Huisache Growth, Browse Quality, and Use Following Burning

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Abstract

Exposure of huisache plants to fire for 5, 10, or 20 sec on Coastal Prairie in June, August, October, or December 1979, and February or April 1980 usually killed canopies of 90% or more of the plants. However, all burned huisache plants sprouted following treatment, regardless of season or intensity of burning. Precipitation, rather than season of treatment appeared to regulate rate of huisache regrowth following burning. Huisache 1 to 2 m tall replaced their original heights by the end of the second growing season after burning. New growth of huisache plants burned in winter contained more crude protein and phosphorus into late summer, than did browse from unburned plants. Differences in crude protein contents between twigs from burned and unburned plants were greatest following significant rainfall; there were no differences during dry periods. Although burning in late August increased number of twigs available for browsing, it did not affect percentage of available huisache twigs which were browsed. Large browsers (white-tailed deer and cattle) and small animals (rodents and lagomorphs) apparently accounted for most browse removal during the first 60 to 90 days postburn. However, insects apparently consumed most of the huisache browse during the growing season following burning in August.

Huisache *(Acacia farnesiana)* is a thorny, multi-stemmed shrub or small tree which occurs on about 1.1 million ha in Texas, primarily in the Gulf Coast Prairies and South Texas Plains (Smith and Rechenthin 1964). It is a prolific seed producer (Scifres 1974), and the seeds readily germinate after soil disturbance (Mutz et al. 1978). Moderate to heavy canopy covers of huisache seriously reduce production of desirable, warm season bunchgrasses and hinder effective management of livestock (Scifres et al. 1982).

Huisache is not highly susceptible to herbicide sprays normally used for range improvement. Only picloram sprays, applied at 1.1 kg/ha (a.i.) or more, have effectively controlled huisache (Bovey et al. 1970). Mechanical top removal only temporarily suppresses huisache. Huisache trees, 15 to 20-years-old grew to half their original heights by 5 months after shredding (Powell et al. 1972). Box and Powell (1965) reported that shredding, rolling chopping, or scalping caused huisache densities to increase on clay sites. Rootplowing or rootplowing followed by raking temporarily reduced huisache densities (Box and Powell 1965) but, without followup management, ultimately resulted in increased huisache stand densities (Mutz et al. 1978).

Prescribed burning required less increase in returns than herbicides or low-energy grubbing (Bontrager 1977) and may offer benefits not possible with other range improvement methods. For example, crude protein content of browse plants was increased for 1 year after burning in southeast Texas (Lay 1956), for longer than 2 years in Idaho (Leege 1968), and for at least 4 years in Arizona (Swank 1956), compared to that of browse from unburned areas. However, seasonal effects must be considered when comparing nutritional values of browse from burned with that from unburned areas. Increases in crude protein content of browse on burned areas may average more than that in unburned plants only during periods of most active growth (Dills 1970). The length of time for which nutritional values of regrowth are increased varies among browse species and with the area on which it occurs.

Burning may increase availability of browse by stimulating sprouts from plant bases, increase browse production with species such as willows (*Salix* spp.) (Leege 1969, Wolff 1978), and allow establishment of seedlings of species such as redstem *(Ceanothus sanquineus)* and certain legumes (Leege 1969, Martin and Cushwa 1966). Huisache is a preferred summer and fall browse for white-tailed deer *(Odocoileus virginianus)* on clay soils (Drawe 1968). However, the thorny spines inhibit browsing so that only the outside branches are used. Mechanical top removal increased the preference value of huisache eight-fold by removing the thorny top, stimulating new growth, and increasing crude protein contents of available browse (Powell and Box 1966).

Objectives of this research were to determine (1) rate of huisache topgrowth replacement after burning at different seasons, (2) nutritional status of huisache browse after burning, and (3) influence of burning on utilization of huisache browse.

Materials and Methods

The study area is on the Rob and Bessie Welder Wildlife Foundation's Refuge, approximately 11 km north of Sinton, Texas, in the Coastal Bend of the Prairies and Marshes Vegetational Area (Gould 1975). Climate is subtropical with about 300 frost-free days annually. Average rainfall for the past 26 years is 91.5 cm with peaks in spring and fall. Vegetation development is dictated by prolonged wet periods alternated with dry conditions (Gould and Box 1965).

