# Spring Burning Effects on Redberry Juniper-Mixed Grass Habitats

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## Abstract

**Habitat and plant species parameters were compared among untreated, chained, chained/burned, burned/chained, and burned/chained/reburned treatments on redberry juniper-mixed grass rangeland. Chaining followed by burning with a standardized fire plan in mid-March drastically decreased shrub and debris cover, while increasing percentage bare ground. Perennial grass yields were maintained or increased compared to previously chained or untreated areas following burning in a year of above-normal rainfall. Burning in a "dry" year reduced grass yields by 50% of that on areas chained only, but yields were only slightly less than on untreated areas. Grass species density was reduced for 2 growing seasons following burning. Burning greatly reduced annual forbs from March through June of a moist spring. Total forb densities on burned areas were generally similar to, or higher than, those on unburned treatments by July because of extended growth of perennial forbs. March burns appeared to have the most severe impact on the least desirable shrub (redberry juniper), grass (threeawn), and forb (common broomweed) species.**


Redberry juniper *(Juniperus pinchotii)*-mixed grass habitats are most widely developed on Rough Breaks and Shallow range sites along the High Plains escarpment and adjacent Rolling Plains of west Texas. Primary resource values of these areas are associated with domestic livestock grazing and wildlife habitat.

Redberry juniper stands often become so dense that livestock handling is difficult. Perennial grass production in untreated stands may be less than half that following juniper control (Robinson and Cross 1970, Graves 1971). Understory shrubs and herbs generally are suppressed with increasing juniper cover on western rangelands (Clary 1974, Barney and Frischknect 1974, Tausch and Tueller 1979). However, unlike other western junipers (except alligator juniper [*J. deppeana*]) redberry juniper is a strong sprouter (Vines 1960). Sprouts develop from meristematic tissue located at the stem base (Smith et al. 1975). Therefore, development of redberry juniper-mixed grass habitats following disturbance is different from juniper stands that establish from seedlings only.

Mechanical control has been essentially the only technique for managing redberry juniper in Texas (Bell and Dyksterhuis 1943, Wolff 1950). Rootplowing is effective, but expensive relative to site productivity. Chaining lowers redberry juniper canopies, but residual stems, sprouts, and debris continually build up. Soil-applied picloram at 2.24 kg/ha has resulted in 70% mortality of redberry juniper (Robinson and Cross 1970, Scifres 1972, Schuster 1976).

Use of fire in the management of redberry juniper-mixed grass habitats may provide an economical and ecologically sound alternative to present methods. The objectives of this study were to define the species and habitat changes which can be expected following spring burning of redberry juniper-mixed grass habitats.

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## Study Area and Methods

Study areas were on the Masterson JY Ranch in northeastern King County, Texas. The ranch lies within the Rolling Plains resource area (Gould 1969) at an elevation of 550 m. King County has a subtropical climate with dry winters and hot, humid summers. Average annual precipitation is 59 cm. Peak precipitation months are May and June. Topography ranges from nearly level to extremely steep. Study sites were restricted to the rocky, moderately sloping, well-drained, loamy soils of the Shallow range sites. These areas are typically intermediate between the Rough Breaks and Deep Hardland range sites. The Talpa series (loamy, mixed, thermic, lithic Calciustoll) was the major soil series on study sites. Study areas established in 1980 were on steeper slopes and had a higher proportion of Cottonwood soils than the plots established in 1979. Cottonwood soils contain more gypsum, are less productive, and responded differently than the Talpa soils treated in 1979.

