The effect of grazing duration on forage quality and production of meadow foxtail

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Wenick, J. J., Svejcar, T. and Angell, R. 2008. **The effect of grazing duration on forage quality and production of meadow foxtail**. Can. J. Plant Sci. **88**: 85–92. For the past 50 yr, meadow foxtail (*Alopecurus pratensis* L.) has been invading native flood meadows throughout the Harney Basin in southeastern Oregon. The expansion of this grass species has been the result of its broad climatic adaptation and ability to withstand drought while thriving in saturated soil conditions for a large part of the growing season. The growth of meadow foxtail starts as soon as adequate soil moisture exists. Managing this early-maturing hay species can prove to be a challenge because soil saturation and elevated water tables make it difficult to harvest hay when forage quality and yield are maximized. The purpose of this study was to evaluate whether planned grazing would retard maturation and thus prolong forage quality. Treatments included a non-grazed control and grazing durations of 2, 4, 6, and 8 wk. Grazing was initiated in May of 1998 and 1999 on six replications of each treatment arranged in a randomized block design. Within each treatment/replication combination, ten 0.2-m^2 plots were clipped to ground level at about 2-wk intervals from May to August. The samples were weighed and dried for standing crop estimation and 4 of the 10 samples were selected at random and analyzed for acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein (CP). We found that early spring grazing decreased forage yield significantly ($P \leq 0.05$). Grazing tended to slow the seasonal decline in CP. The effects of grazing on the forage fiber components, however, were inconsistent. The relatively small increase in forage quality does not appear to compensate for the large decline in hay yield (a 40% decline in the shortest grazing duration treatment). We recommend that unfertilized meadow foxtail pastures be used for either haying or grazing, but not both in a given growing season.

Key words: Grazing, beef cattle, regrowth, forage yield

Wenick, J. J., Svejcar, T. et Angell, R. 2008. **Incidence de la durée de la paissance sur la qualité fourragère et la production du vulpin des prés**. Can. J. Plant Sci. **88**: 85–92. Le vulpin des prés (*Alopecurus pratensis* L.) envahit les prés indigènes inondables du bassin Harney, dans le sud-est de l'Orégon, depuis un demi-siècle. On doit l'expansion de cette graminée à sa facilité d'acclimatation et à sa résistance à la sécheresse, associée à une croissance exubérante dès que le sol est saturé d'eau, pendant la majeure partie de la période végétative. Le vulpin croît dès que le sol est assez humide. La gestion de cette espèce fourragère précoce pourrait s'avérer problématique, car la saturation du sol et la hauteur de la nappe phréatique compliquent la récolte du foin quand la qualité et le rendement des fourrages atteignent leur maximum. L'étude devait établir si la paissance peut retarder la maturation du vulpin, donc en prolonger la qualité fourragère. Les traitements comprenaient une parcelle témoin sans paissance, et des parcelles avec 2, 4, 6 et 8 semaines de paissance. La paissance a débuté en mai 1998 et 1999 à raison de six répétitions par traitement, organisées en blocs aléatoires. Pour chaque traitement/combinaison, les auteurs ont tondu dix parcelles de 0,2 m^2 au ras du sol à intervalles d'environ deux semaines du mois de mai au mois d'août. Ils ont ensuite pesé et séché le foin pour estimer le peuplement sur pied. Ils ont ensuite sélectionné quatre échantillons sur dix au hasard pour les analyser et établir la concentration de fibres au détergent acide, de fibres au détergent neutre et de protéines brutes (PB). Les auteurs ont découvert que la paissance au début du printemps diminue sensiblement le rendement fourrager ($P \leq 0{,}05$). Elle a tendance à freiner la réduction saisonnière de PB, mais son incidence varie sur les fibres. La hausse minime de la qualité du fourrage ne semble pas compenser l'importante baisse du rendement en foin (de 40 % pour la plus courte période de paissance). Les auteurs recommandent que les pâturages de vulpin des prés non bonifiés servent à la récolte de foin ou à la paissance, mais pas aux deux durant la même saison de croissance.