Data were gathered from 3 pastures which were moderately grazed yearlong at 5.8 ha/AU. Two pastures are in a 4-pasture, 3-herd grazing system and 1 is grazed continuously. The study site is characterized by Victoria clay (Udic Pellustert) with $\leq$1% slope (USDA 1979).

The prevalent plant community on the immediate study site is Chaparral *(Acacia-Prosopis)*-mixed grass (Drawe et al. 1978). Broadcast burns were applied as headfires in February 1979 and February 1980, respectively, to portions of the continuously grazed pasture and on 1 pasture in the 4-pasture rotation system. Data on nutritional status of huisache following burning were gathered from these pastures. Part of 1 pasture in the 4-pasture system was rootplowed in 1962 and is dominated by uniform-aged stands of huisache which were used for evaluation of browsing use after burning.

Growth of Huisache Following Burning

Huisache plants were exposed to fire in a portable burning chamber (Britton and Wright 1979) fueled with propane at 1.14 kg/cm². The burning chamber was hexagonal, 1 m tall, 1.1 m diameter, and had six, 0.16-mm orifices pointed upward at a 30° angle and oriented toward a 0.5-m diameter circle in the center of

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Approved as TA-17671 by the Director, The Texas Agricultural Experiment Station and as Contribution 208 of The Rob and Bessie Welder Wildlife Foundation.
Received for publication May 3, 1982.

the chamber. Sets of 25 each, randomly selected,huisache plants were burned for 5, 10, or 20 sec at approximately 60-day intervals from June 1979 to April 1980.

Prior to burning, original height, canopy diameter, diameter of each stem at 15 cm above ground line, and number of stems were recorded for each tree. Fine fuel loads were estimated based on double-sampling techniques. Water content of fine fuel from under each tree was determined by oven drying samples at 105° C for 1 hr, 60° C for 22 hr, and then at 105° C for 1 hr. Instantaneous wind speed, wind direction, air temperature, and relative humidity were recorded at the beginning of each burn.

Maximum temperatures generated inside the chamber were determined by placing pellets with melting points ranging from 66° C to 538° C (56° C increments) at approximately 30 and 60 cm above ground line next to three randomly selected trees from each set for each exposure time.

Average height, canopy diameter, and number and origin of sprouts were recorded for each huisache plant at approximately monthly intervals after burning. Model I regression analysis was applied to the data with the equation expanded until best fit was achieved where $\hat{Y}$ = height or canopy replacement (cm) and X = days after burning. Three-way analysis of variance was also applied to the data to isolate the effects of burning duration, season of burning, and time of measurement. Means were separated by Student-Newman-Keuls' test (α=.05).

Crude Protein, Prosphorus and Digestible Organic Matter Contents

Crude protein (CP), phosphorus (P), and digestible organic matter (DOM) contents of current year's growth from plants in a 4.1-ha area burned in February 1979, and in a 16.2-ha area which was burned in February 1980 were compared to contents of plants on adjacent unburned areas. Twenty to 50 randomly selected trees from each plot were sampled. Only twig tips (including leaves) from unbrowsed branches were selected for analysis. Amount of twig sampled for laboratory analysis was determined by feeling down the stem until the thorns became hard and inflexible to the touch. Browse was sampled at approximately monthly intervals from July 6, 1979 until the end of the growing season (November 26, 1979). Sampling was resumed in spring after the onset of vegetative growth (April 12, 1981 for the 1980 burn; May 20, 1980 for the 1979 burn).

Percentage CP was estimated using the micro-Kjeldahl procedure for nitrogen determination (AOAC 1960). Ground samples were digested with sulfuric acid and hydrogen peroxide, and P content determined colormetrically. The in vitro technique was utilized for determining percent DOM (Tilley and Terry 1963) followed by a neutral detergent fiber extraction which completed the digestibility estimate (Van Soest and Wine 1967). Heirarchical analysis of variance was used to isolate the contribution of trees within dates of sampling, dates of sampling within burns and burning date to the total variation, and means were separated by Duncan's multiple range test (α=.05).