Redberry juniper is the dominant woody species on the area. Associated shrubs include skunkbush *(Rhus aromatica)*, littleleaf sumac *(R. microphylla)*, algerita *(Berberis trifoliolata)*, lotebush *(Ziziphus obtusifolia)*, catclaw acacia *(Acacia greggii)*, feather dalea *(Dalea formosa)*, honey mesquite *(Prosopis glandulosa* var. *glandulosa)*, catclaw mimosa *(Mimosa biuncifera)* and elbowbush *(Forestiera pubescens)*. Major grasses were sideoats grama *(Bouteloua curtipendula)*, perennial threeawn *(Aristida wrightii, A. purpurea, A. longiseta)*, little bluestem *(Schizachyrium scoparium)*, silver bluestem *(Bothriochloa saccharoides)*, tall dropseed *(Sporobolus asper* var. *asper)*, rough tridens *(Tridens muticus)*, hairy grama *(Bouteloua hirsuta)*, buffalograss *(Buchloë dactyloides)*, hairy tridens *(Erioneuron pilosum)*, and fall witchgrass *(Leptoloma cognatum)*.

The study was conducted from January 1979 through September 1981. Rainfall from April through September 1979 was 18% above the long-term average and temperatures were moderate. Rainfall was 32% below the long-term average and temperatures set record highs during April through September 1980. The 1981 growing season had slightly lower than average precipitation and moderate temperatures.

Treatment areas were established in 1979 and 1980 using a completely randomized design with 2 replications. Treatments included untreated, chained two ways in 1974-75, and burning in March 1979 of areas chained in 1974-75. These same treatments were established again in 1980 along with 1969 burn/chained (1974-75) and a 1969 burn/chained (1974-75)/1980 burn. Burned plots were located within an 800-ha broadcast burn in March 1979 and a 280-ha broadcast burn in March 1980. Fire plans were similar to the one for volatile fuels described by Wright (1974) except that no large juniper piles were present. Fine fuel loads across burned pastures averaged 2,573 kg/ha in 1979 and 1,508 kg/ha in 1980. Weather conditions were: relative humidity 25 to 40%, temperature 20 to 26°C, winds 12 to 24 km/hr. Fire spread was excellent in both years resulting in nearly 100% coverage of pastures.

Livestock were removed from pastures before burning and returned on approximately June 1 following the March burns. Stocking rates were 1 A.U. per 20 to 22 ha year-long grazing on all study areas. This represented light to moderate stocking.

Vegetation and habitat measurements were obtained along 6, 30.5-m permanent line transects within each replication. Transects were randomly located and laid out perpendicular to local contour. Pretreatment measurements were obtained on all study areas and habitat parameters prior to burning in 1979 and 1980.

Aerial cover of shrubs, woody debris and percent bare ground were determined by the line-intercept method (Canfield 1941) in mid-July. Shrub density was recorded on belt transects 3 m either side of the 30.5-m line transects. Forb density was determined from 10, randomly located 0.25-$m^2$ plots per transect in May, July, and September. Perennial grass standing crops were determined by clipping 10, randomly located 0.25-$m^2$ plots along each transect in August. Clipped samples were separated by species into current and past year's growth and litter. Perennial grass frequency was also obtained from clipped plots. The response of redberry juniper, skunkbush, algerita, and littleleaf sumac was determined from 100, 10, 50, and 50 randomly selected plants, respectively, which were marked with a metal stake before burning.

Data were analyzed using analysis of covariance with least squares mean separation or analysis of variance with Duncan's multiple range mean separation. Significant differences were identified at the 95% confidence level.

## Results and Discussion

Large changes occurred in cover values following burning in both 1979 and 1980 but tended to be less dramatic following the 1979 burn. Woody debris coverage was 17 to 25% on chained areas but was reduced to less than 2% following burning. Debris cover on the reburned areas was similar to that on the untreated and 11-year-old burned areas (4 to 6%). The consumption of woody debris appears to be a major source of increased bare ground following burning of chained sites (Table 1). Based on our results, burning of redberry juniper-mixed grass habitats similar to those in this study will increase bare ground for more than 2 growing seasons. Bare ground averaged 52% during the growing season following burning in 1979 (wet), and 79% following the 1980 fire (dry). Bare ground averaged 36% and 40% on untreated, and 26% and 29% on chained areas during the 1979 and 1980 growing seasons, respectively. The effects of increased bare ground on watershed qualities and subsequent management have been described for similar sites by Wright et al. (1976). Prescribed burning should be confined to gently-to-moderately sloping sites (3% to 12%) to minimize potential soil loss.