Mots clés: Paissance, bovins de boucherie, repousse, rendement fourrager

Because of a long, unfavorable winter feeding period, the beef industry in the Intermountain West experiences an economic disadvantage compared with other regions

Abbreviations: **ADF**, acid detergent fiber; **AUD**, animal unit days per hectare; **CP**, crude protein; **NDF**, neutral detergent fiber; **NG**, non-grazed

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of the United States and Canada. Intermountain beef producers often need an average of 2 tons of hay per cow during these months.

In southeastern Oregon, flood meadows provide much of this feed through hay production, which allows these producers to stay competitive with more temperate regions. Species composition of these meadows dictates both the quality and quantity of hay produced and the stages at which feed value is highest. The composition of the meadows has changed considerably in the past 40 yr, and research is needed to understand the growth and maturity characteristics of introduced meadow species.

Meadow foxtail (*Alopecurus pratensis* L.) was introduced to the area in contaminated hay grown in other areas. This species has subsequently spread throughout the Harney Basin and now dominates most hay fields. It does not appear to be sensitive to extreme temperatures as long as fertile and wet conditions exist. Its long-lived perennial nature, winter hardiness, and broad climatic adaptations (Schoth 1945) as well as its ability to withstand drought (Hannaway and McGuire 1981) have resulted in its rapid expansion throughout the region.

Meadow foxtail starts growth in early spring. Managing early-maturing hay species can prove to be difficult because of the very nature of flood meadows. Meadow grasses have been observed to steadily decline in crude protein after maturity. Such decreases in quality become a major factor in determining harvest dates, but early haying is not an option for most ranchers because standing water often remains on fields at its time of maturity.

In the northern United States, meadow foxtail is used most commonly as a pasture grass. It is a climatic opportunist and will resist dormancy as long as adequate soil moisture conditions persist. Meadow foxtail pastures subjected to livestock grazing have been shown to be very productive and recover quickly once grazing is removed. Angell and Bailey (1998) proposed that a planned grazing system could be utilized in order to retard maturation and prolong a vegetative stage of growth.

The purpose of this study was to initiate a planned grazing system that could be utilized to retard maturation and to evaluate plant response in relation to duration and timing of livestock grazing. It was our assumption that grazing would increase protein yields and lower fiber content in harvested grass. Simply stated, the null hypotheses of this study were (1) that grazing would not influence hay yield, and (2) that grazing would not influence hay quality.

MATERIALS AND METHODS

Study Site

The study was conducted at the Eastern Oregon Agricultural Research Center (EOARC), approximately 8 km (5 miles) southeast of Burns, Oregon (43°31′N, 119°02′W). Burns is located in northern Harney County, 300 km (180 miles) west and slightly north of Boise, ID. The site is approximately 1260 m (4135 feet) in altitude, with annual precipitation of 30.5 cm (12 inches) consisting primarily of winter snowfall. The average frost-free period is 83 d, with a range of 20 to 116 d (Gomm 1979). The study site was located in a 27-ha flood meadow pasture, which hosts a variety of grasses (mainly meadow foxtail), sedges, rushes, and forbs.

The study site soil type has been classified as a Fury-Skidoosprings-Opie complex. The three components of the complex vary in regard to soil parent material, with Fury and Opie soils originating from alluvial deposits and Skidoosprings soils originating from lacustrine sediments. Soil depth is greater than 152 cm (60 inches) to bedrock and the soil is poorly drained. Ponding, frost heave, salinity, and alkalinity are major soil limitations (Natural Resources Conservation Service 1999).

A modified step-point technique (Owensby 1973) was used to determine species composition within the study area. A total of 600 points were sampled within the study area. Identification occurred at the species level for all vegetation except sedges and rushes. These species were documented as "*Carex*" and "*Juncus*". This procedure was performed on Aug. 03 and Aug. 05 of 1999.

Experimental Design

The field study was conducted in 1998 and 1999 and utilized a randomized complete block design to account for varying topography, flooding depth, and plant composition. The design consisted of six blocks (15 m by 15 m in size) distributed within the pasture. Each block served as a replication of five treatments (3 m by 15 m in size). Electric fence was used to manipulate the timing of grazing for each treatment.