Huisache Browse Utilization

Fifteen sampling stations consisting of 4 plants each (3 burned in the propane-fueled chamber and one unburned) were established in August 1979. One burned tree of each set was surrounded by reinforcing wire enclosure 1.8 m tall with 15- by 15-cm openings to exclude large browsers (cattle and white-tailed deer). Another burned tree in each set was excluded from large browsers, lagomorphs, and large rodents by wrapping 2.5-cm-diameter mesh wire around the lower 45 cm of the reinforcing wire. Each enclosure had an internal area of approximately 1.9 m^2. One burned plant of each set was not excluded from browsers. Plant height, numbers of sprouts, browsed twigs and unbrowsed twigs occurring from ground line to 1.8 m were recorded monthly from September 1979 to December 1979. There was no attempt to distinguish between twigs browsed since the last sampling period. No usable browse (twig tips on which thorns had not lignified) occurred on plants after November 1979, and no additional browse use occurred from November to December, so sampling was ceased until April 1980, when vegetative growth resumed, and was terminated in September 1980. Data were subjected to analysis of variance and the means separated by Duncan's multiple range test (α=.05).

Results and Discussion

Growth of Huisache Following Burning

Environmental conditions during the individual-plant burns were conducive to effective broadcast burns except on April 11, 1980 when relative humidity was 82 to 88%, misting occurred intermittently, and fine fuel water content was 50 to 56%. Moreover, standing dead fine fuel was estimated to be less than 20% of the total fuel load. Total fine fuel loads under the trees exceeded the minimum (about 2500 kg/ha) suggested by Scifres (1980) for effective prescribed burning.

No huisache plants were root killed by burning, but most were top killed. There was no difference (α=.05) in percent top kill among seasons of burning nor was the interaction of season with duration of burning significant. Percent top kill of trees exposed to fires for 5 sec averaged 90% across burning dates which was significantly less (α=.05) than percent top kill of huisache burned for 10 and 20 sec which averaged 98 and 99%, respectively.

Differential responses to burning durations were expected since cell death is an exponential function of exposure temperature and duration (Hare 1961). Maximum temperatures at 30 cm above ground line during burning varied from 92° C during the 5 sec exposures in April 1980 (88% top kill) to 459° C during the 10 sec exposures in August 1979 and 20 sec exposures in December 1979 (100% top kill). However, because differences in percentage of trees top killed among durations were relatively small, we concluded that huisache may be top killed by relatively low heats. Moreover, the few plants not top killed by burning tended to be taller and with greater stem diameter than plants top killed by fires, but not significantly so.

Height of regrowth from plants top killed by burning were not significantly different (α=.05) among burning durations within a season of treatment. Therefore, data from burning durations were pooled for each season for further statistical analysis. Huisache sprouts from burned plants actively elongated from early March through mid-December, but replaced little height during the cool season, regardless of season of burning (Fig. 1). Plants burned in the middle, or at the end of the growing season had no appreciable stem elongation the first month after leaf emergence in the spring. The delayed growth was postulated to be the result of reductions in stored carbohydrates available to treated plants as noted with chamise *(Andenostoma fasciculatum)* by Jones and Laude (1960). Plants burned in December 1979 or February 1980 did not develop new sprouts until after March 1, 1980. Rainfall pattern during the growing season after burning also affected vegetative growth of huisache, with stem elongation reduced during dry periods, as in summer 1980 (Figs. 1 and 2). Rate of height increase of burned plants, regardless of date of burning, exceeded that of unburned plants, except during the 1981 growing season. Rainfall during 1979 and 1980, 77 and 100 cm respectively, was near the annual average. However, 138 cm of rainfall, approximately 150% of the average and the greatest annual amount received during the previous 26 years, occurred in 1981 (Fig. 2).

Based on prediction equations (Table 1), lengths of time required for huisache plants to replace 50% of their original height (Ht_{50}) were 14.3, 14.7, 11.6, 8.5, 7.9, and 8.1 months after burning plants $\geq$1 m in June, August, October, December, February or April, respectively. Thus, plants burned in winter 1979-1980 had replaced 50% of their original height by the end of the 1980 growing season (Fig. 1). Powell et al. (1972) reported that huisache regrowth reached an inflection point within 60 days after top removal by shredding, then growth rate declined. However, sprouts from burned plants elongated rapidly, even in the second growing season after burning, except during brief, extremely dry periods.