**Table 1. Changes in woody debris coverage (adjusted for covariate) and bare ground for untreated (UN), chained (CH), chained/burned (CH/BU), burned/chained (BU/CH), and burned/chained/burned (BU/CH/BU) treatments; 1979 and 1980.**

| Year-treatment | Growing season | Woody debris coverage (%) | Bare ground (%) |
|---|---|---|---|
| 1979 - UN | 1st | 6.7 b[1] | 36.4 b |
| | 2nd | — | — |
| CH | 1st | 16.7 c | 25.8 a |
| | 2nd | — | 31.0 a |
| CH/BU | 1st | 1.4 a | 52.2 c |
| | 2nd | — | 49.3 b |
| 1980 - UN | 1st | 11.5 c | 39.6 b |
| | 2nd | — | 41.8 b |
| CH | 1st | 24.7 d | 29.4 a |
| | 2nd | — | 31.2 a |
| CH/BU | 1st | 0.5 a | 78.8 c |
| | 2nd | — | 64.3 c |
| BU/CH | 1st | 6.0 b | 44.6 b |
| | 2nd | — | 41.6 b |
| BU/CH/BU | 1st | 4.7 b | 79.6 c |
| | 2nd | — | 56.2 c |

[1]Values within the same treatment year and season identified by the same letter are not different ($P$>.05).

### Shrubs

Total shrub cover was reduced to less than 7% during the first growing season following burning (Fig. 1). Total shrub cover on untreated and chained areas ranged from 21 to 31% during the same period. Shrub cover on burned areas doubled during the second growing season, while nonsignificant increases in shrub cover occurred on untreated and chained areas.

While total shrub cover was low immediately following burning, the rate of recovery was slower for redberry juniper than for other shrubs (Fig. 1). All species had the potential to sprout with survival rates of redberry juniper controlled by bud zone location, growing season and site characteristics (Steuter and Britton 1983).

Redberry juniper cover on burned areas remained less than half of that on untreated or chained areas during the third growing season (Fig. 1). Data collected in 1981 on the area burned in 1969 indicated that 13 growing seasons after a fire, redberry juniper cover will be similar to untreated or chained areas. Adult redberry juniper regrowth initially forms a dense globe-shape with as many as 100 stems originating from buds in the stem base.

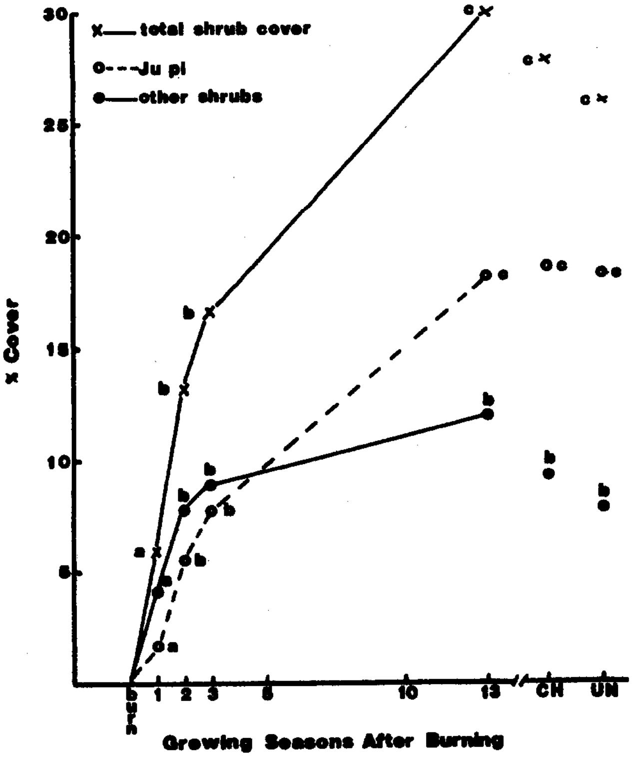


**Fig. 1.** *Comparison of cover changes for redberry juniper (Jupi) versus all other shrubs, and total shrub cover over 13 growing seasons following spring burning, and on untreated (UN) and chained (CH) areas. Values averaged across similar treatments applied in 1979 and 1980. Data points for a cover variable (e.g. Jupi) identified by the same letter are not different (P>.05).*