Angus × Herford heifers belonging to the EOARC were used. Grazing intensity was manipulated by determining the necessary number of livestock required to graze the meadow to about 50–70% utilization and maintain herbage availability of 1000 to 1500 kg ha^{-1}. On 1988 May 03, 76 heifers were placed in the meadow pasture. Forage availability became inadequate by mid to late-July and 16 head were removed. On 1999 May 20, 55 heifers were placed in the meadow and none were removed from the study that year.

Prior to grazing, electric fence was placed around 15 m by 3 m non-grazed treatments within each replication. At 2-wk intervals the electric fence was extended an additional 3 m into the meadow. Thus, within each replication, treatments were: (1) non-grazed (NG), (2) grazed for 2 wk (G2), (3) grazed for 4 wk (G4), (4) grazed for 6 wk (G6), or (5) grazed for 8 wk (G8). At the end of the grazing period each block was 15 m by 15 m in size. During 1998, animal unit days per hectare (AUD ha^{-1}) were 39, 78, 118, and 154 for the 2-, 4-, 6-, and 8-wk treatments, respectively; the grazing days were 28, 56, 84, and 112 AUD ha^{-1} for the same treatments in

1999. Animal weight gains associated with these grazing periods can be found in Wenick (2000).

Sampling

Within each treatment/replication combination, ten 0.2-m^2 plots were clipped to ground level at each sampling date for a total of 60 plots per treatment (10 plots $\times$ 6 replications). Sampling began when cattle were initially placed in the pasture (mid-May). Sampling dates were May 14, Jun. 01, Jun. 16, Jul. 01, Jul. 14, and Aug. 11 of 1998 and May 18, Jun. 04, Jun. 18, Jul. 02, Jul 16, and Aug. 12 of 1999.

Lab Analysis

The clipped samples were dried at 60°C for at least 48 h in a forced-draft oven. Weights were then recorded to determine total biomass for the treatments at each clipping date.

Four of ten samples for each clipped treatment/replication combination were randomly selected and ground through a 1-mm screen. Samples were analyzed for NDF (Robertson and Van Soest 1981) and ADF (Goering and Van Soest 1970) using procedures modified for a Ankom 200 Fiber Analyzer (Fairport, NY). Crude protein was analyzed using the Tecator Digestion System 20 and Tector Kjeltec 1030 Auto Analyzer (Fischer Scientific, Kent, WA). Total samples per treatment/date combination were 24 (4 samples per treatment $\times$ 6 replications).

Data Analysis

Analysis of variance was conducted using a two factor model (treatment $\times$ replication). Separate analyses were conducted for each sampling date within year using SAS software (SAS Institute, Inc. 1996). There were six replications in each analysis, but treatment number varied from two to five depending on date. When a significant treatment effect ($P < 0.05$) was detected, least significant differences (LSD) were used for mean separation.

RESULTS

Temperature and Precipitation

Temperature profiles were similar during the growing seasons of 1998 and 1999, although precipitation (timing and amount) differed greatly (Fig. 1). In 1998, the wettest months included January (4.3 cm), February (4.4 cm), March (2.8 cm), and May (6.2 cm). Total annual precipitation in 1998 was 29.8 cm, with 23.5 cm occurring from January through September. In 1999, only January and February were at or above average, receiving 3.5 cm each month. Total annual precipitation in 1999 was 15.7 cm, with 12.9 cm occurring from January through September. Spring months were dry, with 3.4 cm from March through May. Monthly average temperatures were similar to long-term averages in both 1998 and 1999.