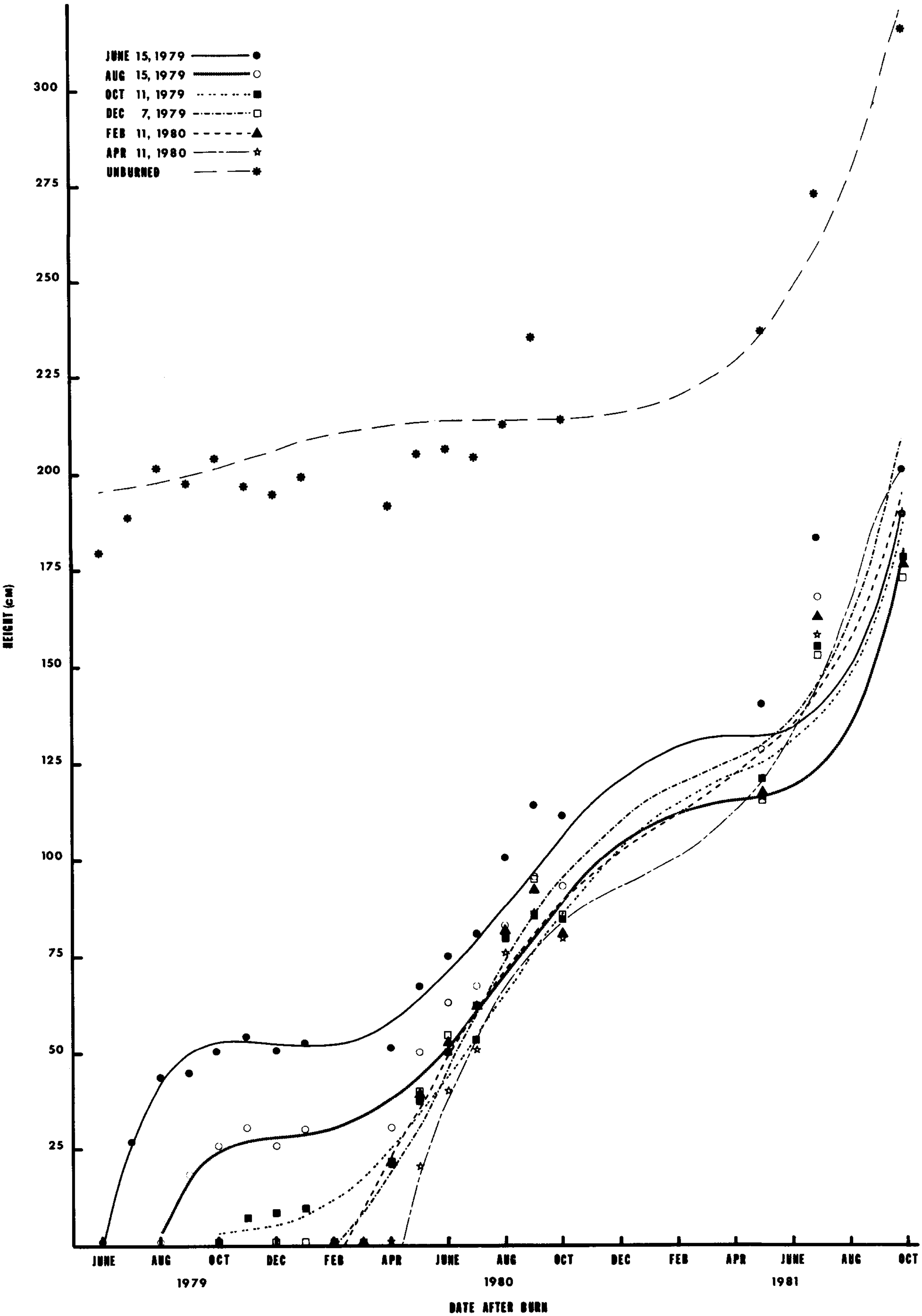

Fig. 1. *Regrowth heights (cm) of huisache at various times after burning individual plants ≥1 m tall in June, August, October or December 1979 and February or April 1980 on the Rob and Bessie Welder Wildlife Refuge near Sinton, Texas.*

Table 1. Prediction equations for height change of unburned plants and height replacement after burning huisache ≥1 m in June, August, October, or December 1979, and February or April 1980 on the Welder Wildlife Refuge near Sinton, Texas.

