Manipulating Sandpaper Oak for Livestock and Wildlife Forage

Circular 663

Samuel T. Smallidge, Sid Goodloe, Terrell T. "Red" Baker, M. Karl Wood, Richard E. Estell[1]

Cooperative Extension Service • College of Agricultural, Consumer and Environmental Sciences

INTRODUCTION

Oak brush (*Quercus* spp.) is a common plant in the mountains and foothills of the Southwest. Entrepreneurial land managers and livestock producers are interested in oak brush management strategies that will benefit livestock and wildlife. It has been hypothesized that oak brush can be manipulated to improve forage quality for livestock as well as for deer (*Odocoileus* spp.) and elk (*Cervus elaphus*). Specifically, mowing or burning may improve its nutritional quality by reducing plant characteristics (e.g., tannins and phenolics) known to reduce palatability and digestibility. Mowing may be a more feasible approach in the Southwest since burning is frequently limited by liability concerns and narrow prescribed burn windows due to weather and fuel load conditions.

Figure 1. **Cattle foraging in a mowed oak stand on Carrizo Valley Ranch, NM.**

Cattle and deer have been observed foraging on sandpaper oak (*Quercus pungens*) in the late spring to early summer (May–June) in the south-central montane region of New Mexico (Figure 1). Thetford et al. (1971) reported that oak made up 20% of spring cattle diets in south-central New Mexico, while Pfister et al. (1984) reported that oak was an important part of cattle diets in fall and winter in this same area. Spring is typically a dry time of year on New Mexico ranches, and new oak growth (Figure 2) appears to be palatable and nutritious compared to decadent forage. The possibility that sandpaper oak could serve as a valuable source of nutrition and feed during spring deserves further investigation. Our objective was to determine the effects of using spring and fall mowing to manipulate sandpaper oak nutritional quality and palatability indicators for livestock and large mammal wildlife species (Figure 3).

STUDY SITE

All work was conducted on the Carrizo Valley Ranch (CVR) located approximately 17 miles northwest

[1]Respectively, Extension Wildlife Specialist, Department of Extension Animal Sciences and Natural Resources, New Mexico State University; Proprietor of Carrizo Valley Ranch; Chair, Department of Forestry, University of Kentucky; Emeritus Professor, New Mexico State University; and Research Animal Scientist, Jornada Experimental Range, USDA Agricultural Research Service.

of Capitan, NM. Elevation of the ranch is 6,000 to 7,500 ft. The site was located in the piñon-juniper (*Pinus* and *Juniperus* spp.)/ponderosa pine (*P. ponderosa*) transition zone with interspersed grasslands. Large established stands of sandpaper oak were common. Annual precipitation is 19 inches, with the majority falling during the monsoonal summer months (July–September). The period from May to June is historically warm and dry.

METHODS

Oak Manipulation and Sampling: Three different pastures were selected in July 2008. Each pasture was then subdivided into three 60-by-300-ft plots and randomly assigned one of three treatments: control, growing season mow (growing-mow), and dormant season mow (dormant-mow). We were unable to apply a prescribed fire treatment because weather patterns and state and county burn bans prevented its use.

Newly sprouted (young) and mature sandpaper oak leaves were collected at the same time along the entire length of each plot and placed in separate paper bags to constitute one composite sample for each leaf age class. Leaf samples were analyzed for dry matter, crude protein, and lignin by SDK Laboratories in Hutchinson, KS. Unused portions of ground samples were used to determine condensed tannin and total phenolic content in the laboratory of Dr. Richard E. Estell, Research Animal Scientist, USDA Agricultural Research Service.

Data Analysis: Means and 95% confidence intervals were calculated for each treatment and leaf age class grouping, and were used for means separation (Ramsey and Shafer, 2002).

