The Professional Animal Scientist 33:472–482
https://doi.org/10.15232/pas.2016-01560

Performance of alfalfa–sainfoin mixed pastures and grazing steers in western Canada

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ABSTRACT

A multi-year, multi-location grazing study with alfalfa (*Medicago sativa* L.) and sainfoin (*Onobrychis viciifolia* Scop.) mixed pastures was undertaken to determine pasture productivity and quality. At Lethbridge, mixed pastures of 3 experimental sainfoin populations (LRC-3401, LRC-3432, and LRC-3519) and Nova sainfoin with AC Blue J alfalfa were established in a replicated experiment in 2008. A similar experiment with Beaver alfalfa was established in 2009 at Swift Current, Saskatchewan, Canada (SC). The experimental populations were developed to persist in mixtures with alfalfa under a multiple-cut system. Pastures were grazed by steers using a rotational grazing system at a stocking rate of 4.0 animal unit month ha/yr (8.6 steers/ha per season). Four-year mean DM yields of LRC-3432 (10,713 kg/ha) and LRC-3519 (10,530 kg/ha) mixed pastures were higher ($P < 0.05$) than Nova (9,668 kg/ha) pastures. Percentages of DM in LRC-3432 (28–30%) and LRC-3519 (30–43%) in the mixed pastures were higher ($P < 0.05$) than Nova (5–8%) after the first rotation of grazing in all years at Lethbridge and in 2010 at SC. In continuous stocking experiments with different alfalfa mixtures, the same 2 sainfoin lines produced higher ($P < 0.05$) DM forage yields than Nova at Lethbridge but not at SC. Average daily gains of steers varied between 0.7 and 1.2 kg/d at both Lethbridge and SC, but the differences among pastures were not significant. New sainfoin populations, LRC-3432 and LRC-3519, can be used in alfalfa pastures for high ADG and bloat prevention, because they produced high DM yields and proportions in the mixed pastures.

Key words: alfalfa, sainfoin, cattle grazing, pasture bloat, productivity

INTRODUCTION

Alfalfa is by far the most productive forage legume crop in western Canada (Popp, 1995; McCartney and Horton, 1997). This fact, coupled with its high nutritional value (Dahlberg et al., 1988; Mir et al., 1994), and particularly its rapid digestibility (Dahlberg et al., 1988), make alfalfa one of the few forage crops that is capable of sustaining beef cattle growth of 1 to 1.5 kg/d (Popp et al., 2000). Gains of 535 to 923 kg/ha have been reported for steers grazing alfalfa pastures (Joyce and Brunswick, 1977; Burris et al., 1993). Cattle grazing alfalfa can bloat, thus reducing ADG, and in extreme cases this can cause animal death (Majak et al., 1995). In addition, the rapid protein degradation in the rumen also causes loss of nitrogen in the form of urea, thereby reducing N use (Dahlberg et al., 1988). Animals, therefore, do not fully use protein content, resulting in loss of N from the pasture system (Dahlberg et al., 1988).

Sainfoin is a perennial forage legume containing condensed tannin (McMahon et al., 1999; Wang et al., 2006) that has the capacity to produce high DM yield (Fortune, 1985; Goplen et al., 1991; Acharya et al., 2013) and high-quality forage (Spedding and Diekmahns, 1972; Sottie et al., 2014) and is well suited for grazing and making hay or silage. Interestingly, when sainfoin is consumed with alfalfa, the presence of tannins from sainfoin reduces the proteolysis of alfalfa proteins in the rumen and this leads to significant bloat reduction (McMahon et al., 1999). The tannin–protein complex formed in the rumen is disassociated in the abomasum and enables plant protein to be digested and absorbed in the small intestine, by increasing protein use (McMahon et al., 1999). A 72 to 98% bloat reduction in cattle grazing alfalfa–sainfoin mixed pastures with 25 to 35% sainfoin DM in the mixture has been reported (Wang et al., 2006; Sottie et al., 2014). In addition, Li et al. (1996) and McMahon et al. (1999) indicated that a minimum of 10% sainfoin DM in mixtures with alfalfa will control pasture bloat, but the incidence of bloat reached 47% in the study by McMahon et al. (1999) when the sainfoin was fed as hay or fresh herbage to confined Jersey steers. It has been reported that steers grazing on pure sainfoin pasture gained 0.86 and 0.96 kg/d (Parker and Moss, 1981; Mowrey et al., 1992), which is comparable to ADG on alfalfa pastures. However, old sainfoin

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cultivars have poor regrowth after haying or grazing (Bolger and Matches, 1990; Acharya et al., 2013) and seldom produce as much biomass as alfalfa in pure stands. In mixed sainfoin–alfalfa stands with newly developed sainfoin cultivars, the biomass reduction can be minimized or eliminated, while reducing the bloat incidence compared with animals grazing pure alfalfa pastures (Acharya et al., 2013; Sottie et al., 2014).

