics and their responses to the influence of fire, mowing and total protection while sufficient examples remain.

A description of the remnants of the Blackland Prairie is provided elsewhere (Collins 1972). The purpose of this report is to evaluate the response of spring burning and semiannual mowing (July and October) on the species composition, production and mulch structure of native Blackland Prairie. The results will hopefully provide implications for management of native preserves and for re-established native grass pastures. The results are to be considered preliminary.

STUDY AREA

The study area is a 2.5 hectare (ha) native grassland located near the center of the Blackland Prairie Resource Area of Texas (Godfrey, Carter and McKee 1970). It is on the USDA, Blackland Conservation Research Center at Riesel, Texas.

Mean annual precipitation is 85 cm with two peaks in May (10.7 cm) and September (7.1 cm) and generally a hot, dry period during July and August. The mean annual temperature is 19°C while the January and July means are 79°C and 30°C, respectively. The frost-free season is 250 days (Carr 1967).

Topographically the landscape is level to gently rolling. The soils are Vertisols and the two major series represented are the Houston Black and the Heiden. These soils have a high montmorillonite clay content which results in shrink-swell properties that produce an irregular surface micro-topography known as gilgal (hog-wallow). Heiden soils occupy the micro-highs and Houston Black soils the micro-lows (Godfrey 1964, Collins 1972).

The Blackland Prairie is the southern extension of the True Prairie (Dodd 1968) and the study area is included in the Sorghastrum-Schizachyrium (Indiangrass-little bluestem) community-type of Collins (1972). The vegetation is characterized by tall, perennial grasses and major dominants are little bluestem (Schizachyrium scoparium), Indiangrass (Sorghastrum nutans) and big bluestem (Andropogon gerardii). The study area has never been cultivated and has had no grazing for over 30 years. It has been mowed and harvested for hay annually or semiannually for at least 30 years. There is no history of burning for the past 30 years.

METHODS

The 2.5 hectare prairie was sampled in June, 1972 for basal cover with 2000 single, vertically placed point quadrats and for frequency with 120, 25 cm x 50 cm quadrats. A stratified random sampling procedure was used. Samples were randomly placed along several parallel compass lines sighted across the area.

These data were used to determine degree of homogeneity of the vegetation and to describe the vegetation. Within the prairie 8, 15 m x 15 m experimental plots were established in the spring of 1970. There were four treatments with two replications. Treatments were:
1. No burn-no mow beginning 1970 (control) (no burn-no mow)
2. No burn-semianual mow 1970 but not thereafter (no burn-mow)

Mowing was accomplished with a side-mounted, sickle-type tractor mower, the hay raked, baled and removed. Burning was conducted between 1:00 and 3:00 p.m., March 15, 1971. At the time of the burn, wind speed was 8 to 13 km/hr, air temperature 20°C, relative humidity 60 percent and soil moisture was near field capacity.

In each of the eight plots five 0.5 m² (25 cm x 50 cm) quadrats were hand clipped at ground level at monthly or bimonthly intervals during the 1970, 1971 and 1972 growing seasons. No quadrat was clipped more than once during a growing season. Plants were sorted into the major grasses (little bluestem, Schizachyrium scoparium; big bluestem, Andropogon gerardii; Indiangrass, Sorghastrum nutans), other grasses, forbs and total mulch (fresh, cured and humic). They were oven-dried at 270°C for 48 hr and the results reported in kg/ha.

During August, 1972 stem counts were made in all plots of some of the more numerous forbs. Ten 25 cm x 50 cm quadrats were counted in each plot. In addition, 20 quadrats were taken in adjacent plots with a continuous history of semiannual mowing.

Precipitation records were obtained from the Blackland Conservation Research Center which is located within 2 km of the study site. Soil moisture was determined gravimetrically (NAS-NRC 1962) in all plots on May 15 and July 15, 1971.


RESULTS AND DISCUSSION

Basal cover of the 2.5 ha prairie was 23 percent and percent composition was: little bluestem 41 percent, Indiangrass 32 percent, big bluestem 9 percent, other grasses 11 percent and forbs 7 percent. End-of-season (November) green herbage production for the first year of study (1970) was 6662 kg/ha (Table 1). Periods of maximum growth were May through early June and late August through September. Composition based on end-of-season production was little bluestem 61 percent, Indiangrass 20 percent, big bluestem 12 percent and the remaining 7 percent made up of other grasses and forbs (Table 1).