RESULTS AND DISCUSSION

Mowing appeared to affect crude protein and lignin contents of young oak leaves (Table 1). Crude protein was generally higher in young leaves of the mowed treatments when compared with the control. There was no difference in crude protein between dormant-mow and growing-mow treatments within leaf age class. Mature leaves did not differ in crude protein content among treatments. Although there was considerable overlap in the estimates, crude protein was higher in young oak leaves of mowed plots. New growth of mowed oak brush could represent an important protein source for cattle, elk, and deer during certain times of the year. A trade-off for cattle is that oak contains lignin and tannins that reduce digestibility, digestive action, and protein intake and may be toxic at high intake levels. Deer would not be affected by tannin content and would benefit from the higher protein content of the young leaves; elk would likely benefit similarly. We also observed more available new growth in plots that had been mowed compared to control plots.

Figure 2. **New leaf sprout on sandpaper oak branch.**

Lignin content of young oak leaves differed between the control and dormant-mow treatment; growing-mow data were inconclusive (Table 1). Lignin content of mature oak leaves differed among treatments; it was lowest in the dormant-mow and incrementally increased in the growing-mow and control treatments. The dormant-mow treatment had the lowest lignin content for young and mature leaves. Lignin is essentially indigestible by rumi-

Figure 3. **Oak brush was mowed to stimulate shoot production on the Carrizo Valley Ranch in south-central New Mexico.**

nants (Van Soest, 1994), and higher percentages in forages decrease digestibility. Lignin content in leaves tends to increase as the growing season progresses.

Although crude protein and lignin contents of leaves were positively affected by mowing, condensed tannins and hydrolysable tannins (partially represented by total phenolics) could potentially offset these benefits. Condensed tannins (CT) and total phenolics (TP) are displayed by sample collection date because timing in the growing season affected their concentration (Table 2). As expected, young leaves had lower concentrations of CT than mature leaves because concentrations typically increase as the growing season progresses. Concentrations of tannins should be viewed within year since they vary from year to year. Although typically not toxic, CT binds with proteins and may lower protein availability as well as reduce digestive action. As CTs accumulate their astringency increases, reducing palatability of leaves.

Estimated TP was highly variable within sample date, treatment, and leaf age class (Table 2). Estimates of TP include condensed and -hydrolyzable tannins as well as many other phenolic compounds. Concentrations of TP were higher in young than mature leaves within treatment and sample date for 2008. This pattern could not be conclusively determined for 2009. The highest estimated concentration of TP was about 22% for young leaves in the dormant-mow sample taken in May of 2009. Hydrolyzable tannins break down into their constituent phenolics and sugars, making them more readily absorbed by a ruminant's digestive tract. These phenolics can cause poisoning in animals that do not produce tannin-binding proteins in their saliva.

Leaf and bud tannin concentrations responsible for oak poisoning in cattle are typically greatest

Table 1. Mean Crude Protein and Lignin Content for Young and Mature Leaf Samples

Treatment	Leaf Age Class	*n*	95% CI[a] Lower	Crude Protein (%)	95% CI Upper	95% CI Lower	Lignin (%)	95% CI Upper
Control	young	12	10.11	12.62	15.13	7.59	8.61	9.63
	mature	9	11.50	12.14	12.78	10.61	11.49	12.37
Dormant-mow	young	9	12.80	14.53	16.26	4.33	4.97	5.61
	mature	3	11.29	12.39	13.49	7.20	8.09	8.98
Growing-mow	young	10	12.11	14.22	16.33	4.82	6.96	9.10
	mature	6	11.49	12.37	13.25	9.18	9.99	10.80

[a]CI = confidence interval

early in their growth during sprouting (Cheek and Shull, 1985). Deer do not appear to get oak poisoning because of tannin-binding proteins in their saliva (Austin et al., 1989); this may also be true for elk, although it has not been studied (Cook, 2002). As leaves mature, condensed tannin concentrations increase and hydrolyzable tannin concentrations decrease. This may affect livestock management because oak brush is often favored forage early in the spring before cool-season grasses become accessible. Shinnery oak (*Quercus havardii*) in southeast New Mexico is closely associated with oak poisoning and is an ongoing concern for ranchers (Vermeire and Wester, 2001). All oak species appear to be capable of poisoning livestock. Poisoning is often seasonal; animals eat buds and leaves in spring and acorns in the fall (Cheeke and Shull, 1985). Oak poisoning is not common on lightly to moderately grazed ranges with adequate plant diversity or when it does not make up a large portion of the diet. Regardless, checking your cattle often when they are on oak rangelands is recommended.

