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Research Observation: Cattle preference for Lambert locoweed over white locoweed

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Abstract

White (*Oxytropis sericea* Nutt. in T.& G.) and Lambert (*O. lambertii* var. biglovii Pursh) locoweed grow adjacent to each other on the foothills of the Rocky Mountains from southeastern Wyoming to northeastern New Mexico. Lambert locoweed matures later and flowers about 3–4 weeks after white locoweed, thus potentially increasing the critical period of poisoning when livestock graze areas infested by both species. The objective of this study was to evaluate cattle consumption of these 2 species as they progress phenologically. In 1998, 15 Hereford cows grazed a 32 ha pasture infested with both species from the time white locoweed flowered in mid June until both species were mature and senesced in August. In 1999, 4 cows were placed in a 5 ha pasture infested with both species for 4 days in each of the following periods: (1) flower stage of white locoweed, (2) flower stage of Lambert locoweed, immature pod at white locoweed, (3) immature pod stage of Lambert locoweed, mature pod while (4) mature pod and seed shatter stage respectively. Diets were estimated by bite-count. Lambert locoweed was preferred over white locoweed in the season-long grazing trial in 1998, and in each of the 4 intensive grazing trials in 1999. The cows consumed white locoweed as availability of Lambert locoweed declined in 1998, but little white locoweed was consumed in the 4 intensive grazing trials in 1999. The toxic locoweed alkaloid swainsonine ranged from 0.04 to 0.06% in white locoweed, but was not detected in Lambert locoweed in this study.

Key Words: *Oxytropis lambertii, Oxytropis sericea*, poisonous plant, cattle grazing, swainsonine

Resumen

Las especies "white locoweed" (*Oxytropis sericea* Nutt en T.& G.) y "Lambert locoweed" (*Oxytropis lambertii* var. Biglovii Push) crecen adyecentes una de otra en las áreas de pie de monte de las montañas rocallosas desde el sudeste de Wyoming hasta el nordeste de New Mexico. "Lambert locoweed" madura más tarde y florece 3–4 semanas después que el "white locoweed", lo que incrementa potencialmente el período crítico de enveneamiento cuando el ganado apacienta áreas infestadas con ambas especies. El objetivo de este estudio fue evaluar el consumo de estas dos especies por el ganado conforme progresan fenológicamente. En 1998, 15 vacas Herford apacentaron un potrero de 32 ha infestado con ambas especies, apacentaron desde que el "white locoweed" floreció, a mediados de Junio, hasta que ambas especies maduraron y senescieron en Agosto. En 1999, 4 vacas fueron colocadas en un potrero de 5 ha infestado con ambas especies y permanecieron en el por 4 días en cada uno de los siguientes períodos: (1) etapa de floración del "white locoweed", (2) etapa de floración de "Lambret loco weed", (3) etapa de vainas inmadura de "Lambert locoweed" y (4) etapa de vainas maduras y caida de semilla de ambas especies. Las dietas se estimaron mediante el conteo de mordidas. En el ensayo de apacentamiento estacional de 1998 el ganado prefirió el "Lambert locoweed" sobre "white locoweed" y la misma respuesta se obtuvó en cada uno de los 4 ensayos de apacentamiento intensivo conducidos en 1999. Las vacas consumieron "white locoweed" conforme la disponibilidad de "Lambert locoweed" disminuyó en 1998, pero poco "White locoweed" fue consumido en los 4 ensayos de apacentamiento intensivo de 1999. En este estudio el alcaloide tóxico swainsonina que contiene el "Locoweed" varió de 0.04 a 0.06% en "white locoweed" y no fue detectado en "Lambert locoweed".

Locoweeds are the most wide-spread poisonous plant problem on western rangelands (Kingsbury 1964). White locoweed (*Oxytropis sericea* Nutt. in T.& G.; also known as silky crazyweed) is locally abundant on shallow rocky soils (Payne 1957) along the eastern foothills of the Rocky Mountains from Montana to northern New Mexico. It also occurs on mountain tops in the Great Basin and Colorado plateau. Lambert locoweed (*Oxytropis lambertii* var. biglovii Pursh; also known as Lambert crazyweed) occurs on sandy plains, sagebrush mesa and mountain sides from southern Wyoming southward along the foothills of the Rocky Mountains into New Mexico.

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The taxonomy of theses 2 species has been confusing. Marsh (1909) included both the white flowered (*O. sericea*) and the lavender flower (*O. lambertii*) in his description of the locoweed *Aragallus lambertii.* Later (Marsh 1919) he referred to the white locoweed as (*Astragalus lambertii*). Taxonomists have clearly separated the 2 species based on the color of their flowers (white to slightly yellow—*O. sericea*; purple violet or lavender—*O. lambertii*) and the dolabriform (ox head-like) pubescence that is unique to *O. lambertii* (Barneby 1952). Early toxicology research implicated both species in causing locoism.