Date burned	Prediction equation[1]	r^2
1979		
June	$\hat{Y}=1.5580+1.0811X-0.0811X^2+2.6041 \bullet 10^{-5}X^3-3.4830 \bullet 10^{-8}X^4+1.6506 \bullet 10^{-11}X^5$	0.87
August	$\hat{Y}=3.0131+0.5943X-0.0053X^2+2.1317 \bullet 10^{-5}X^3-3.3658 \bullet 10^{-8}X^4+1.8292 \bullet 10^{-11}X^5$	0.90
October	$\hat{Y}=3.2567+0.0091X+5.4052 \bullet 10^{-5}X^2+5.4735 \bullet 10^{-6}X^3-1.4772 \bullet 10^{-8}X^4+1.0729 \bullet 10^{-11}X^5$	0.92
December	$\hat{Y}=2.0593-0.2004X+0.0044X^2-1.1568 \bullet 10^{-5}X^3+1.0729 \bullet 10^{-9}X^4$	0.85
1980		
February	$\hat{Y}=-4.7864+0.4429X+0.0004X^2-3.5888 \bullet 10^{-6}X^3+4.3526 \bullet 10^{-9}X^4$	0.90
April	$\hat{Y}=-5.6336+0.9116X-0.0030X^2+3.8244 \bullet 10^{-6}X^3$	0.89
Unburned	$\hat{Y}=196.3439-0.0011X+0.0006X^2-1.8563 \bullet 10^{-6}X^3+1.6142 \bullet 10^{-9}X^4$	0.31

[1]Y=Height of regrowth (cm); X=Days after burning.

Predicted times required for huisache plants ≥1 m tall to replace their original heights (Ht_{100}) were 27.3, 25.7, 22.8, 19.8, 18.9, and 16.8 months after burning in June, August, October, December, February or April, respectively. Thus huisache plants had replaced their original heights by the end of the second complete growing season, regardless of season of burning. Regrowth of plants which were <1 m tall when burned followed the same trend as described for plants ≥1 m, but the shorter plants replaced 50% of their original height (Ht_{50}) within 2 to 3 months, and replaced their original height by the end of the first complete growing season after burning (data not shown).

Numbers of basal sprouts per huisache plant after burning were not significantly different (α=.05) among burning dates, but numbers of sprouts were significantly different between size classes of plants. Prior to burning, plants ≥1 m tall averaged two stems where those <1 m usually consisted of a single stem. Stem numbers averaged 7 and 4 on plants ≥1 m and <1 m when burned, respectively, by the end of the first growing season after burning.

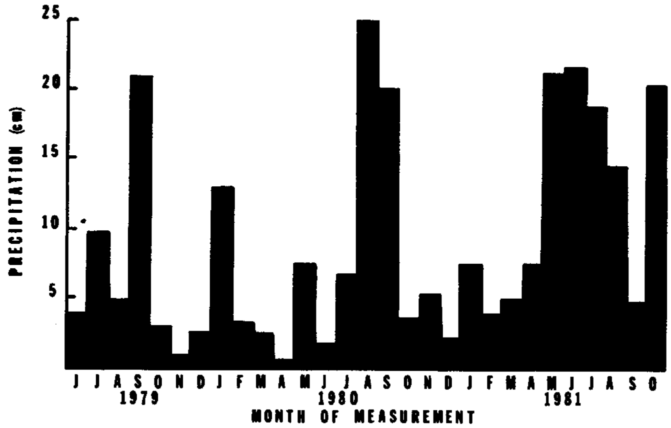

Fig. 2. *Monthly rainfall (cm) on the Rob and Bessie Elder Wildlife Refuge near Sinton, Texas during the period (June 1979-October 1981) that huisache responses to fire were monitored.*