Poisoning typically affects cattle that have been eating large amounts of oak forage for as little as 2 to 3 days to a week or longer (Cheeke and Shull, 1985; Burrows and Tyrl, 2001). Listlessness, constipation with blood, clear nasal discharge, excessive thirst, no desire to forage, and lack of rumen activity are early signs of oak intoxication but are easy to miss. More noticeable symptoms appear with continued exposure, including diarrhea that is often thin, dark, and possibly bloody; dehydration; colic; frequent urination; rough hair coat; and accumulation of fluid under the skin of the neck, brisket, abdomen, and perineum (Burrows and Tyrl, 2001).

Oak made up 20% of cattle diets in spring (Thetford et al., 1971) and was important to cattle diets during the fall and winter in south-central New Mexico (Pfister et al., 1984). Cattle diets comprised up to 50% oak in Arizona without clinical signs of poisoning (Ruyle et al., 1986). Cattle have relied on oak almost exclusively at times on the CVR without signs of poisoning and appeared to thrive under those conditions (Sid Goodloe, personal communication, 2009). Early in the fall, crude protein content was higher in young and mature leaves of mowed oak when compared to grass samples collected on the same date (Table 3). Grass in spring, prior to green up, will have low protein content (below 5%; Pieper et al., 1978), and cattle may be attracted to and benefit from protein-rich oak browse at that time. Deer and elk benefit from increased quantity, quality, and availability of oak forage as well. Oak on CVR represents important forage for cattle at times of the year when little else is green, and oak protein content is greater than herbaceous forages at times when it is utilized without apparent negative effects from oak tannins.

In fall, deer need to accrete fat before the winter and rut. Elk also rut in the fall and may benefit from more protein in their diets. Pieper et al. (1978) collected grass samples near Capitan, NM, and reported September protein contents for blue grama (6.2%) and sideoats grama (5.7%). These estimates were similar to those collected on the CVR in 2009. Grasses listed in Table 3 are abundant and well distributed among the pastures on the CVR. Mowing oak brush improved growth and availability of grasses within oak shrub stands and may have increased herbaceous forage intake along with oak forage.

Table 2. Mean Condensed Tannin and Total Phenolics Estimates for Young and Mature Leaf Samples

Sample Date	Treatement Category	Leaf Age Class	*n*	95% CI Lower[a]	Mean Condensed Tannins (mg/g)	95% CI Upper	95% CI Lower	Mean Total Phenolics (mg/g)	95% CI Upper
June 2008	control	young	3	--	4.96	12.303	97.430	152.68	207.920
Sept. 2008	control	young	3	15.419	45.50	75.574	141.854	162.93	184.005
May 2009	control	young	3	--	2.66	6.150	115.076	165.57	216.056
July 2009	control	young	3	23.634	41.77	59.899	81.460	101.35	121.242
June 2008	control	mature	3	1.780	3.05	4.319	78.721	84.12	89.526
Sept. 2008	control	mature	3	26.936	52.16	77.385	113.188	133.27	153.354
July 2009	control	mature	3	4.626	30.19	55.755	104.791	116.53	128.278
June 2008	dorm-mow	young	3	1.624	4.05	6.485	146.014	175.77	205.532
May 2009	dorm-mow	young	3	--	7.96	27.261	192.437	219.31	246.180
July 2009	dorm-mow	young	3	--	16.73	34.493	9.881	133.86	257.844
July 2009	dorm-mow	mature	3	5.929	16.85	27.762	114.964	162.78	210.604
Sept. 2008	grow-mow	young	3	--	14.38	31.587	162.891	173.79	184.697
May 2009	grow-mow	young	3	1.674	2.68	3.688	141.115	175.49	209.859
July 2009	grow-mow	young	3	--	19.32	38.843	96.760	107.95	119.138
Sept. 2008	grow-mow	mature	3	5.851	31.22	56.580	120.351	134.84	149.323
July 2009	grow-mow	mature	3	15.519	20.73	25.941	94.979	132.14	169.298

