

Effects of Growing-Season Prescribed Burning on Vigor of the Noxious Weed *Sericea Lespedeza (Lespedeza cuneata)* in the Kansas Flint Hills

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Introduction

Sericea lespedeza (SL) was introduced into the United States from Asia in the late 19th century. Early land managers recognized that SL was adaptable; tolerant of shallow, acidic or low-fertility soils; and resistant to insects and disease. This combination of traits made SL a widely-used plant for reseeding strip-mined lands, highway right-of-ways, dams, and waterways in the US for nearly a century.

Regrettably, SL is highly fecund. Individual plants are capable of producing up to 850 lb of seed per acre annually. Vigorous seed production allows SL to rapidly infiltrate native grasslands that are adjacent to reseeding projects; seed can be transported great distances via the alimentary canal and hair of wild and domestic herbivores. In Kansas alone, SL has infested approximately 980 square miles of pasture, primarily in the Flint Hills region. The resulting damage to native habitats for wildlife and pasture quality for domestic herbivores has been devastating.

The predominant grazing management practice in the Kansas Flint Hills involves annual spring burning in March or April, followed by intensive grazing with yearling beef cattle for a relatively short period from April to August. During seasonal grazing, 40 to 60% of annual graminoid production is removed and grazing lands then remain idle for the remainder of the year. Under this prevailing management practice, invasion by SL into the Tallgrass Prairie biome has steadily increased. Oklahoma State University researchers speculated that dormant-season, spring fires may stimulate SL growth by scarifying seeds lying on the surface of the soil. In contrast, plants with robust canopies respond more strongly to growing-season prescribed burns than to dormant-season prescribed burns. Previous research reported that application of growing season fire at 3-yr intervals decreased the rate of SL invasion. Therefore, the objective of our study was to evaluate the effects of growing-season prescribed burning of native tallgrass range on vigor of *sericea lespedeza*.

Key words: *sericea*, cattle, burning

Experimental Procedures

A 125-acre native tallgrass pasture located in Geary Co., KS was used for our study. The site was historically grazed during the winter and spring by beef cattle; moreover, the infestation of sericea lespedeza on the site was problematic for the 20-year period preceding our study. Escort XP (E. I. du Pont de Nemours & Co., Wilmington, DE) was flown onto the site in the fall of 2013 at a rate of 1 ounce per acre. In spite of herbicide treatment, canopy frequency of SL was approximately 36% the following spring.

The study site was divided along watershed boundaries into nine fire-management units (12 ± 6 acres). Unit boundaries were delineated by mowing firebreaks (approximately 20 feet wide) around each perimeter. Units were assigned randomly to one of three prescribed-burning times ($n = 3/\text{treatment}$): early spring (April 1; CONTROL), mid-summer (July 30; EARLY), or late summer (September 1; LATE). Prescribed burns were carried out on or near target dates when appropriate environmental conditions prevailed: surface wind speed = 5 to 12 mph; surface wind direction = steady and away from urban areas; mixing height greater than 1800 feet; transport wind speed = 8 to 20 mph; relative humidity = 40 to 70%; ambient temperature = 55 to 80 °F; and Haines index 4 or less. All prescribed burning activities were carried out with the permission of Geary Co. Emergency Services, Junction City, KS (permit no. 348).

Forage biomass, SL frequency, SL maturity, and SL stem height were measured along a single, permanent 100-yard transect in each fire-management unit ($100 \times 12\text{-in}^2$ plot points/transect). Transects were laid out on a southwest-to-northeast gradient; transect ends were marked using steel fence posts. Transects were read on July 10, August 4, September 4, and October 14. A 100-yard measuring tape was stretched from the southwestern end to the northeastern end of each transect. At 3-foot intervals along each transect, biomass was measured using a visual obstruction technique. In addition, a $12 \times 12\text{-in}$ plot was projected on the eastern side of transects at each point of measurement. Within the plot, presence of SL was noted (e.g., yes or no). If SL was present, stem height and crown maturity of the SL plant closest to the 3-foot interval on the measuring tape was recorded. Stem height was measured in inches from the surface of the soil to its maximum length by manually holding the SL stem erect. Crown maturity was evaluated visually; SL plant crowns containing any senescent material were judged to be old growth (at least 1 year old), whereas SL plant crowns without evidence of senescence were judged to be new growth (less than 1 year old).

A total of 100 mature SL plants were collected adjacent to permanent transects in each burn-management unit immediately after the first killing frost (approximately November 1). Plants were clipped at ground level and placed into a labeled paper bag. Bagged samples were dried using a forced-air oven. Individual plants in each sample were defoliated by hand. Resulting seeds, chaff, and stems were separated using a South Dakota Seed Blower (E.L. Erickson Products, Model B; 4-inch tube). The total amount of seed recovered from each sample was weighed to the nearest milligram. Seed weight was converted to seed count, assuming a density of 770 seeds/gram. Average seed production was calculated by dividing the number of seeds by the number of SL plants in each sample ($n = 100$).

Results and Discussion

Forage biomass, SL canopy frequency, SL crown maturity, and SL stem height were influenced by treatment and measurement date (treatment \times time, $P \leq 0.01$; Table 1). Forage biomass was not different ($P \geq 0.77$) between treatments on July 10. As expected, forage biomass in each treated unit decreased immediately following fire application. Forage biomass decreased ($P \leq 0.03$) in EARLY compared to CONTROL and LATE on August 4 but recovered ($P \geq 0.18$) relative to its pre-fire levels when measured on September 2 and October 14. Forage biomass in LATE on September 2 was less ($P < 0.01$) than that in CONTROL or EARLY on September 2; moreover, CONTROL had greater ($P < 0.01$) forage biomass than EARLY at that time. Forage biomass on LATE tended to recover ($P = 0.09$) to its pre-fire level by October 14. All burn management units had greater than 1,900 lb of forage dry matter per acre before seasonal plant dormancy occurred. We concluded that post-fire regrowth was likely sufficient to prevent erosion and soil-moisture loss during the dormant season.