Both species grow abundantly and adjacent to each other in southeast Wyoming and northcentral Colorado. However, they

differ in their phenology. White locoweed flowers in late May and early June, while Lambert locoweed flowers 3 weeks later in late June and early July. Grazing studies on short grass prairies of northeast New Mexico show that cattle readily graze white locoweed in the spring when it is green and growing rapidly and warm-season grasses are still dormant, but cease grazing it as it matures into the pod stage and warm-season grasses begin rapid growth in June (Ralphs et al. 1993, 1994, 1997). The later growing period of Lambert locoweed may cause additional management problems by extending the time cattle are likely to eat locoweeds into the summer grazing season. The objective of this study was to determine the amount of the 2 locoweed species grazed by cattle during their advancing phenological stages through the late spring and summer grazing season.

Methods

The study was conducted at the Colorado State University Research Foundation Maxwell Ranch, located 40 km north west of Fort Collins (40° 56' N, 105° 15' W). White locoweed was abundant throughout the area on sandy loam to gravely soils on gently sloping to steep ridges, while Lambert locoweed occurred on deeper loam soils in swales. Associated cool-season grasses included needleandthread (*Stipa comata* Trin. & Rupr.), bottlebrush squirreltail (*Elymus elymoides* Raf. Swezey), prairie June grass (*Koeleria macrantha* (Ledeb.) Schultes) and western wheatgrass (*Pascopyron smithii* (Rybd) A. Love). Warm-season grasses included blue grama (*Bouteloua grazilis* (H.B.K.) Lag. ex Steudel), and ring muhley (*Muhlenbergia torreyi* (Kwyth) M.E. Jones). Dominant forbs included penstemon ((*Penstemon glaber* Persh), geranium (*Geranium caespitosa* James), rose pussytoes (*Antennaria parvifolia* Nutt), fringed sage (*Artemisia frigida* Willd.), and other nontoxic *Astragalus* spp..

In 1998, fifteen 2-year old Hereford cows and their calves were used for the grazing study. They had been used in a locoweed grazing study during the previous 5 weeks. The cows were placed in a 32 ha pasture and grazed from 19 June to 30 July. This corresponded to the time that white locoweed was in full flower, through the flowering period of Lambert locoweed, until both species matured and pods ripened. White and Lambert locoweed were present in equal proportions, but neither were very abundant (Table 1).

Table 1. Standing crop of forage classes at the beginning and end of the grazing trials in 1998 and 1999.

Year	Time	Grass	Forb	White loco	Lambert loco	*Astragalus* spp.	Total
		(kg/ha)					
1998	Begin	457 ± 64	302 ± 58	14 ± 9	26 ± 25	—	800 ± 70
	End	452 ± 72	166 ± 19	0	6 ± 5	—	624 ± 61
1999	Begin	429 ± 66	153 ± 29	165 ± 66	86 ± 23	—-	833 ± 77
	End	219 ± 28	179 ± 25	50 ± 13	36 ± 13	37 ± 27	522 ± 65

Cattle diets were estimated using a bite count technique. Each cow was observed for 5 min periods during the morning and evening grazing periods. The number of bites of grass, forbs, white locoweed ,and Lambert locoweed were counted and their percentage of the diet calculated. Each cow was observed for 5 min, then the observer rotated to another cow, so that each animal was observed at least once during each morning and evening grazing period. The percentage of bites of white and Lambert locoweed were compared by paired t-tests.

In 1999, 4 of the cows were selected for intensive grazing trials corresponding to the phenological development of the 2 locoweed species. Cows were placed in a 5 ha pasture for 4 days in each of the following periods: (1) flower stage of white locoweed (8–11 June), (2) flower stage of Lambert locoweed and immature pod stage of white locoweed (28 June–1 July), (3) immature pod stage of Lambert locoweed and mature pods of white locoweed (20–23 July), (4) mature pods and seed shatter of both species (17–20 Aug). White locoweed occurred in a patch covering about 15% of the pasture along a ridge. Lambert locoweed covered about 30% of the pasture in deeper soils of a swale. Bite counts were taken as described above by 2 observers so that 5 to 10 observations were obtained on each cow during each morning and evening grazing period. The amount of white and Lambert locoweed in diets was compared by t-tests.