Species Composition and Basal Cover

The botanical composition and cover for various species within the study area were measured. Meadow foxtail was the dominant species, averaging 82% of total composition. Rushes (*Juncus* spp.) sedges (*Carex* spp.) and blue wild rye (*Elymus triticoides* Buckl.) made up the majority of remaining vegetation on the site. Percent basal cover for all species, litter, and bare ground

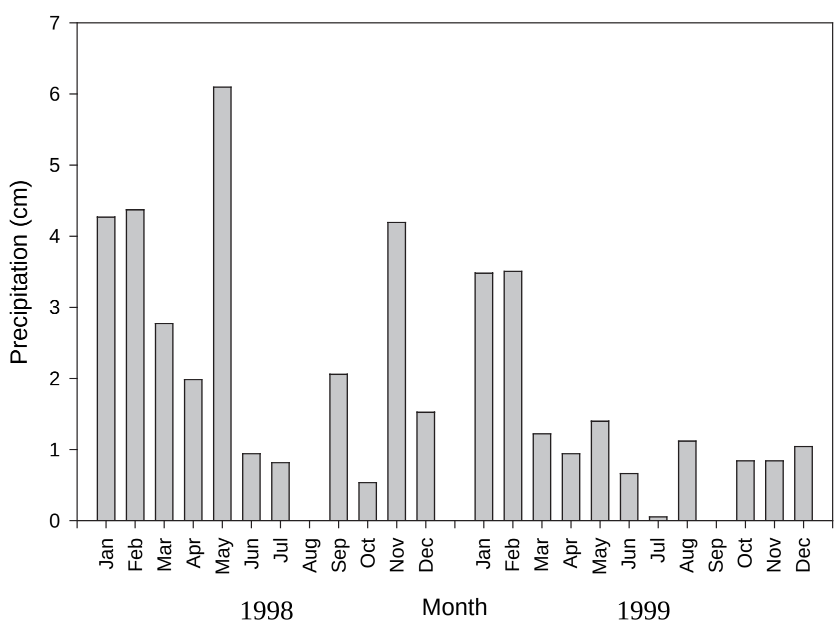

Fig. 1. Monthly precipitation totals during the 2 study years.

averaged 29, 68, and 4%, respectively, across all enclosures.

Forage Yield and Quality

Total biomass production was significantly different among treatments in 1998 and 1999 (Fig. 2). Grazing reduced hay yield regardless of timing or duration. On 1998 Jul. 14 and 1999 Jul. 16, the yields of G2 were 60 and 64% that of NG, respectively.

Crude protein content decreased with forage maturity. As a result, CP was higher in grazed than in non-grazed treatments (Fig. 3). In 1998, all treatments (except G4 and G6 harvested on Jul. 01) were significantly different from adjacent treatments through all clipping dates. Crude protein values declined from 12.9% on 1998 May 14, to 6.2% on 1998 Aug. 11 in the NG treatment. Treatment differences were less pronounced in 1999 than they were in 1998. Significant differences between NG and G2 were found on Jun. 18, Jul. 02, and Jul. 16. Differences between G4 through G8 were generally not significant (Fig. 3b).

The effect of grazing on NDF and ADF values was inconclusive (Figs. 4 and 5). During both 1998 and 1999, NDF values were not significantly different among treatments. Exceptions were for 1998 Jun. 01 and 1999 Jul. 02, where NG and G2 and NG and G8, respectively, were significantly different. In 1998, the values for NG rose from 53.1% on May 14 to 59.5% on Aug. 11. In 1999, NG NDF values rose from 50.9% on Jun. 04 to 61.8% on Jul. 16, but then fell to 50.9% by Aug. 12.

There were more statistically significant treatment differences for ADF than there were for NDF, but the