Redberry juniper sprouts from adult root systems averaged 38.0 ± 7.3 cm tall at the end of the first growing season after burning. The rate of regrowth slowed during the third growing season. Plants on the area burned in 1969 averaged 1.4 ± .3 m tall 13 years after the fire. The number of stems on these adult plants was 10 or less and they were similar in growth form, but shorter than untreated adult plants. Redberry juniper regrowth 13 years after a fire was beginning to impede livestock handling, although not a severely as in untreated stands.

In contrast with heavy seed production by untreated plants, regrowth of redberry juniper from adult root systems was not producing seed three growing seasons after burning. Since young redberry juniper are relatively easy to kill with fire (Steuter and

Britton 1983), delayed seed production of established plants caused by an initial burn might allow a longer interval for a second fire to prevent new plant establishment.

Chaining may reduce cover of redberry juniper, but tends to increase other shrubs, especially skunkbush. Total shrub cover of species other than redberry juniper was equivalent to values on chained and untreated areas during the second season following a burn (Fig. 1). Data from the 1969 burn area indicated that the cover value of shrubs, other than redberry juniper, will be maintained or slightly increased for at least 13 years following a burning treatment.

Mortality of individually marked littleleaf sumac was 30% following burning in a dry year. Algerita plants which were evaluated tended to occur in the debris piles left by chaining. These plants were subjected to extreme fire intensities, and although regrowth rates were slow, only 13% of the algerita plants were killed by burning in 1979. Despite mortality of littleleaf sumac, algerita, and redberry juniper on burned sites, overall shrub density among treatments was not great enough to be significant.

**Perennial Grasses**

Yield response of perennial grasses was strongly affected by growing conditions following burning (Fig. 2). New growth yield was equivalent on burned and unburned areas during the first and second seasons following burning in 1979. Burning of previously chained or burned areas in the dry year (1980) reduced new growth yields to less than half of that on chained or burned/chained areas. This reduced yield existed through the second growing season although differences between treatments were not as large as during the first season. New growth yield in untreated stands was also low in 1980 being only slightly higher than on burned areas.

Density of grass species declined following all burning treatments (Fig. 2). The reduction in species present averaged less than one per plot. The 11-year-old burned area had a species density equivalent to or higher than untreated or chained areas. Species recovery during the second year after burning also appeared higher on the reburned area than on the initial burn areas. The rapid recovery of species density on the reburned area may be attributed in part to changes in species composition resulting from the first fire in 1969.

Sideoats grama and perennial threeawn, the dominant perennial grasses, responded differently to burning (Fig. 3). Yield of sideoats grama on the area burned in 1979 (wet) and the reburned area in 1980 (dry) was similar to, or slightly greater than, untreated and chained areas during the first and second growing seasons. The burn in 1980 decreased the yield of sideoats grama to 50% of that on the chained area. These results are similar to those reported by Wink and Wright (1973) for sideoats grama in a bull-dozed and burned Ashe juniper *(J. ashei)* community. Sideoats grama appeared to respond more favorably to burning in a wet year than

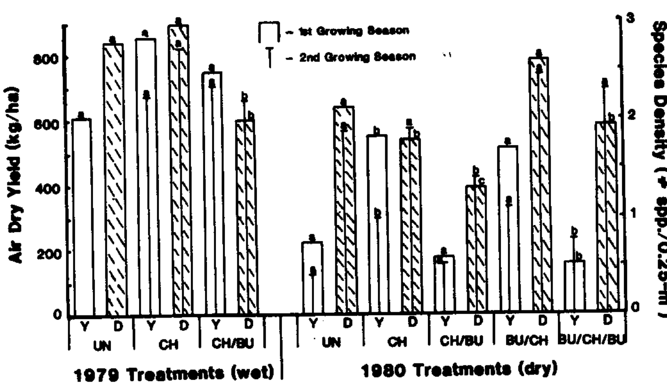


**Fig. 2.** *Yields of perennial grass new growth (Y), and species density (D) (adjusted for covariate) for 2 growing seasons following untreated (UN), chained (CH), chained/burn (CH/BU), burn/chained (BU/CH), and burn/chained/burn (BU/CH/BU) treatments. Parameter values within a treatment year identified by the same letter are not different (P>.05).*