Canopy frequency of SL was not different ($P \geq 0.61$) between treatments on July 10 (Table 1). In general, occurrence of SL in plant canopies decreased immediately after application of fire. Canopy frequency of SL decreased ($P \leq 0.04$) in EARLY compared to CONTROL and LATE on August 4 and was still less ($P = 0.05$) than CONTROL on September 2. Conversely, SL canopy frequency in EARLY recovered ($P = 0.78$) to pre-fire levels by October 14. The LATE treatment had SL canopy frequency that was not different ($P \geq 0.61$) from CONTROL on July 10 or August 4; however, SL canopy frequency in LATE was less ($P \leq 0.04$) than CONTROL on September 2 and October 14. Canopy frequency of SL in LATE did not recover ($P = 0.19$) to pre-fire levels by October 14.

Crown maturity of SL and mean SL stem height were not different ($P \geq 0.26$) between treatments on July 10 (Table 1). Fire appeared to sharply reduce the number of old-growth SL crowns and mean height of SL over time. Percentage of old-growth SL crowns was less ($P < 0.01$) in EARLY and LATE compared to CONTROL on October 14. Height of SL stems in LATE and EARLY was less ($P \leq 0.05$) than that in CONTROL on October 14.

Whole-plant dry matter weight of SL at dormancy, total seed weight per SL plant, and seed production per SL plant were greatly diminished ($P < 0.01$) in EARLY and LATE compared with CONTROL (Table 2). Seed production in areas treated with mid-summer fire was less than 3% of that in areas treated with dormant-season spring fire. In areas treated with late-summer fire, seed production was 0.01% that of areas treated with dormant-season fire. We interpreted these data to indicate that prescribed burning during the growing season had only transient effects on SL canopy frequency. In contrast, growing-season prescribed burning had strong suppressive influences on vigor and reproductive capabilities of individual SL plants.

Implications

Compared to traditional spring, dormant-season burning, burning during the summer months resulted in significant decreases in seed production by SL. Growing-season prescribed burning may be an inexpensive and fairly comprehensive means to control

sericea lespedeza propagation. At the time of this writing, prescribed burning in the Kansas Flint Hills had a cash cost of less than \$1 per acre, whereas fall application of herbicide was estimated to cost between \$10 and \$20 per acre. It is unknown at this time how forage species composition, soil cover, forage biomass, and sericea lespedeza will respond when growing season burns are applied in consecutive years. This manuscript presents results of year 1 of a 4-year experiment.

Table 1. Effects^{*} of growing-season prescribed burning of native tallgrass range on forage biomass and canopy frequency, crown maturity, and stem height of sericea lespedeza (SL; *Lepedeza cuneata*)

Evaluation date	Prescribed-burn timing	Forage biomass, kg DM/ha	Plant canopies containing SL, % of total	SL canopies with old-growth crowns, % of total	SL stem height, in
07/10	Early spring (04/01)	3,537 ^a	41.3 ^a	88.5 ^a	7.3 ^a
	Mid-summer (07/30)	3,713 ^a	35.0 ^a	69.5 ^a	5.6 ^a
	Late summer (09/01)	3,282 ^a	32.3 ^a	82.1 ^a	6.7 ^a
08/04	Early spring (04/01)	2,702 ^a	47.7 ^a	93.7 ^a	9.1 ^a
	Mid-summer (7/30)	281 ^b	1.7 ^b	0 ^b	0.3 ^b
	Late summer (09/01)	2,342 ^a	40.0 ^a	79.7 ^a	7.1 ^a
09/02	Early spring (04/01)	9,246 ^c	54.0 ^a	73.7 ^a	9.7 ^a
	Mid-summer (07/30)	2,331 ^a	17.0 ^b	1.1 ^b	0.6 ^b
	Late summer (09/01)	114 ^b	0 ^b	0 ^b	0 ^b
10/14	Early spring (04/01)	9,148 ^c	47.3 ^a	67.0 ^a	8.0 ^a
	Mid-summer (07/30)	3,311 ^a	30.0 ^{a,b}	0 ^b	1.6 ^b
	Late summer (09/01)	1,754 ^a	8.7 ^b	0 ^b	0.3 ^b
	SE [†]	872.2	17.46	16.26	3.35

^{*}Treatment × time ($P < 0.01$) for all dependent variables.

[†]Mixed-model SE for means within a column.

^{a,b,c} Means within a column with unlike superscripts are different ($P \leq 0.05$).

Table 2. Effects of growing-season prescribed burning of native tallgrass range on whole-plant DM weight and seed production by sericea lespedeza (SL; *Lespedeza cuneata*) as measured immediately following a killing frost

Item	Early spring burn (April 1)	Mid-summer burn (July 30)	Late-summer burn (September 1)	SE ^c	P-value
Whole-plant dry matter weight, mg/plant	1,775 ^a	312 ^b	138 ^b	328.8	< 0.01
Total seed weight, mg/plant	374.3 ^a	9.7 ^b	<i>tr</i> ^b	70.98	< 0.01
Number of seeds per plant	287.7 ^a	7.4 ^b	0.03 ^b	54.62	< 0.01

^c Mixed-model SE for means within a row.

^{a,b} Means within a row with unlike superscripts are different ($P \leq 0.05$).