Rangeland Ecology & Management xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Rangeland Ecology & Management

journal homepage: http://www.elsevier.com/locate/rama

Original Research

Effects Energy Supplementation and Time on Use of Medusahead by Grazing Ewes and Their Lambs☆

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ARTICLE INFO

Article history:
Received 23 April 2016
Received in revised form 29 November 2016
Accepted 30 November 2016
Available online xxxx

Keywords:
diet selection
foraging behavior
preference
weed control

ABSTRACT

Medusahead is an annual weed that invades millions of acres in the western United States. This study explored the effect of energy supplementation on use of this unpalatable weed by ewes and their lambs. Thirty-six ewes with their lambs (2 − 3 mo old) were randomly assigned to 12 groups (3 ewes with their lambs per group), and half of the groups received 2.5 kg group d^{-1} of an energy-based supplement (beet pulp − barley − Ca-propionate, 66:30:4; as-fed basis). After supplementation, all groups grazed plots with medusahead infestation for 15 d. Lambs were then weaned, kept in the same groups but without supplementation, and allowed to graze medusahead-infested plots for 3 d. Grazing events were recorded daily at 5-min intervals, and defoliation of medusahead tillers was measured in all plots. The proportion of grazing events recorded on medusahead and the proportion of defoliated medusahead tillers were not affected by supplementation in either ewes or lambs ($P > 0.05$). All ewe-lamb groups presented a greater proportion of medusahead use during the second half of the grazing period ($P < 0.05$). Nevertheless, the average proportion of events recorded for medusahead use was never greater than 7%, which was similar to the relative availability of medusahead in the community (i.e., 6%). Use of medusahead by ewes was correlated with that observed for their lambs ($r = 0.83$; $P < 0.05$), and weaned lambs showed a similar proportion of grazing events on medusahead to those observed before weaning ($P > 0.05$). These results suggest that mothers influence medusahead use by their offspring. They also suggest that despite the low palatability of medusahead, sheep will not avoid medusahead when grazing moderately infested rangeland. The diversity of the plant community likely contributed to this outcome, which might have also reduced the impact of the supplement on medusahead use by sheep.

Introduction

Medusahead (*Taeniatherium caput-medusae* subsp. *asperum*) is a Eurasian annual grass that has invaded > 10 million ha of rangeland in the Pacific Northwest, California, Utah, and Nevada (Johnson and Davies, 2012). Grazing represents a sustainable and low-input method for weed control. In fact, stakeholders, scientists, and land managers see high potential for the use of grazing as a tool to control medusahead in western rangelands (James et al., 2015). Nevertheless, livestock have reportedly displayed remarkably low preference for medusahead during grazing, attributed to the low nutritional value and high silica content of the weed (Lusk et al., 1961; George et al., 1989; Young, 1992). In turn, medusahead avoidance increases grazing pressure on palatable native plants, which further reduces animal carrying capacity and contributes to the spread of the weed (Hironaka, 1961; Torrel et al., 1961).

Paradigms on foraging behavior emphasize the importance of positive experiences early in life with the biochemical context (provided by the plant community or supplements) on preference for target feeds (Villalba et al., 2015). Preference for a particular feed depends on not only its intrinsic (i.e., nutritional, toxicologic) properties but also the nutritional context where that food is ingested. An instance of this type of phenomenon is called the *induction effect,* which consists of an increased intake of an unpalatable food when it is associated with the ingestion of a preferred food in a sequence familiar to the animal (Flaherty, 1996; Provenza et al., 2003). Caton and Dhuyvetter (1997) and Garcés-Yépez et al. (1997) reported that concentrates containing highly digestible fiber (i.e., beet pulp) increase intake of low-quality forages by livestock because such supplements maintain a favorable rumen environment (i.e., pH and digestible fiber). Thus, conditioning animals with appropriate supplemental feeds may lead to a more even utilization of palatable and unpalatable resources in a plant community and, as a consequence, to the maintenance of biodiversity in the landscape (Provenza et al., 2003; Baraza et al., 2005).