Between the intensive grazing trials, the cows were grazed with a larger group of cows (the remainder from the 1998 trial) in an adjacent pasture. White locoweed was locally abundant in this pasture, but Lambert locoweed, and the other Astragalus species were scarce. Bite counts were taken on this group of cattle periodically to monitor locoweed consumption throughout the summer in a free-ranging setting.

Standing crop was estimated by clipping twenty, 1 x 0.25 m quadrats placed systematically along transects running the length or breadth of the pastures in both years. The vegetation was separated into forage classes of: grasses, white locoweed, lambert locoweed, and other forbs; dried in a forced air oven at 60°C for 48 hours and weighed. The toxic alkaloid swainsonine was measured in composite samples of both species at the beginning of the 1998 trial, and at beginning and end of the 1999 trial, by gas chromotography (Molyneux et al. 1989).

Results

In the previous grazing trial (Ralphs, unpublished data), cows consumed white locoweed for an average of 5% of their bites as it matured from the vegetative stage to full flower. When placed in the larger pasture of this study containing both white and Lambert locoweed, cows selected Lambert locoweed (up to 40 % of bites, Fig. 1), at the exclusion of white locoweed. Consumption of Lambert locoweed declined over the next 2 weeks due to the reduction in its availability. Cows began eating white locoweed as Lambert locoweed declined during the second week. Cows started selecting the immature pods of white locoweed, then progressed to selecting its leaves. A combination of decreasing availability, maturity, and drying of the leaves of the 2 species contributed to the cows ceasing to graze them after the third week of the trial. Cool-season grasses were beginning to form heads and comprised 76% of bites. Mean consumption of the 2 locoweed species for the first 3 weeks of the trial were 8 ± 1.1 % of bites for Lambert locoweed, compared to 3 ± 0.52 % for white locoweed (Table 2).

In the 1999 intensive grazing trial, cattle clearly preferred Lambert locoweed (Table 2). Only a small amount of white locoweed was consumed in the flower stage in the first trial. By the middle of the first trial, the cows selected Lambert locoweed when encountered. Three other Astragalus species were present in the pasture (*A. lax-*

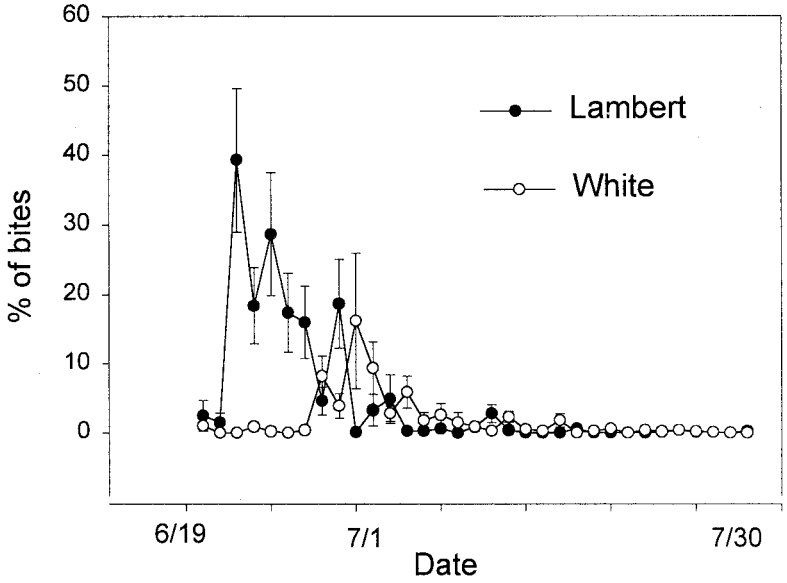

Fig. 1. Cattle consumption of Lambert and white locoweed over the grazing trial in 1998. White locoweed was in full flower at the beginning of the trial and Lambert locoweed was in the bud stage, but flowered by the first of July.

mannii, A. wingatanus, A drummondii). These species were intermingled with Lambert locoweed in the swales and were highly preferred (Table 2).

Lambert locoweed was in full flower in Trial 2. The cows would seek it out (41% of bites, Table 2) and graze it along with the other Astragalus species. Cows consumed Lambert locoweed for 15% of bites in Trial 3, and readily grazed the other *Astragalus* species (Table 2). Cattle almost ceased grazing Lambert locoweed in Trial 4, due to its reduced availability and mature foliage. The other *Astragalus* species were also becoming mature and rank. Other forbs were abundant due to the plentiful rains and comprised a large part of the diet in the last 2 trials [sand lily (*Leucocrinum montana* Nutt.), western wallflower (*Erysimum asperum* Nutt.), western ragweed (*Ambrosia psilostachy*a DC.)]. The cool-season grasses needleandthread, prairie junegrass and bottlebrush squirreltail dominated diets while cattle grazed uplands, and western wheatgrass, Kentucky bluegrass (*Poa pratensis* L.) and sedges (*Carex* spp.) dominated diets when cattle grazed the swales.

