Sand Sagebrush Response to Fall and Spring Prescribed Burns

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Abstract—Sand sagebrush (*Artemisia filifolia*) is a dominant shrub on sandy soils throughout the Great Plains and Southwest. Sand sagebrush is reported to reduce wind erosion and provides valuable forage and cover to numerous wildlife species. However, the fire ecology of sand sagebrush is not well understood. Our objectives were to evaluate fire-induced mortality, occurrence of resprouting, and changes in sand sagebrush canopy structure and total non-structural carbohydrates (TNC) following fall and spring prescribed burns. We selected twelve 4-ha plots on sand sagebrush-dominated sites in high-seral sand sagebrush-mixed prairie near Woodward, OK. Four plots were burned during fall, four were burned during spring, and four served as controls. Soil temperature and soil water content were monitored. About 93 percent of burned shrubs resprouted and TNC was similar across burning treatments. Canopy volume in May was reduced 87 and 99 percent by fall and spring burns, respectively. Fall burning had no effect on soil water content and elevated soil temperature only during April and May. Spring-burned plots had greater soil water content and higher soil temperatures than control plots in May.

Introduction

Sand sagebrush (*Artemisia filifolia*) is a dominant climax shrub on sandy soils from South Dakota through northern Mexico and eastern Nevada through western Oklahoma. Sand sagebrush has high potential for reducing wind erosion (Hagen and Lyles 1988) and provides valuable forage for numerous wildlife species and occasionally livestock. The shrubs also provide important nesting and protective cover for lesser prairie chickens (*Tympanuchus pallidicinctus*) and other upland game birds (Cannon and Knopf 1981). However, the ecological impact of burning sand sagebrush is not well documented. Sand sagebrush has been classified as both a sprouter (Wright and Bailey 1982) and a non-sprouter capable of recolonizing disturbed sites with abundant seedlings (Sosebee 1983; Wright 1972; Wright and Bailey 1980). Numerical data are lacking to support either hypothesis. Our objectives were to evaluate the effects of fall and spring prescribed burns on (1) fire-induced mortality and occurrence of resprouting in sand sagebrush, (2) canopy structure, (3) total non-structural carbohydrate (TNC) trends, (4) soil water content, and (5) soil temperature.

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Methods and Materials

Study Area

The study was located on the Hal and Fern Cooper Wildlife Management Area, 15 km northwest of Woodward, OK (36° 34' N, 99° 32' W, elevation 640 m). The area consists of sandhills in a high seral stage of the sand sagebrush-mixed prairie vegetation type. The climate is continental with 602 mm average annual precipitation, 70 percent of which occurs during the April to September growing season. The study was conducted on deep sand ecological sites. Soils were Pratt loamy fine sands (mixed, mesic, Psammentic Haplustalfs) with no limiting layers of clay in the top 150 cm. The woody plant community is strongly dominated by sand sagebrush, with lesser amounts of Chickasaw plum (*Prunus angustifolia*). Dominant grasses include little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), sand bluestem (*Andropogon hallii*), and sand lovegrass (*Eragrostis trichodes*). Western ragweed (*Ambrosia psilostachya*), sand lily (*Mentzelia nuda*), and annual buckwheat (*Eriogonum annuum*) were prominent forbs at the time of the study.

Methods

We selected twelve 4-ha plots on sand sagebrush-dominated sites. Twenty shrubs in each plot were marked with rebar stakes, and canopy height, area, and volume were measured in November. Four plots were burned during fall (16 November 1999), four were burned during spring (17 April 2000), and four served as controls. Resprouting and canopy structure of marked plants were reevaluated in May 2000. Roots located below the bud zone were collected from five shrubs per burn treatment each month. Total nonstructural carbohydrates were measured colorimetrically (absorbance at 612 nm) with an anthrone reagent (Murphy 1958) and glucose as a standard. Soil water was determined gravimetrically from five soil cores taken monthly to 15- and 30-cm depths at each plot. Five mid-day soil temperature readings were recorded monthly from each plot at 7.5 and 22.5 cm below the soil surface.