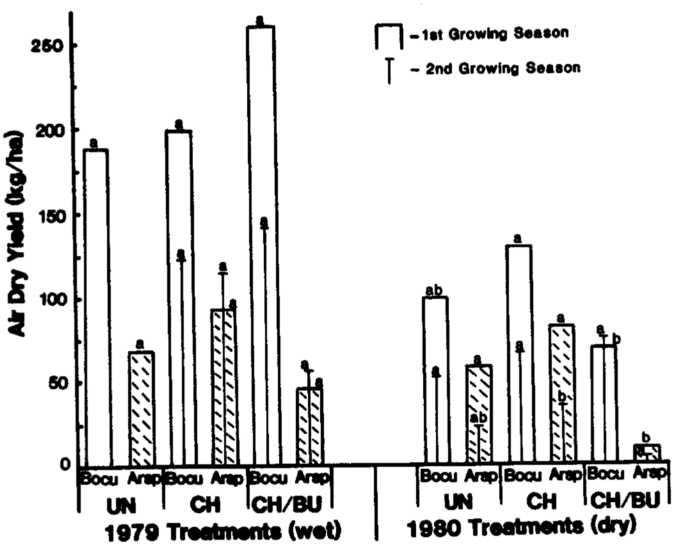


**Fig. 3.** *Yield of sideoats grama (Bocu) and perennial threeawn (Arsp) for two growing seasons following untreated (UN), chained (CH), and chained/burn (CH/BU) treatments (adjusted for covariate). Parameter values within a treatment year identified by the same letter are not different (P>.05).*

reported in earlier studies. Still, it should be noted that the yield of sideoats grama on untreated areas during 1980 (dry) was only slightly greater than on burned areas.

The yield of perennial threeawn was slightly-to-greatly reduced for at least 2 growing seasons following burning (Fig. 3). Reductions of threeawn yield were the more severe after burning in the dry year (1980). Threeawn is a bunchgrass with a shallow root zone. It accumulates large amounts of dead litter which decomposes slowly. It has low palatability and is damaged by fire partially because of intense heat that is generated when dead plant material burns in the crown.

**Forbs**

Abundance and diversity of forbs in redberry juniper-mixed grass communities fluctuate in response to season and timing of annual rainfall. Moist winter/spring conditions result in annual forb densities as high as 40 individual plants/0.25-m$^2$ in May. Nearly all annual forbs except common broomweed *(Xanthocephalum dracunculoides)* were senesced by July leaving only 5 to 6 perennial forbs/0.25-m$^2$, even in a year of above normal rainfall. In 1980, dry winter/spring conditions resulted in a near absence of annual forbs in May, allowing perennial forbs to dominate throughout the growing season. Plant densities ranged from 1 to 6 individuals/0.25-m$^2$ from May through July on untreated and chained areas in a dry year. Forb densities in May tended to be higher in untreated juniper stands than in chained stands following a wet winter/spring. The reverse was true following a dry winter/spring season. This was attributed to the dominance of annual forbs on the untreated areas in a wet year and the dominance of perennial forbs on the chained areas in a dry year.

Spring burning in a wet year (1979) caused a drastic, but relatively short-term, decrease in numbers of forb species and densities (Tables 2 and 3). Burning in a dry year (1980) had no effect on densities of either forb species or individuals in May when compared to untreated and chained areas. Forb abundance and diversity were higher during July and September following spring burning in a dry year as compared to untreated or chained areas. This increase was attributed to a lengthened green period for perennial forbs on the burned areas. Reduced competition from grasses, and extensive root systems of perennial forbs apparently allowed them to obtain moisture for growth on the burned areas long after plants on unteated and chained areas had become dormant because of drought.

