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Fire and Nitrogen Addition Increase Forage Quality of *Aristida purpurea*

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Abstract

Purple threeawn (*Aristida purpurea* Nutt.) is a native perennial bunchgrass with limited forage value that dominates sites with disturbed soils and persists with repeated severe grazing. Fire and nitrogen addition have been used to reduce threeawn and can increase grazing utilization of threeawn by livestock. We evaluated effects of fire, spring urea addition, and phenological stage on purple threeawn forage quality 1 yr postfire on two similar sites in southeastern Montana during the 2011 (site 1) and 2012 (site 2) growing seasons. Fire (no fire, summer fire, fall fire) and rate of nitrogen addition (0, 46, 80 kg N·ha^{-1}) were arranged in a completely randomized, fully factorial design. Samples were collected at five phenological stages throughout each growing season. Forage quality was assessed using nutrient analyses of crude protein (CP), net energy (NE_m), and total digestible nutrients; antiquality analyses of neutral detergent fiber (NDF), acid detergent fiber, and silica; in vitro fermentation for organic matter disappearance (IVOMD) and NDF disappearance; and gas production (asymptotic [maximum] gas production, fractional rate of gas production, lag time, and average fermentation rate). In vegetative stages, summer and fall fire increased CP from 6.2% to 12.1% and 13.0%, respectively, and NDF decreased from 72.1% to 69.4% and 68.2%, respectively. Summer and fall fire reduce silica content from 7.0% to 4.1% and 4.3%, respectively. Purple threeawn IVOMD increased by 14.0% and 13.0% following summer and fall fire, respectively, compared to nonburned plots. Nitrogen addition increased CP from 7.5% to 8.0% and 8.4%, respectively, with 46% and 80 kg N·ha^{-1}, respectively. In vitro fermentation and gas production variables did not change due to nitrogen addition. Fire generally improved purple threeawn forage quality to a greater extent than did nitrogen addition. Results indicate fire can potentially improve the suitability of purple threeawn as a forage species.

Key Words: digestibility, gas production, in vitro fermentation, prescribed burning, purple threeawn, silica

INTRODUCTION

Purple threeawn (*Aristida purpurea* Nutt.) is a warm-season (C_4) perennial bunchgrass native to North America. Purple threeawn varieties are mostly found on hillsides and dry upland areas of rangelands (Evans and Tisdale 1972), but can also be found in pastures where it is often considered to be undesirable for forage and wildlife habitat (Hyder et al. 1975). In the western United States, purple threeawn has been shown to dominate overgrazed rangelands and disturbed areas such as old fields and roadsides (Klipple and Costello 1960; Evans and Tisdale 1972). Purple threeawn is generally unpalatable to grazing animals due to sharp awns and calluses that can irritate or injure the mouth, nostrils, and eyes (Vallentine 1961). Purple threeawn also has high fiber and low protein concentrations, which reduce forage value relative to other rangeland grasses (Rauzi et al. 1969; Cogswell and Kamstra 1976; Meyer and Brown 1985; Ramirez et al. 2004). Purple threeawn reproduces vegetatively and is also capable of producing abundant seeds, which enter the ground quickly and have a high probability of germination (Evans and Tisdale 1972; Fowler 1984). Seedlings rapidly develop a deep, robust root system, making purple threeawn very competitive and increasing purple threeawn's ability to withstand drought and herbivory (Evans and Tisdale 1972; Fowler 1984; Busso et al. 2001).

Purple threeawn is of poor to fair forage nutritive quality in most regions (Dittberner and Olsen 1983; Ramirez et al. 2004). It is generally accepted that fire improves forage quality of grasses by removing mature, less palatable plant material, thus increasing both crude protein and digestibility of grasses (Norton 1982; Mbatha and Ward 2010). Fire can also indirectly improve forage quality by creating more optimal conditions for nitrogen mineralization through combustion of litter, thereby increasing plant-available nitrogen (Seastedt and Knapp 1993). Large herbivores favor burned areas with new succulent vegetation over nonburned areas where biomass has accumulated from previous years (Tomor and Owen-Smith 2002; Vermeire et al. 2004). Although fire effects on purple threeawn density and competitive ability are well-documented (Evans 1967; Trlica and Schuster 1969; Wright et al. 1978; Russell et al. 2013), there are few data describing how fire affects its forage quality. Improving forage quality of purple threeawn relative to other forage species in the plant community is paramount for improved herbivory in a targeted grazing strategy.

Soil nitrogen availability can limit forage quality and quantity, especially in semiarid rangelands (Wilman 1975;

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