[a]CI = confidence interval. Negative lower bounds were not reported because it is not possible to have negative tannin content.

SUMMARY

Mowing oak brush appeared to improve the quantity and availability of oak forage to wild and domestic herbivores. Cattle on CVR rely on sandpaper oak almost exclusively following dry winters. Mowing improved protein content and reduced lignin content of oak forage but resulted in increased concentrations of tannins in young leaves. Dormant season mowing may have produced slightly lower concentrations of lignin when compared to growing season mowing. There was no apparent difference in CT between dormant and growing season mowing. Concentrations of TP in growing season mow areas were generally less than dormant season mow areas, but only in 2009; no difference was detected in 2008.

Successfully using oak brush as forage for cattle requires a balance between increased protein content of oak leaves and the digestive inhibitors and plant toxins represented by condensed tannins and hydrolyzable tannins, respectively. Oak poisoning is unlikely on lightly to moderately grazed rangelands. Heavily grazed rangelands, or rangelands where oak makes up a large portion of the diet, greatly increase the possibility for oak poisoning. No signs of oak poisoning were observed in CVR cattle foraging on oak. Although we did not observe any symptoms, we did not specifically monitor cattle to determine if there was reduced digestive performance related to plant components. These phenomena deserve further study. Vegetation conditions on CVR were excellent, with a diverse community of abundant grasses that allowed cattle to benefit from oak forage.

Table 3. Estimated Crude Protein of Six Grasses Collected on September 10, 2008, at the Carrizo Valley Ranch, NM

Scientific Name	Common Name	Crude Protein (%)
Muhlenbergia wrightii	Spike muhly	5.52
Aristida spp.	Threeawn	6.25
Phleum spp.	Timothy	6.44
Bouteloua gracilis	Blue grama	7.29
Bouteloua curtipendula	Sideoats grama	8.13
Pascopyrum smithii	Western wheatgrass	10.68

Changes to the quality, quantity, and availability of oak forage represent a benefit to wild herbivores because deer (and likely elk) appear unaffected by oak tannins. Oak brush was left standing and interspersed among mowed sites to provide hiding cover for deer and elk. Elk are transient on the CVR and use it when they are not on high-elevation summer ranges. Deer reside on the CVR year-round and benefited from the varied vegetation structure. Acorns are important to deer and elk in the fall as well.

The following suggestions apply to land managers interested in utilizing oak brush as supplemental feed for cattle. Identify the species of oak intended

for forage. Ask your county Extension agent and neighbors if they are aware of oak poisoning problems in the area. Familiarize yourself with the symptoms of oak poisoning. Closely monitor your cattle for signs of oak poisoning. Start small and only mow a small area of oak. There was no clear benefit to dormant season versus growing season mowing, so mow when it is most convenient. Ensure that a variety of other herbaceous forages are available. Supplements containing 5 to 10% calcium hydroxide, activated charcoal, polyvinylpyrrolidone, and PEG appear to protect somewhat against dietary tannins (Burrows and Tyrl, 2001). Consider using a dietary supplement when your cattle are on oak brush rangelands to ensure you will not experience problems. If you suspect oak poisoning, take appropriate action immediately.

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Samuel T. Smallidge *is the Extension Wildlife Specialist at New Mexico State University. He has degrees in wildlife and range management. His Extension program focuses on wildlife damage management, wildlife enterprises, and wildlife ecology and management education for youth and adults.*

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