A major weakness of sainfoin cultivars (e.g., Melrose and Nova) registered for western Canada is that they do not persist in alfalfa pastures and do not grow back at the same rate as alfalfa after grazing. New sainfoin populations were developed for persistence in mixed alfalfa stands with similar growth pattern to that of alfalfa in a multiple-cut system at the Lethbridge Research and Development Centre (**LRC**), Alberta, Canada (Acharya et al., 2013). These populations were developed using a selection criteria for maintaining a minimum of 25% DM in the mixture coming from sainfoin over the growing season in a multiple-cut system. Although no direct grazing was involved at the time of selection, the hypothesis was that the populations developed would have adaptation for a rotational grazing system (Acharya et al., 2013). Some of the populations developed at LRC were found to perform better in mixed stands with alfalfa under multiple-cut systems in western Canada than old cultivars registered for commercial production in this area (Acharya et al., 2013). One of the new populations was found to prevent 98% bloat in cattle, significantly ($P < 0.01$) better than old Nova sainfoin in mixed alfalfa stands under conditions suitable for bloat development over 3 yr (Sottie et al., 2014).

Forage production and animal BW gains are good indicators of productivity of pasture land (Large et al., 1984), and different grazing systems can have an effect on the pasture production and species composition. Greater changes have been reported in botanical composition of forages in continuously grazed pastures than in rotationally grazed pastures (Walton et al., 1981).

The hypothesis is that the alfalfa–sainfoin mixed pastures with newly developed sainfoin populations have higher DM yield, which will lead to greater animal growth performance than the old cultivars. We also hypothesize that sainfoin persistence will be greater in rotationally grazed pastures than in continuously grazed pasture because of reduced grazing pressure.

The objectives of this study were to determine pasture productivity, botanical compositions of alfalfa and sainfoin in mixed pastures, nutritional value of the forages, and animal productivity under rotational grazing in 2 different ecoclimatic zones in western Canada.

MATERIALS AND METHODS

Experimental Locations

Three experiments were conducted, with a rotational and a small-plot continuous stocking at LRC, Alberta, and a rotational grazing experiment at the Semiarid Prairie Agricultural Research Centre, Swift Current, Saskatchewan (**SPARC**).

The LRC plots were located at 49°42′N latitude 112°47′W longitude at 899 m above sea level. In the summers of 2010, 2011, and 2012, direct grazing was conducted on mixed alfalfa–sainfoin stands established on June 19, 2008. The mixed pastures were grown on a dark brown Chernozem soil that is a slightly alkaline clay loam (Larney and Janzen, 2012). It is important to note that Lethbridge enjoys a semiarid climate with an average maximum annual temperature of 12.3°C and an average minimum annual temperature of −1.1°C with precipitation averaging 365 mm/yr (Environment Canada, 2013).

Semiarid Prairie Agricultural Research Centre is located at 50°16′N latitude 107°44′W longitude at 825 m above sea level in Swift Current. The pastures were established on a brown Swinton silt loam soils (Ayres et. al., 1985). Swift Current has an average maximum annual temperature of 9.7°C and an average minimum annual temperature of −2.5°C and precipitation averages of 330 mm/yr (Environment Canada, 2013).

Pastures and Experimental Design

Sixteen mixed pastures of 4,050-m^2 size were seeded in 2008 as in a 4-times replicated randomized complete block design at LRC, Lethbridge. It should be noted here that the size of individual pastures at both locations was limited by the availability of seeds for the newly developed experimental populations. Pasture treatments consisted of AC Blue J alfalfa (**BJ**) in mixtures with an old sainfoin cultivar Nova and 3 new sainfoin populations (LRC-3401, LRC-3432, and LRC-3519 designated as LRC-A, LRC-B, and LRC-C, respectively). All 4 alfalfa–sainfoin pasture treatments were seeded at 5 and 15 kg/ha alfalfa and sainfoin, respectively, to achieve a 50:50 ratio of the 2 populations on a DM basis. Alfalfa and sainfoin were seeded in alternate rows with row spacing of 18 cm. All 16 pasture plots were divided by electric fences, and each plot was further divided into 4 paddocks for rotational grazing. The LRC pastures were irrigated with 5 cm of water when needed using a wheel-line irrigation system. In 2009 the LRC pastures were given multiple cuts on June 11 and July 19 using a forage harvester, and the plant material was removed after harvest. Grazing was done in 2010 to 2012 at this location.

A similar experiment with the same experimental design, seeding rate, and plot size was established in 2009, and grazing was carried out in 2010 and 2011 at SPARC, Swift Current, Saskatchewan. At this location, the alfalfa cultivar used in the mixed pasture was Beaver, which is a common alfalfa cultivar seeded in southern Saskatchewan, commonly used for dryland areas of western Canada. The row spacing used was 30 cm. These plots were not irrigated (rain fed).