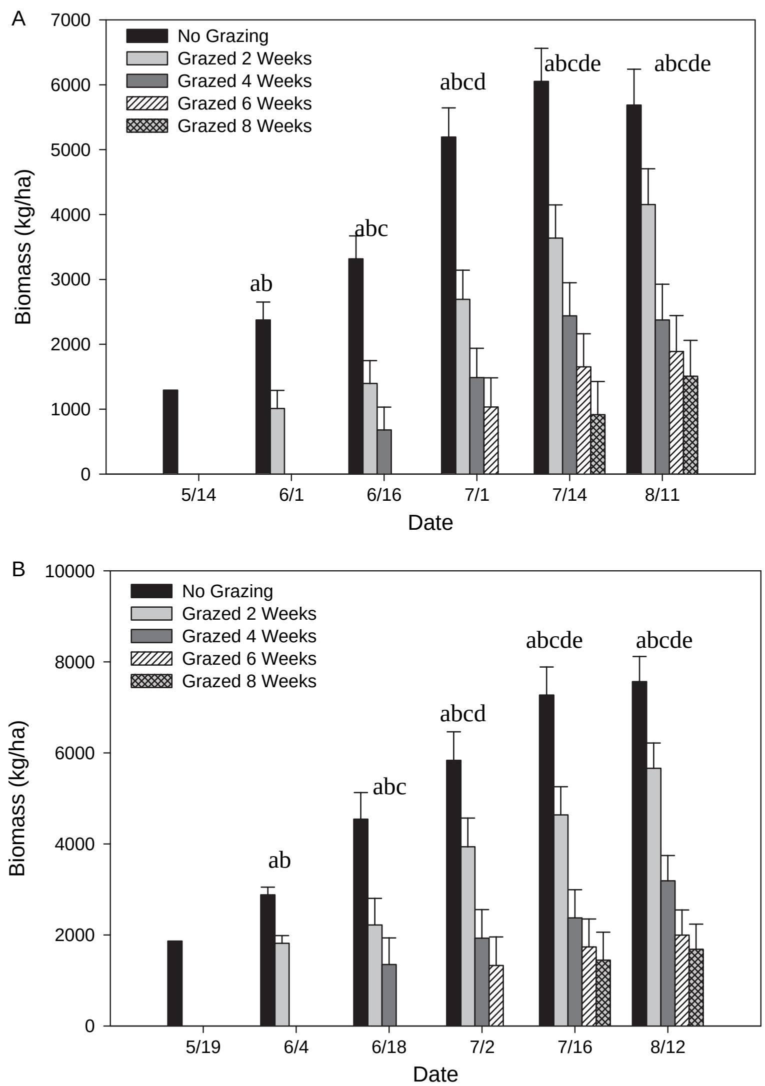

Fig. 2. Response of standing biomass (kg ha^{-1}) of meadow vegetation to duration of grazing during 1998 (A) and 1999 (B). Error bars are one standard error of the mean. Different lower case letters above a bar indicate significant treatment differences ($P<0.05$) within a date.