CP, P and DOM Contents of Browse

Browse from huisache plants burned in 1979 contained significantly more CP in July, August, and October 1979 than did twig tips from adjacent unburned plants (Table 2). CP contents of browse on burned plants were significantly less in late November 1979 than in browse from unburned plants. Browse from huisache plants burned in 1979 also contained significantly more CP than did browse from unburned plants in June and August 1980. Increases in CP content of browse from burned plants, compared to unburned plants generally coincided with peaks in rainfall. There apparently was not adequate time for plants to utilize moisture from rains (3.1 cm) on May 18 before the May 20, 1980 sampling date. Plants sampled on June 20, 1980 had received 8.41 cm of rainfall during the 11 days prior to sampling.

New growth on huisache in the pasture burned in February 1980 and on an adjacent unburned area was initiated between March 1 and April 12. The CP contents of browse were greatest the first month following initiation of growth, then declined in both the burned and unburned plants until August 1980 (Table 2). Crude protein contents were greater in browse from burned than from unburned huisache plants until midsummer. No precipitation fell in July 1980, nullifying differences in CP contents of browse from

Table 2. Mean crude protein, phosphorous and in vitro digestible organic matter contents (%) of browse from huisache after burning in February 1979 or 1980 and from unburned plants, and the amount of precipitation received since last sampling period on the Rob and Bessie Welder Wildlife Refuge near Sinton, Texas.[1]

Collection date	Crude protein (%)				Phosphorus (%)				Digestible organic matter (%)				Precipitation received (cm)
	1979		1980		1979		1980		1979		1980		
	Burned	Unburned	Burned	Unburned	Burned	Unburned	Burned	Unburned	Burned	Unburned	Burned	Unburned	
1979													
July 6	27 a	23 bc	—	—	0.54 a	0.29 de	—	—	51 a-c	51 a-c	—	—	8.3
Aug. 8	24 bc	19 e-g	—	—	0.39 b-d	0.28 ef	—	—	53 ab	53 ab	—	—	6.1
Sept. 16	24 bc	23 bc	—	—	0.35 cd	0.29 de	—	—	57 a	51 a-c	—	—	17.1
Oct. 7	25 b	17 g	—	—	0.39 b-d	0.21 e-g	—	—	52 ab	47 b-e	—	—	15.7
Nov. 26	12 i	15 h	—	—	0.18 fg	0.24 ef	—	—	34 g	37 fg	—	—	2.8
1980													
Apr. 12	—	—	32 a	23 c	—	—	0.65 a	0.28 cd	—	—	48 b	49 b	2.2
May 20	19 e-g	17 g	26 b	21 d	0.31 de	0.38 b-d	0.50 b	0.25 c-e	47 b-e	42 d-f	47 b	47 b	7.2
June 20	22 c-d	18 fg	20 d	17 e	0.45 ab	0.34 d	0.40 bc	0.16 de	49 b-d	51 a-c	38 c	43 bc	5.3
July 12	20 ef	19 e-g	17 e	16 e	0.35 cd	0.30 de	0.33 c	0.29 cd	44 c-f	47 b-c	48 b	48 b	0
Aug. 16	23 bc	21 de	24 c	23 c	0.54 a	0.46 ab	0.36 bc	0.27 cd	57 a	50 a-c	58 a	58 a	25.5
Sept. 13	11 i	13 i	13 f	13 f	0.12 g	0.12 g	0.12 e	0.16 de	40 e-g	42 d-f	46 bc	44 bc	2.1

[1]Means followed by the same letter within a nutrient and year of treatment are not significantly different (α=.05) Duncan's multiple range test.

burned, compared to unburned plants. A high amount of rainfall occurred during the first part of August 1980, and CP contents of browse from both burned and unburned plants increased significantly, compared to the July sampling. However, CP contents of huisache browse from the area burned in February 1980 did not differ with that from unburned areas as it had in 1979.

Variation in P contents of huisache browse after burning followed the same pattern as with CP contents, with browse from burned areas generally containing more P than browse from unburned areas when rainfall was not limiting (Table 2). Average percentage of P during the second growing season of browse from burned plants was significantly greater than in unburned plants only during the June 1980 sampling period. Concurrent with precipitation in August 1980, the P contents increased significantly in both burned and unburned browse, compared to that of the previous month, but there was no difference in P contents between burned and unburned plants.