<table>
<thead>
<tr>
<th>Species</th>
<th>June</th>
<th>August</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little bluestem</td>
<td>1618</td>
<td>2240</td>
<td>3330</td>
<td>4046</td>
</tr>
<tr>
<td>Big bluestem</td>
<td>222</td>
<td>329</td>
<td>697</td>
<td>809</td>
</tr>
<tr>
<td>Indiangrass</td>
<td>293</td>
<td>660</td>
<td>1175</td>
<td>1310</td>
</tr>
<tr>
<td>Misc. grass</td>
<td>292</td>
<td>106</td>
<td>181</td>
<td>446</td>
</tr>
<tr>
<td>Forbs</td>
<td>666</td>
<td>142</td>
<td>200</td>
<td>82</td>
</tr>
<tr>
<td>Total</td>
<td>3090</td>
<td>1468</td>
<td>5943</td>
<td>6682</td>
</tr>
</tbody>
</table>

End-of-season production values agree with studies of other central bluestem prairies with similar composition and precipitation. Values range from 4000 to 8000 kg/ha for sites in
North Dakota (Hadley 1970), Minnesota (Smeins and Olsen 1970), Iowa (Ehrenreich and Aikman 1963), Missouri (Kucera and Ehrenreich 1962) and Kansas (Owensby and Anderson 1967). Generally production of the present study is somewhat greater compared to other reports.

Control plots (no burn-no mow) has significantly greater production than other treatments for all dates except April and November during 1971 (Table 2). By November all treatments were the same except burn-mow plots which were 2590 kg/ha or 37 percent lower in production than controls. It appeared that either mowing or burning had a depressant influence on production while a combination of the two yielded the most pronounced reductions (Table 2).

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total seasonal green herbage production (kg/ha) for the year of the burn (March 15, 1971). All plots were moved semiannually for 30 years prior to 1970. Mow plots were moved semiannually through the 1970 growing season while mowing ceased in no mow plots the fall of 1969.</td>
</tr>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>April</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>August</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November</td>
</tr>
</tbody>
</table>

Total Annual Precipitation 83 123

\* Values within each date followed by the same letter are not significantly different at the 0.05 level.

Caused of reduced production, particularly on the burn-mow plots is difficult to ascertain. Seasonal precipitation, soil moisture and time of burn may be involved. Seasonal precipitation for 1971 deviated considerably from the 35 year averages (Table 2). Longterm cumulative precipitation for June is 48 cm while in 1971 it was 22 cm or less than half of normal. By the end of August, 1971 precipitation equaled the 35 year average and by the end of the year it exceeded the average by 18 cm.

Limited precipitation early in the growing season may have produced a severe environment that retarded plant development particularly where the mulch had been removed by mowing and burning. Plant development on treated plots was from 1 to 2 weeks behind controls the first 6 weeks of the growing season. This is contrary to the results of Ehrenreich and Aikman (1963), Hadley and Kieckhefer (1963) and others who have shown burn plots to start growth earlier and develop faster. In the present study, however, timing of the burn just prior to an unseasonal drought may have produced opposite results. As indicated by Aldous (1934) and Owensby and Anderson (1967) as time between burning and beginning of spring growth lengths, forage yield diminishes. Although time of burn in this investigation coincided with growth initiation, limited precipitation reduced growth rates for nearly 3 months.

Why all treatments except the burn-mow eventually caught up with the controls after favorable precipitation occurred in August is not apparent. Perhaps the double treatment so impaired growth that the plants were unable to respond. The data show, however, that all treatments were essentially the same until October and thereafter the burn-mow plots failed to keep pace with the others. An obvious difference observed in the field was reduction in number of flowering culms of the major grasses on the burn-mow plots. It was estimated that reduction was at least 50 percent of other treatments. This reduction of course, lowered production but again it is difficult to propose a reason for the limited flowering behavior of plants in these plots.

Surface soil moisture (0-15 cm) showed no significant differences between treatments during May and July of 1971. All plots were at or near the permanent wilting point (15 bars) during both of these months but growth continued. This suggests that most of the species are able to remove moisture from the soil at tensions much greater than the standard 15 bar value. Soil moisture does not explain the production differences between plots for 1971.

Many studies have shown fire to increase production (Ehrenreich and Aikman 1963, Hadley and Kieckhefer 1963, Kucera and Koeling 1964) while others (Aldous 1934, Owensby and Anderson 1967) indicate that burning, particularly at the wrong time, may reduce production. The results of this study agree with the latter.