In addition to the nutritional context, positive experiences early in life with the mother can have lifelong influences on herbivores by causing neurologic, morphologic, and physiologic changes that influence

☆ This research was supported by grants from the National Institute of Food and Agriculture, US Department of Agriculture (agreement no. 2009-35101-05360).

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http://dx.doi.org/10.1016/j.rama.2016.11.005
1550-7424/

foraging behavior (Provenza and Balph, 1990; Distel et al., 1994, 1996). Given the appropriate nutritional context at an early stage of development, animals may increase consumption of medusahead and its use may persist throughout the lifetime of the individual.

We hypothesized that the use of an energy supplement would enhance intake of and preference for medusahead by sheep and that this effect would transmit from mother to offspring. To test this hypothesis, we determined the influence of an energy-based supplement on use of medusahead by ewes and their lambs and the subsequent use of the weed by weaned lambs.

Material and methods

Study Site

The experiment was conducted on privately owned land with medusahead infestation in Mantua, Box Elder County, Utah, United States (41°29′51″N and 111°56′32″W). The ecological site is Mountain Stony Loam (Wadman, 2012), which is located between 1670 and 2560 masl and has slopes between 5% and 70%. The soils transitioned from the Goring-Yeates Hollow association, on alluvium and colluvium derived from quartzite and sandstone at the lowest slope position, to the Agassiz-Picayune association at the highest slope positions, composed of colluvium and limestone residuum. The soils were Xerolls with a well-developed organic-rich A-horizon. They had a stony, cobbly, or gravelly loam texture upslope and clayey texture downslope, with moderate permeability and moderate erosivity. Upslope soils tended to be shallower and drier.

Cold snowy winters and cool dry summers characterize the climate. The plant community is Mountain Big Sagebrush with introduced non-native plant species (Wadman, 2012). The functional group of grasses is composed of mainly *Elymus trachycaulus, Poa secunda, Poa bulbosa, Poa fendleriana,* and *Leymus cinereus*. Some representative forbs are *Achillea millefolium* L., *Balsamorhiza sagittata* (Pursh) Nutt., *Lupinus caudatus* L., and *Crepis acuminata* L. The dominant shrubs are *Artemisia tridentata* Nutt. subsp. *vaseyana*. Non-native grasses are medusahead and *Bromus tectorum* L. Identification of plant species was made with support of Natural Resources Herbarium collection, Utah State University (USU).

Grazing Blocks

Six 0.18-ha blocks, each divided into 2 plots (0.09 ha plot^{-1}), were marked at the study site in order to evaluate the effect of an energy-rich supplement on use of medusahead by ewes and their lambs. Each plot was delimited using electric fence, and a pen of ∽3.0 m^2 was assembled outside each plot for overnight enclosure of the animals. Culinary water, salt (White Salt Block, North American Salt Company, Overland Park, KS), and trace-mineralized salt blocks (Morton iOfixt T-M, Chicago, IL) were provided in ad libitum amounts inside each pen throughout the study. Three control plots (no grazing) were randomly located between the grazed blocks.

In order to test for the effects of exposure with their mothers to a supplement on medusahead use by weaned lambs, six 0.021-ha blocks, each divided into 2 plots (0.0105 ha plot^{-1}) were marked on the study site with outside pens and fenced as described earlier. Blocks were assembled 50 m to the northeast of the blocks that were grazed by ewes and their lambs.

Effect of Supplementation on Medusahead Use by Ewes and Their Lambs

Experimental Design

The study was conducted according to procedures approved by the Utah State University Institutional Animal Care and Use Committee (Approval #1551). Thirty-six crossbreed ewes with their lambs (2 − 3 months of age) grazed an orchardgrass *(Dactylis glomerata)* pasture at the Green Canyon Ecology Center, USU, Logan, Utah, during May 2013. All animals were also fed ∽8 kg d^{-1} of an energy-based supplement from 7 May to 31 May 2013, in order to familiarize the animals with this feed before they grazed medusahead-infested rangeland. The energy supplement was a mixture of beet pulp, barley, and Ca-propionate (Sigma-Aldrich, St. Louis, MO) at a rate of 66:30:4 (as-fed basis).