Digestible organic matter contents of huisache browse ranged from 58% during the growing season to 34% at the end of the growing season but varied with amount of precipitation (Table 2). DOM contents of browse from burned and unburned plants never differed by more than 7% within sampling dates, and differences were not significant (α=.05).

Table 3. Percentage of available twigs browsed within enclosures on various dates after burning individual huisache plants in August 1979 on the Rob and Bessie Welder Wildlife Refuge near Sinton, Texas.

Date of measurement	Enclosure type[1] None, unburned	None burned	Single,[2] burned	Double,[2] burned
1979				
September	77 b-e	77 b-e	33 i-l	7 m
October	77 b-e	47 g-h	21 k-m	16 lm
November	85 a-e	79 b-e	65 c-f	61 d-h
1980				
April	91 ab	36 i-k	41 h-k	58 e-h
May	50 f-i	63 d-f	21 k-m	28 j-l
June	93 ab	44 g-j	80 a-d	75 b-e
July	62 d-h	75 b-e	61 d-h	62 d-h
August	65 c-f	41 h-k	42 h-j	47 g-j
September	98 a	99 a	99 a	99 a

[1]Means followed by the same letter are not significantly different (α=.05) Duncan's multiple range test.

[2]Single=large browsers excluded; double=large browsers, large rodents and lagomorphs excluded.

Huisache Browse Utilization

Apparent use of huisache by large rodents and lagomorphs (single enclosure) during the month following burning was greater than the proportion of new growth apparently used by insects and small rodents (double enclosure) (Table 3). After the first month, however, there were no differences in percentage of browse removed from the two enclosure types.

During the second growing season following burning, height of most twigs (>48 cm) within the enclosures suggests that insects instead of rodents or lagomorphs were primarily responsible for twig utilization. The insect occurring most often on huisache was the leaf-footed bug *(Mozena obtusa)* which sucks sap from plants (Hewitt et al. 1974). Leaf-footed bugs were seed feeding on terminals of growing twigs, and their feeding generally killed twig tips. No insects were seen feeding on mature (lignified) branch parts.

Greatest utilization by large browsers occurred during the first 2 months following burning of huisache plants (Table 3). Differences in use of huisache browse between the enclosure types were insignificant during the 1980 growing season. Browse utilization during the 1980 growing season may have been confounded with damage by low temperatures. Unbrowsed twig tips were frozen and dropped during the winter, causing them to appear browsed.

Regrowth heights of burned, unprotected plants tended to be suppressed but not significantly, when compared to that of plants in single and double enclosures. The addition of browsing of large animals also caused a significant increase (α=.05) in numbers of basal sprouts on burned plants. The burned unprotected plants averaged 10 sprouts while protected plants averaged 6 or 7 stems by September 1980.

Burned huisache plants produced more than 100 "browsable" twigs each during the study period while unburned plants produced an average of 18 twigs each. Average air-dry weight of a "browsable" twig tip from burned and unburned huisache plants was 0.04 g. Thus, an average huisache plant burned in August 1979 produced about 5.5 times more usable browse than did an unburned plant by September 1980.

Management Implications

Although huisache may be top killed by burning at any season, essentially all the plants regrow to their preburn stature within two growing seasons. Single burns were evaluated in this study but there is no evidence that repeated burning would increase mortality.

Burning increases crude protein and phosphorus contents and availability of huisache browse. However the amount of usable browse produced by huisache is relatively low even after burning, and most heavy browse use occurs for a few months after the burns.

These results indicate that the primary use of prescribed fire for huisache management would be to prevent further development of stands. Maintenance of huisache stands in a particular state (canopy cover, density) can be achieved by burning at 2- to 3-year intervals. Because of huisache tolerance to fire, and since brush suppression is usually not the sole objective of prescribed burning, other management objectives such as improving botanical composition of the forage stand, increasing utilization of otherwise unpalatable species, and improved livestock distribution should be primary considerations for timing burns on Coastal Prairie.

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