Cattle Consumption of Velvet Lupine (*Lupinus leucophyllus*) in the Channel Scablands of Eastern Washington

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Abstract

Certain lupines (*Lupinus* spp.) contain alkaloids that cause contracture-type skeletal birth defects and cleft palate (“crooked calf syndrome”) when consumed by cows during the 40th to 70th day of gestation. The objective of this study was to determine when cattle graze velvet lupine (*Lupinus leucophyllus* Dougl.) during its phenological development, and whether this period overlaps the critical period of gestation. Grazing studies were conducted in 2001, 2002, and 2003 in the same 100 ha pasture in eastern Washington. A second objective was addressed in 2001 to determine if cows with crooked calves consumed more lupine than cows with normal calves. Five mature Hereford cows with crooked calves at their side and 6 mature Hereford cows with normal calves grazed together for the summer. There was no difference (*P* = 0.17) in the amount of lupine consumed between groups, and all cows consumed some lupine. In 2002, 10 3-year-old Hereford cows with normal calves were used, and in 2003, 8 of the same cows from the 2002 study with normal calves were used. In all 3 years, cows started consuming lupine in July and August after annual grasses dried and annual forbs matured. Lupine is a deep-rooted perennial that remained green and succulent longer into the summer than the associated forages. Concentration of the teratogenic alkaloid anagyrine declined as lupine seeds shattered in late June and early July. Lupine consumption occurred during the critical period of gestation in 2 of the 3 years, but no crooked calves were produced. Apparently, the cows did not ingest sufficient amounts of anagyrine over the susceptible period of time to produce crooked calves. The management recommendation for this site is to restrict access to lupine during July when cattle begin to graze lupine and anagyrine levels may still be relatively high. Once the seeds shatter, toxicity greatly declines.

Key Words: birth defects, cattle grazing, poisonous plant, lupine

INTRODUCTION

Many common lupine (*Lupinus* spp.) species contain quinolizidine and piperidine alkaloids that can be toxic and/or teratogenic to livestock. Calf losses from congenital birth defects have been reported in several western states (Panter
et al. 1997). Ingestion of lupine by the dam during the 40th to 70th day of gestation can cause a crooked calf syndrome (Shupe et al. 1967). The quinolizidine alkaloid anagyrine (Keeler 1976) and some piperidine alkaloids (ammodendrine and N-methyl ammodendrine) cause the crooked calf syndrome by reducing fetal movement during this critical period of gestation (Panter et al. 1990), causing the spine and limbs to develop in contracted or malformed positions.

Keeler et al. (1977) proposed a simple management solution: stagger grazing of lupine-infested pastures so that the susceptible period of gestation does not overlap the flower and pod stage of growth when anagyrine is highest. However, this recommendation does not consider when cattle are likely to graze lupine. The principal objective of this study was to determine when cattle graze velvet lupine (Lupinus leucophyllus Dougl.) in the channel scabland region of eastern Washington, and to determine if it overlaps the critical stage of gestation. A second objective was addressed in 2001 to determine whether those cows that had crooked calves had a propensity to consume more lupine than those with normal calves.

METHODS

The study site was in the channel scabland region of eastern Washington about 25 km southeast of Ritzville (lat 46°15.347′, long 118°13.031′). The original plant community was a palouse prairie but has been degraded to annual species, such as cheatgrass (Bromus tectorum L.), fiddleneck (Amsinckia intermedia Fisch. & Mey), tansy mustard (Brassica napus L.), rush skeleton weed (Chondrilla juncea L.), horsebrush (Tetradymia canescens D.C.) and rabbitbrush (Chrysothamnus nauseosus [Pallas ex Pursh] Britt.) were dominant shrub species, which suggests a relatively frequent fire regime. Average density of velvet lupine was 1.5 plants m⁻². The experimental pasture was about 100 ha and was fenced off by a mature Hereford bull was placed in with the cows each year around 10 May. The date that each cow bred was recorded. Based on the breeding dates, the susceptible period of gestation (40th to 70th day of pregnancy) was calculated and compared to the time lupine was consumed.