During the 1972 growing season all treatments produced the same amount of green herbage for all sample dates. Thus, one year after the treatments were applied all plots had returned to the same level of production. Yields for November, 1972 samples varied from 6300 to 7100 kg/ha with no significant differences between treatments.

Total mulch present on plots is presented in Table 3. The no burn-no mow plots had 2935 kg/ha of mulch in June of 1970. This was primarily the litter left after the last mowing in November, 1969 as well as some late fall growth that was added to the standing dead material. In 1971, the year of the burn, burn plots had significantly less mulch than other treatments. The no burn-mow treatment had 1612 kg/ha while the no burn-no mow, in its second year with no mulch removal, had 3270 kg/ha. By 1972 the no burn-no mow, in its third year with no harvest, had reached 6484 kg/ha by June. The other treatments had also reached similar values. By comparison, adjacent plots that had continued under a semiannual mow regime had only 2683 kg/ha or 41 percent of the no burn-no mow. The burn-mow was still lagging behind other treatments with only 5871 kg/ha.

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total mulch (fresh, cured and hurnic)weight (kg/ha).</td>
</tr>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1970</td>
</tr>
<tr>
<td>1971</td>
</tr>
<tr>
<td>1972</td>
</tr>
</tbody>
</table>

\* Values within each date followed by the same letter are not significantly different at the 0.05 level.

Dyksterhuis and Schmutz (1947) noted regions of the Fort Worth Prairie of Texas to have approximately 8000 kg/ha total mulch. This would suggest that mulch accumulation on sites in this study might increase slightly with one more year of protection. Thus, 3 to 4 years appear to be necessary for mulch to reach an equilibrium in this grassland. Ehrenreich and Aikman (1963) indicate that 4 to 6 years are necessary to reach this state in Iowa prairies.

Results of this investigation are preliminary and as additional data are collected answers to some of the questions may become apparent. Because of the preliminary nature of the study, little
can be surmised about composition shifts but some obvious changes have occurred (Table 4). A comparison of all treated plots with adjacent plots that continued to be mowed semianually showed a significant reduction in densities of some of the more conspicuous forbs. It appears that Centarea americana (American basketflower) is greatly enhanced by semianual mowing. This is a somewhat weedy annual that seems to prefer well-lighted sites where little mulch accumulates. Gaillardia pulchella (Indian blanket) had a similar, though not so obvious, trend. On treated plots that were burned or where some accumulation of mulch occurred these species were greatly reduced in density. Shrankia uncinata (catclaw sensitivebrier) was little influenced by any treatment. Little bluestem was unaffected by treatments except the no burn-no mow which had the lowest density of flowering culms which is attributed to greater accumulation of mulch on these plots.

**TABLE 4**

<table>
<thead>
<tr>
<th>Species</th>
<th>No Burn</th>
<th>Burn</th>
<th>No Burn</th>
<th>Burn</th>
<th>Sidemowing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Now</td>
<td>Now</td>
<td>No Now</td>
<td>Now</td>
<td></td>
</tr>
<tr>
<td>Centarea longiflora</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>26</td>
</tr>
<tr>
<td>Gaillardia pulchella</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Shrankia uncinata</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Schizachyrium scoparium</td>
<td>15</td>
<td>37</td>
<td>26</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>

**LITERATURE CITED**


### PROGRESS REPORT ON THE EFFECTS OF MOWING ON WILD FLOWERS

James F. Hesse and S. S. Salac
Graduate Research Assistant and Assistant Professor, Department of Horticulture and Forestry, University of Nebraska.

Sweet Rocket (Hesperis matronalis, Linn.), butterfly milkweed (Asclepias tuberosa, Linn.), and Gray goldenrod (Solidago nemoralis, Ait.), were subjected to 13 mowing treatments spaced at two week intervals throughout the 1972 growing season. These treatments consisted of one control and 12 mowing dates and a clipping height of four inches was used for each mowing date. The 13 mowing dates employed are listed as follows:

1. May 1
2. May 15
3. May 29
4. June 12
5. June 26
6. July 10
7. July 24
8. August 7
9. August 21
10. September 4
11. September 18
12. October 2

Data were collected by measuring the parameters listed as follows; (1), survival, (2), height and number of lateral shoots forced, (3), date and duration of bloom, and (4), general rating of the esthetic values of plants in each treatment.

**SURVIVAL**

During the 1972 growing season, no detrimental effect was noted among the three species of wild flowers as a result of mowing. A survival of 100 percent in each species was noted.

Kansas State University, Manhattan, September 22-23, 1972