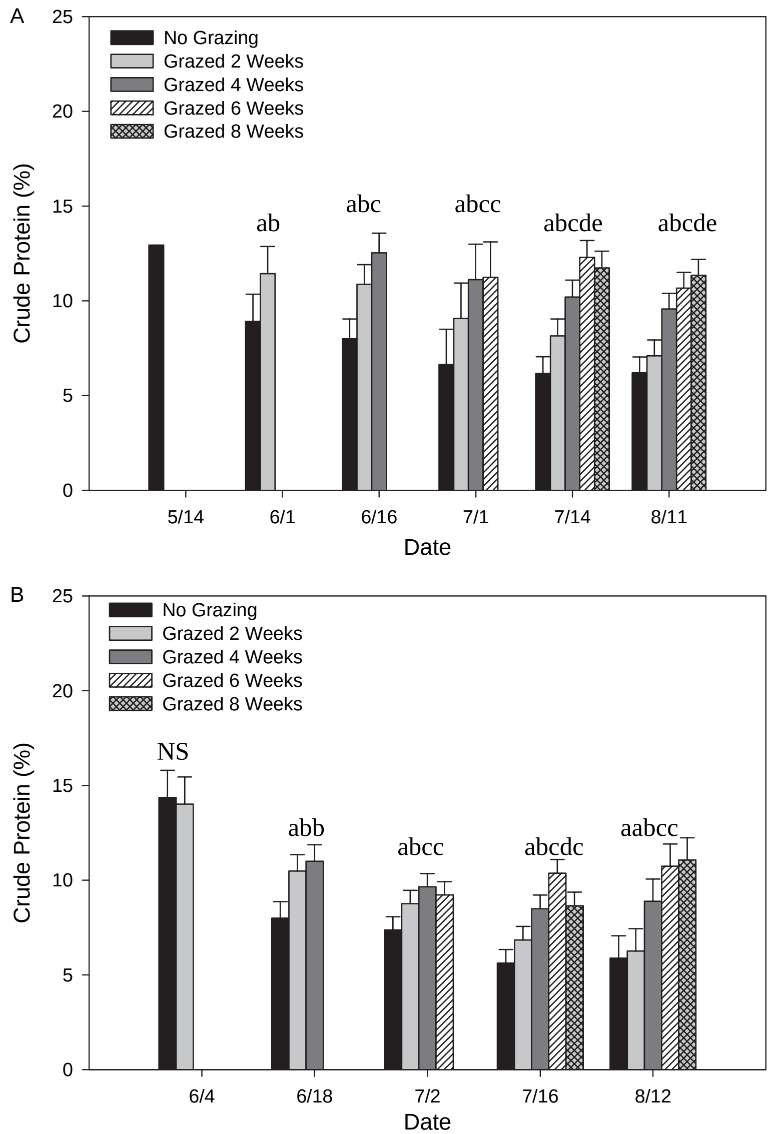

Fig. 3. Response of crude protein (%) of meadow vegetation to duration of grazing during 1998 (A) and 1999 (B). Error bars are one standard error of the mean. Different lower case letters above a bar indicate significant treatment differences ($P < 0.05$) within a date. NS indicates treatments were not different within date.

differences were not consistent. For example, NG and G2 were significantly different on 1998 Jul. 14, but NG and G6 were not. Overall, 1998 ADF values ranged from 30.1 on May 14 to 37.6 on Aug. 11. The 1999 values ranged from 29.1 on Jun. 04 to 35.3 on Aug. 12.

DISCUSSION

We found that early-spring grazing significantly decreased forage yield of flood meadows. An increase in CP with duration of defoliation was observed. However, the effects of grazing on forage fiber components (ADF and NDF) were inconsistent. Potential hay yield was reduced regardless of the timing or duration of grazing during both years of the study (Fig. 2). During 1998 and 1999, G2 treatments had only 60 and 64% of the standing biomass of NG treatments, respectively, at the usual time of cutting for the area (mid-July).

The yield differences observed between the NG and G2 treatments were not expected when this study was initiated. Stewart and Clark (1944) found that early season defoliation had limited impact on yield. They observed that spring-pasturing cattle on wild meadows in Wyoming for 20 to 35 d increased total hay yields slightly. A West Virginia study (Belesky and Fedders 1994) obtained results similar to ours for three cool-season grasses, orchardgrass (*Dactylis glomerata* L.), prairie-grass [*Sphenopholis obtusata* (Michx.) Scribn.], and a tall fescue × perennial ryegrass hybrid [*Festuca*