Standing crop was sampled at the beginning, midseason when cheatgrass had matured, and at the end of each year's study. Composite samples of each forage class was analyzed for crude protein by means of total N (LECO model FP-528; LEKO Corp, St Joseph, MI) and neutral detergent fiber (NDF) (ANKOM200 fiber analyzer; ANKOM, Fairport, NY).

Lupine samples were collected at approximately 2-week intervals during the study each year. Ten uniform plants were harvested at each collection, ground, and analyzed for anagyrine using a gas chromatograph method (Gardner and Panter 1994). Improvements to the previously described procedure included the use of caffeine as an internal standard, and concentration of anagyrine and other major alkaloids was quantified against a 6-point standard curve (S. Lee, unpublished method, 2004). Correlations were run between anagyrine concentration and lupine bites in diets.

RESULTS AND DISCUSSION

Cattle started grazing lupine around the first of July each year (Fig. 1). The average amount of lupine consumed in July and August was 6.1 ± 0.66 (SE) % of bites in 2001, 5.9 ± 0.34 in 2002, and 3.4 ± 0.30 in 2003. The timing of lupine consumption was similar in all 3 years and was dependent on the availability and maturity of the associated forages.

Cattle selected annual grasses while they were still green during the first part of the season each year (Fig. 1). Crude protein content of cheatgrass was 8.5% at the beginning of the season, but declined to 5% after it dried. As the annual grasses matured and dried, cattle selected green forbs, such as fiddleneck, rush skeleton weed, and tansy mustard, during the mid-
dle part of the summer (Fig. 1). Crude protein of forbs ranged from 10% to 14% during the first half of the season, and fiber content (NDF) averaged 55%, compared to 65%–70% in annual grasses. As these forbs were depleted or matured and dried, cattle began selecting the deep-rooted lupine (Fig. 1), which remained green and succulent longer than the other forbs. Crude protein content of lupine was 15% through the middle part of the season, and NDF remained below 55%. Although it was the most nutritious forage throughout the season, cattle did not graze it until the other forages were depleted or matured. We suspect its dense pubescence contributed to its lack of palatability. Lopez-Ortiz (2002) also reported that cattle selected velvet lupine only after annual grass and other forbs became limited in a grazing study in the same area.

The general breeding season in this region is 1 May to 30 July. Therefore, the susceptible period of gestation (day 40–70) runs from 10 June to 8 October. Breeding dates in our study ranged from 20 May through 30 August. Since our cows consumed lupine during July and August, ingestion of the teratogenic alkaloid anagyrine occurred during the critical period of gestation in 2002 and 2003 (Fig. 2).

There was a weak negative correlation between anagyrine and lupine consumption in 2002 ($r = -0.50, P = 0.17$) and 2003 ($r = -0.67, P = 0.01$) (Fig. 2). These negative correlations reflect the declining concentration of alkaloids following seed shatter, which is when the cows started eating lupine around the first part of July. The high levels of total alkaloids during the flower and pod stage of growth may have contributed to its lack of palatability.

**MANAGEMENT IMPLICATIONS**

Lupine was consumed by all cows during July and August each year, which overlaps the critical period of gestation (10 June to 8 October). Anagyrine concentration was highest during early

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**Figure 1.** Annual grasses, forbs, and lupine in cattle diets in 2001, 2002, and 2003 in the channel scablands of eastern Washington.

**Figure 2.** Concentration of the teratogenic alkaloid anagyrine in lupine plants, in relation to the time lupine was consumed and the susceptible period of gestation. The susceptible period (40–70 days of gestation) was calculated from the actual breed dates.
growth and in the flower and pod stage in June, then rapidly declined in early July once the seeds shattered. This information can be used to refine Keeler et al.’s (1977) management recommendation on this site, from restricting access to lupine during the entire critical gestation period, to restricting access only during early July when cattle are likely to eat it and anagyrine concentration is still high. Once the seeds shatter, anagyrine concentrations should be below the threshold to cause crooked calves.

**LITERATURE CITED**