Twenty-three ewes had single lambs, and 13 ewes had twins. The average initial body weight (BW) of ewes and lambs was 72.4 ± 8.3 and 25.0 ± 8.9 kg, respectively. All animals were transported to the study site on 1 June 2013.

Within each of the six 0.18-ha experimental blocks described in the section of *Grazing plots,* one group of three ewes with their lambs (3.8 ± 0.8 lambs group^{-1}) received the energy supplement (Supplemented groups) and grazed in one of the 0.09-ha plots of the block, whereas another group of three ewes and lambs (4.3 ± 1.0 lambs group^{-1}) did not receive a supplement (Nonsupplemented groups) and grazed on the other 0.09-ha plot of the block. Each supplemented group received 2.5 kg of the supplement (94% dry matter [DM]) from 0750 to 0830 daily. Supplement intake ranged from 1.8 to 2.3 kg DM d^{-1}. The supplement's chemical composition is shown in Table 1. All ewes and their lambs were released to graze their respective plots from 0830 to 1700, when all animals were penned overnight. Sheep grazed for 15 consecutive days (from 2 to 16 June 2013). Medusahead was in the late vegetative stage at the beginning of the experiment and in the late reproductive stage toward the end of the experiment.

Scan Sampling

Behavior of ewes and their lambs was recorded at 5-min intervals from 0830 to 1100 and from 1600 to 1700 using the scan sampling technique (Altman, 1974). Foraging activities involved those events when animals were observed grazing medusahead and other functional groups (annual grasses other than medusahead, bunch grasses, and forbs) in the plant community; additional behaviors were walking, resting, ruminating, nursing, and drinking. Observations were made in three blocks per day during alternate days: three randomly selected blocks were scanned by three observers on days 1, 3, 6, 8, 11, and 13, whereas the remaining three blocks were scanned on days 2, 4, 7, 9, 12, and 14. The proportion of grazing events on medusahead and other functional groups in the plant community relative to the total number of scans recorded per day (3.5 h) was determined.

Evaluation of the plant community

Plant biomass production was estimated pregrazing and postgrazing in all grazed and ungrazed plots using a rising plate meter (Michell, 1982), 0.0985 m^2 plate^{-1}. The relative abundance of medusahead and different plant functional groups (forbs, bunch grasses, and annual grasses other than medusahead) on a wet basis (WB) were visually estimated pregrazing and postgrazing in 25 squares (0.0985 m^2 square^{-1}) randomly distributed within a zig-zag transect. These visual estimations were made in a randomly selected plot per block, with the restriction that three plots were grazed by supplemented sheep and three plots were grazed by nonsupplemented sheep. Shrubs occurred in low frequency in all plots (<2% of frequency), and their abundance was thus not considered in the study.

Four squares (0.0985 m^2 square^{-1}) within the aforementioned transect were randomly selected and harvested at the ground level. Plant material was taken to the laboratory, manually sorted into medusahead and plant functional groups, and weighed on a WB. This information was used to calculate the percentage of medusahead and functional groups present in each sample (WB), and these values were compared with the relative abundance estimated visually (WB) in the plots. This was done to test how reliable the visual estimations were.

Samples of supplement, medusahead, and functional groups were dried in a forced air oven at 60°C until constant weight to estimate DM content. A composite of medusahead and each plant functional

Please cite this article as: Montes-Sánchez, J.J., et al., Effects Energy Supplementation and Time on Use of Medusahead by Grazing Ewes and Their Lambs, (2016), http://dx.doi.org/10.1016/j.rama.2016.11.005