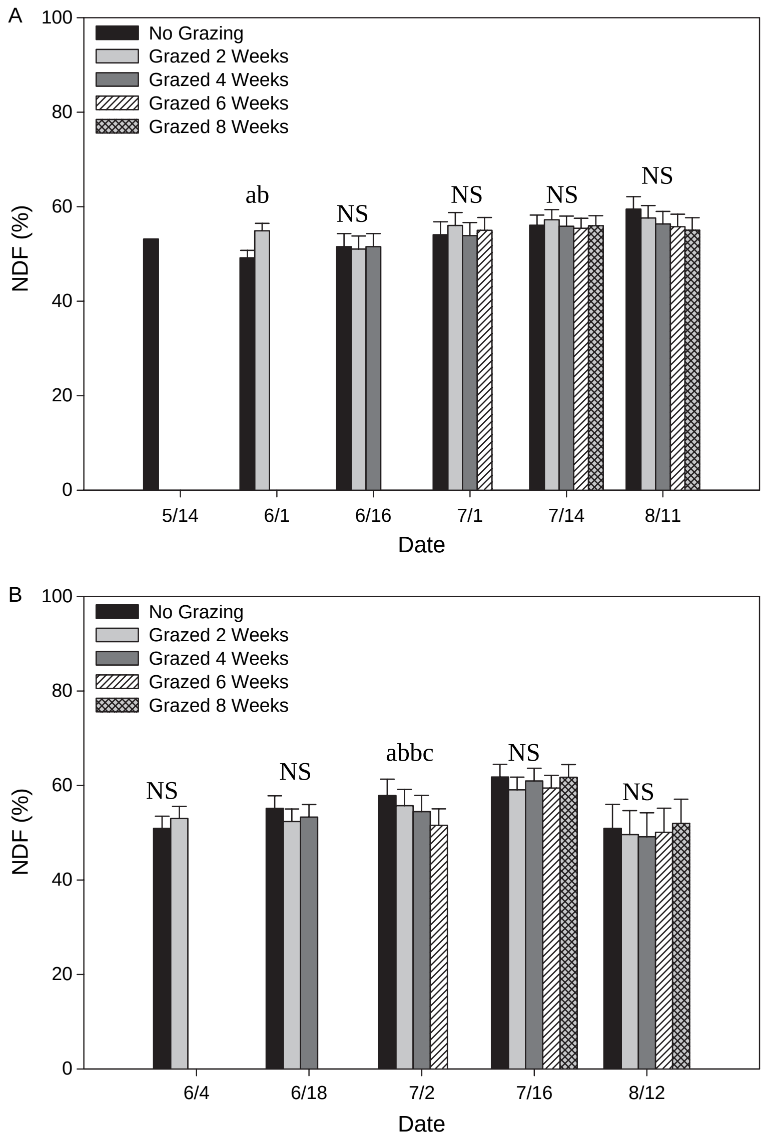

Fig. 4. Response of neutral detergent fiber (NDF) of meadow vegetation to duration of grazing during 1998 (A) and 1999 (B). Error bars are one standard error of the mean. Different lower case letters above a bar indicate significant treatment differences ($P < 0.05$) within a date. NS indicates treatments were not different within date.

arundinacea (L.) Vill. and *Lolium perenne* L.] in hay production systems. Belesky and Fedders (1994) found that growth rates were higher for grasses when managed exclusively for hay as opposed to receiving defoliation early in the growing season.

Historically, the flood meadows in eastern Oregon produced very little regrowth when native grass, rush, and sedge species were removed by livestock or haying equipment (Rumburg 1963). With the shift in dominance from native flood meadow species to meadow foxtail we thought it would be useful to re-evaluate growth after defoliation. Many studies have shown that providing nitrogen fertilizer in the early spring can lengthen the growing season for meadow foxtail (Tingle and van Adrichem 1974; Kline and Broersma 1983; Angell 1998). If fertilization were to stimulate regrowth, it might make early season defoliation a more reasonable practice.

We expected grazed treatments to have higher nutritional quality because defoliation tends to delay plant maturity and increase leaf/stem ratio. There was a tendency for CP to decrease more slowly with grazing duration (Fig. 3). By the middle of August the NG treatment had CP values of about 6%, whereas the G6 and G8 treatments had values above 10%. Our NG values are very similar to those reported by Worrell et al. (1986) and Reece et al. (1994) for Nebraska prairie meadows. Reece et al. (1994) suggested that a protein