Between the intensive grazing trials, the 4 cows grazed in an adjacent pasture with the remainder of the original 15 cows. White locoweed was widely distributed in this pasture, Lambert locoweed was scarce, and other forbs were not as plentiful. The 4 cows consumed white locoweed for an average of 2% of bites during the intervening periods (Table 2). Between Trial 1 and 2, they consumed flowering heads of white locoweed for up to 16% of bites. They started grazing white locoweed leaves after Trial 2, and increased consumption of leaves (10–21% of bites) between Trial 3 and 4. Summer rains were frequent during 1999, and leaves of white locoweed remained green and succulent throughout the summer, in contrast to drying up and senescing as it did in 1998.

The paradox of white locoweed being consumed in the intervening periods between the intensive grazing trials may be explained by the availability of other forage. The 5 ha pasture of the intensive grazing trial contained an abundance of cool- and warm-season forbs (including Lambert locoweed and *Astragalus* spp.), which the cows selected throughout the trial. About 1/3 of the pasture was considered swale or bottom land, and had adequate soil moisture to support growth of cool-season grasses throughout the summer. Apparently, the associated forages were more palatable than white locoweed in the intensive study pasture. Although the cattle preferred grazing in the swales, they did graze a considerable amount of time on the ridges, yet did not select white locoweed. The larger holding pasture contained more uplands with fewer forbs and more arid growing conditions. Here the succulent leaves of white locoweed were relatively palatable considering the alternative forages.

Concentration of the toxic alkaloid swainsonine in white locoweed was 0.06% in 1998 and 0.04% in 1999. However, we did not find swainsonine at detectable levels in Lambert locoweed. We also examined a sample of Lambert locoweed from Union County New Mexico and found no swainsonine. Fox et al. (1998) reported swainsonine in Lambert locoweed at concentrations of 0.026 in Mora County and 0.1% in Sierra County, N.M. Molyneux et al. (1989) measured swainsonine at 0.031% in Lambert locoweed on the Henry Mt. in southeastern Utah. There may be other indolizidine alkaloids in Lambert locoweed that were not detected by the chemical assay that account for its toxicity.

The cows in our study showed no visible signs of intoxication during the study. Locoweed poisoning is chronic, requiring animals to consume it for 15 to 20% or their diets for 3 to 4 weeks before signs of poisoning become apparent. Swainsonine inhibits glycoprotein metabolism, thus there would be no immediate post-ingestive consequence to be associated with consumption of the plant. Further, the low levels of swainsonine in locoweeds are probably below detection thresholds (Molyneux and Ralphs 1992), and thus would not affect palatability.

Table 2. Comparison of cattle consumption of white vs. Lambert locoweed.

Year	Trial	Growth stage White /Lamb.	Grass	Forb	White locoweed	Lambert locoweed	*Astragalus* spp.
			(% of total bites)				
1998	1st 3 weeks		76 ± 1.4	12 ± 1.0	3 ± 0.5 **	8 ± 1.1 **	-
1999	1	flower bud	56 ± 1.5	22 ± 1.2	0.2 ± 0.1**	11 ± 1.2**	11 ±0.8
	2	pod flower	38 ± 2.2	15 ± 1.3	0 **	41 ± 2.4**	6 ± 0.6
	3	pod pod	43 ± 2.0	25 ± 1.7	0 **	15 ± 1.3**	18 ± 1.5
	4	seed pod	68 ± 3.0	30 ± 2.9	0 *	1 ± 0.5*	1 ± 0.5
	Mean		49 ± 1.1	22 ± 0.8	0.1 ± .04**	19 ± 1.0 **	10 ± 0.6
1999	Intervening periods		82 ± 1.5	15 ± 1.3	2 ± 0.7	0	1 ± 0.4

Difference in consumption of white and Lambert locoweed as determined by paired t-tests: ** $P < 0.01$, * $P < 0.05$.

Conclusion

Cattle consumed more Lambert locoweed than white locoweed throughout the June–August grazing season in both years, when both species were available within the same pasture. However, cattle readily consumed white locoweed before the comparison grazing trial in 1998, and in the intervening holding periods between the intensive grazing periods in 1999.

The lack of the toxic locoweed alkaloid swainsonine in Lambert locoweed in this study presents a quandary. Lambert locoweed populations at other locations have been reported to contain swainsonine. Further research is necessary to determine if Lambert locoweed contains other toxic alkaloids, and if there are seasonal and geographic differences in swainsonine content.

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