Table 2. Average number of forb species per 0.25-m² plot for untreated (UN), chained (CH), and chained/burned (CH/BU) treatments during May, July, and September for 2 growing seasons after burning in 1979 and 1980.

| Growing season | Month | 1979 treatments UN | CH | CH/BU | 1980 treatments UN | CH | CH/BU |
|---|---|---|---|---|---|---|---|
| 1st | May | 7.0 a[1] | 6.5 a | 2.0 b | 1.8 a | 2.0 a | 1.8 a |
| | July | 1.9 a | 1.6 a | 1.5 a | 1.2 a | 1.3 a | 1.9 b |
| | Sept. | 1.5 a | 1.6 a | 1.3 a | 0.7 a | 0.9 a | 1.7 b |
| 2nd | May | — | 1.8 a | 2.0 a | 6.3 a | 5.5 a | 6.5 a |
| | July | — | 1.3 a | 1.5 a | 2.3 a | 2.1 a | 2.4 a |
| | Sept. | — | 0.7 a | 0.7 a | 2.0 a | 2.0 a | 2.2 a |

[1]Values within a month and treatment year identified by the same letter are not different ($P>.05$).

Table 3. Average number of individual forbs per 0.25-m² plot for untreated (UN), chained (CH), and chained/burned (CH/BU) treatments during May, July, and September for 2 growing seasons after burning in 1979 and 1980.

| Growing season | Month | 1979 treatments UN | CH | CH/BU | 1980 treatments UN | CH | CH/BU |
|---|---|---|---|---|---|---|---|
| 1st | May | 41.6 a[1] | 30.4 a | 4.4 b | 3.5 a | 6.2 b | 5.6 ab |
| | July | 6.0 ab | 6.2 a | 2.6 b | 2.2 a | 3.1 a | 4.6 b |
| | Sept. | 5.1 a | 7.3 a | 3.0 a | 1.0 a | 1.8 b | 3.3 c |
| 2nd | May | — | 5.2 a | 6.1 a | 30.9 a | 21.1 ab | 18.2 b |
| | July | — | 3.0 a | 5.7 b | 6.0 a | 5.3 a | 5.6 a |
| | Sept. | — | 1.1 a | 2.2 b | 4.8 a | 4.9 a | 5.1 a |

[1]Values within a month and treatment year identified by the same letter are not different ($P>.05$).

The effects of burning on forb species density were negligible during the second growing season after either a wet or dry year (Table 2). Total plant densities were higher on the 1979 (wet) burned area during the second growing season (dry) (Table 3).

Fire in a wet winter/spring, appeared to indiscriminately reduce annual forb density. However, most annual forbs completed their life cycle by July resulting in a short-term impact. An exception is common broomweed, which completes its life cycle in November and is a serious management problem in redberry juniper-mixed grass habitats during some years. Spring burning can provide excellent control of common broomweed for 1 year (Gordon 1982).

## Conclusions

Spring burning of redberry juniper-mixed grass communities resulted in substantial changes in the habitat relative to untreated and chained areas. Increases in bare ground were largely the result of reduced shrub and debris cover. Perennial grass density was reduced during the first season but was approaching values of untreated areas during the second growing season. Perennial grass yield on burned areas was equivalent to untreated and chained areas following burning in a year with above normal rainfall. Burning in a dry year resulted in grass yields equivalent to untreated areas, but below those of chained or previously burned areas, for at least 2 growing seasons.

Indiscriminant use of fire in redberry juniper-mixed grass habitats could lead to accelerated erosion and loss of forage, especially on the steeper or less productive sites. However, the impact of fire was most severe on the least desirable shrub, grass and forb species—redberry juniper, perennial threeawn, and common broomweed, respectively. The slow growth, and delayed reproduction of redberry juniper resprouts, indicate that even a relatively long fire interval (15 years) would reduce management problems caused by redberry juniper. The probability of decreased forage yield can be minimized by burning when soil moisture reserves are good just before green-up.

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