Differences in TNC, resprouting, and canopy structure among burn treatments were determined with t-tests. Soil water content and soil temperature were analyzed with analysis of variance. The model contained terms for burn treatment, sampling depth, month (as a repeated measures effect), and their interactions. Where differences occurred, means were separated by the least significant difference. Unless otherwise noted, an alpha level of 0.05 was used for all hypothesis testing.

Results

Fire-induced mortality was less than 10 percent for fall and spring burns (table 1). Sand sagebrush on fall-burned plots began resprouting in March, a full month after bud break on non-burned shrubs. Shrubs in spring-burned plots initiated resprouting in May. However, TNC concentration was similar among burn treatments except during January (fig. 1). The primary effect of fire on sand sagebrush was the alteration of canopy structure (table 1). Fall burns reduced shrub height by nearly 50 percent, and canopy area and volume by more than 75 percent. The same shrub canopy measures were reduced more than 90 percent by spring burns.

Soil water content and soil temperature were similar among burn treatments from December through March. Soil water was unaffected by sampling depth, but soil temperature was 2.3 °C warmer at 7.5 cm than at 22.5 cm. Spring-burned plots had greater soil water content across sampling depths than fall-burned or control plots in May (table 2). Fall burning increased soil temperature by about 17 percent in April and May. Spring burns increased soil temperature by 16 percent in May.

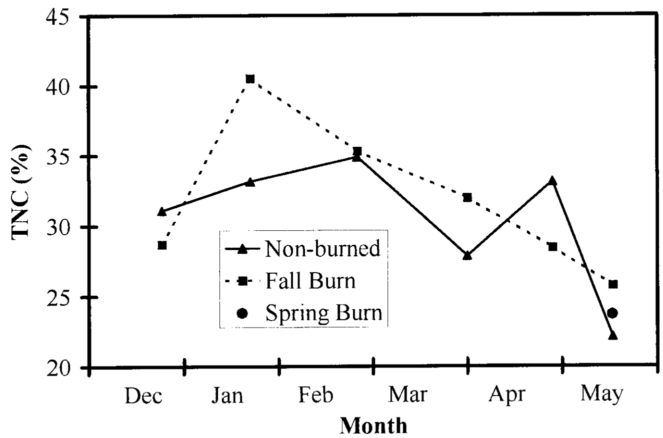

Figure 1—Monthly percent total nonstructural carbohydrates of sand sagebrush roots from non-burned, fall-burned, and spring-burned shrubs.

Discussion

Sand sagebrush resprouts profusely following fall and spring burns, seemingly without any negative effects on carbohydrate reserves. Applying prescribed fire to sand sagebrush communities does not appear to be a viable option for reducing shrub density, unless delayed mortality occurs due to additional stresses, such as infestation by insects. Prescribed fire may be a useful tool for reducing sand sagebrush canopy height and volume and potentially making resources, such as light and water, available to more desirable grasses and forbs. Higher spring soil temperature can be expected on burned sites if non-burned sites are shaded by the plant canopy or sufficiently covered with mulch. We believe soil temperatures were likely similar over the winter because the lack of insulating plant material on burned sites allowed solar heat captured during the day to escape more readily at night. Similarly, increased evaporation rates on unprotected soils of burned sites may negate gains in soil water content from reduced canopy interception. Differences in soil water content occurred when the

Table 1—Percentage of sand sagebrush plants resprouting in May after fall and spring burns and percent reduction in canopy structure.

Burn season	Resprouting	Canopy height	Canopy area	Canopy volume
	Percent	*- - - - - - - - - - -*	*Percent reduction*	*- - - - - - - - -*
Fall	94 a[1]	49 a	76 a	87 a
Spring	92 a	90 b	95 b	99 b

[1]Means followed by different letters within columns are different at alpha = 0.05.

Table 2—May soil water and soil temperature in non-burned, fall-burned, and spring-burned plots.

		Soil temperature (°C)	
Burn treatment	Soil water (percent)	7.5 cm depth	22.5 cm depth
Control	2.2 a [1]	22.6 a	16.4 a
Fall	2.0 a	27.2 b	18.5 b
Spring	3.1 b	25.9 b	19.3 b

[1]Means followed by different letters within columns are different at alpha = 0.05.

dominant plants began active seasonal growth. We suggest the reduced soil water content on fall-burned and non-burned sites was a reflection of their higher live plant cover.

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