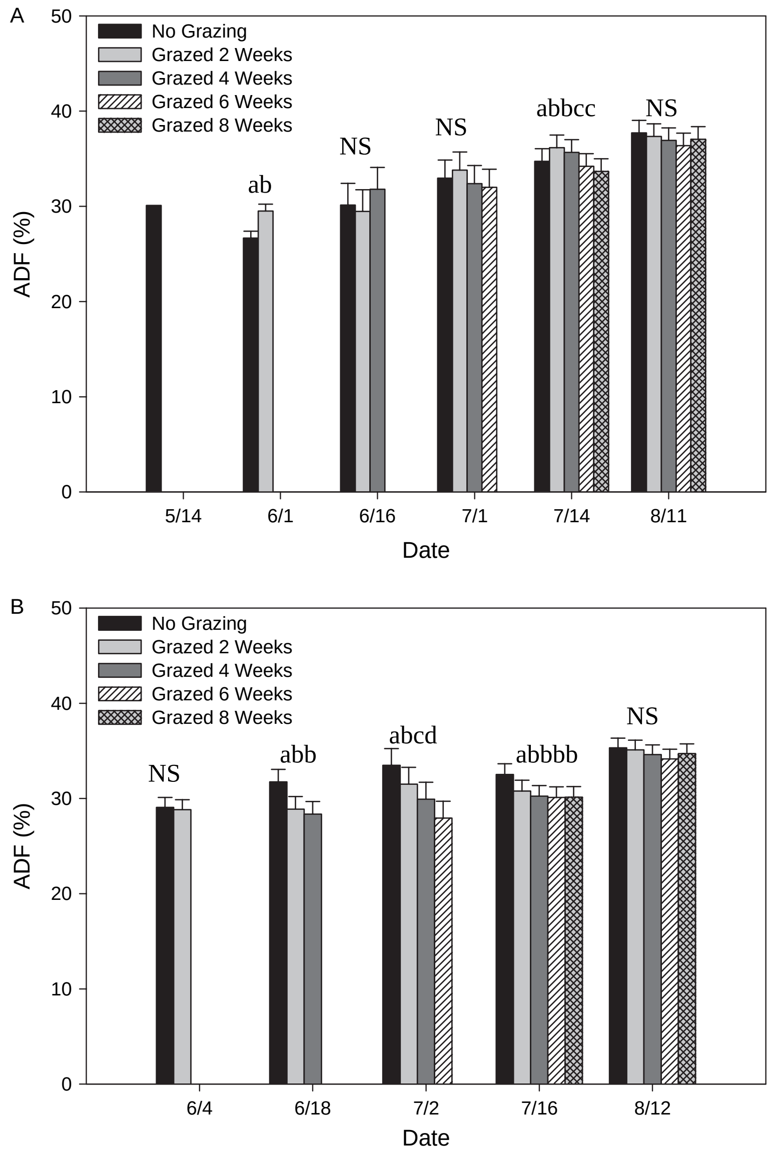

Fig. 5. Response of acid detergent fiber (ADF) to duration of grazing during 1998 (A) and 1999 (B). Error bars are one standard error of the mean. Different lower case letters above a bar indicate significant treatment differences within a date. NS indicates treatments were not different within date.

supplement may be required when feeding meadow hay cut after mid-July to most classes of beef cattle. For example, the NRC (1984) for beef cattle suggests that 227 kg steers or heifers gaining 0.23 kg day[1] will require 8.5% CP in their diets. Pregnant yearling heifers and mature cows (third trimester) require at least 8% CP. Our results support the conclusion of Reece et al. (1994) that a protein supplement may be necessary for hay cut from non-grazed meadows. However, meadows used as a grazing resource appear to maintain CP levels sufficient to support growing cattle well into the summer (Blount et al. 1991; Nixon 1994).

The grazing treatments did not impact the fiber components in the manner we had predicted. The delay in plant maturity and increase in leaf/stem ratio with grazing generally results in lower fiber fractions compared with an ungrazed situation (Laycock and Price 1970). Stage of maturity at harvest is a primary factor in the quality of wild hay (Stewart and Clark 1944). However, neither NDF nor ADF was consistently affected by grazing duration in the present study (Figs. 4 and 5). Neutral detergent fiber values changed little over the course of the season in 1998, and there was a late summer decline in NDF during 1999. In contrast, Cherney et al. (1993) found that the average differences in NDF concentration in five common pasture grasses ranged from less than 40% to more than 65% between early May and late June harvest dates. In our study, ADF exhibited the more typical seasonal increase, but treatment differences were inconsistent. The lack of treatment differences for fiber content were particularly surprising given that duration of grazing did impact CP.

Based on the results of this study we cannot recommend the use of early season grazing as a means of improving the nutritional quality of flood meadow hay. The loss of biomass with even 2 wk of grazing is too great to justify the slight improvement in CP. We recommend using unfertilized flood meadows for either grazing or hay production but not both during any given growing season. Previous research with meadow foxtail has demonstrated that spring fertilization can lengthen the growing season for this species (Tingle and van Adrichsen 1974; Kline and Broersman 1983; Angell 1998). An investigation of grazing by fertilization interactions would seem warranted in light of the results of the study presented here.

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