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Irrigated Birdsfoot Trefoil Variety Trial: Forage Nutritive Value

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Birdsfoot Trefoil Quality in Brief

Birdsfoot trefoil is a high-quality forage recommended for irrigated perennial pastures, either in mixtures with grasses or in pure stands. In this bulletin we report on the forage nutritive value of pure stands of birdsfoot trefoil harvested at 6-week intervals, and compare it to alfalfa harvested at the same intervals. We found that the digestibility of the two forages was similar, but that alfalfa had higher protein than birdsfoot trefoil in spring and autumn. Alfalfa had more fiber than birdsfoot trefoil but the alfalfa fiber was more digestible. However, birdsfoot trefoil had higher non-fibrous carbohydrates than alfalfa, so its relative forage quality was equal to or greater than that of alfalfa.

Introduction

This is the second of two reports of results from a variety trial with 14 cultivars of birdsfoot trefoil (*Lotus corniculatus* L.), a non-bloating legume, and two cultivars of alfalfa (*Medicago sativa* L.). This was an irrigated small-plot trial at the Utah Agricultural Experiment Station Greenville Farm in North Logan (Cache Co.), Utah. As noted in the earlier report, this site is at an elevation of 4580 ft (1397 m) and averages 18 in (450 mm) annual precipitation and 4691 growing degree days (base 40º F)/year. Cultivars of birdsfoot trefoil used in this trial varied in origin: AU Dewey, Georgia 1, NC83-HT and NC83-BT, Norcen, Pardee, and Viking are U.S. cultivars; Bokor is Serbian, Exact is Canadian, Grasslands Goldie is from New Zealand, Lotanova is Italian, Lotar is Czech, Oberhaunstadter is German, and Rodeo is French. Not all cultivars are commercially available. Two U.S. grazing-type alfalfa cultivars, Spredor 4 and WL 326 GZ, were used as check varieties.

Planting and Management

Briefly, birdsfoot trefoil cultivars were drill-seeded at 8 lb pure live seed (PLS)/acre, and alfalfa cultivars were seeded at 12 lb PLS/acre into Millville silt loam (a coarse-silty, carbonatic, mesic Typic Haploxeroll) on 26 April 2005 in a randomized complete block design with three replications. For additional details of the planting and management of this trial, see the Extension publication *Irrigated Birdsfoot Trefoil Variety Trial: Forage Yield* (AG/Forages/2013-01pr).

Forage Nutritive Value

While alfalfa has numerous upright stems with many branches, birdsfoot trefoil has many fine

stems that originate from axillary buds at the base of shoots following harvest. Birdsfoot trefoil produces a denser, shorter stand than alfalfa and is well-suited to grazing, either in mixtures with grass or in pure stands. Because birdsfoot trefoil contains a small amount (2-4% of dry matter; DM) of a unique tannin, it is non-bloating and can be grazed without restriction.

Relevant Data from Earlier Studies: Nutritive value components were determined for birdsfoot trefoil and alfalfa in studies carried out in the Upper Midwest in the 1980s. In Iowa, Buxton and others (1985) determined the DM digestibility of Viking birdsfoot trefoil and compared it with the average of Magnum and Spredor 2 alfalfas. Forage was sampled from 10 May through 20 June, old growth was harvested, and regrowth was sampled from 26 July through 8 September. Except for the first harvest on 10 May, the DM digestibility of birdsfoot trefoil was equal to or higher than for alfalfa. Leaf digestibility was higher for alfalfa than for birdsfoot trefoil, but stem digestibility was higher for birdsfoot trefoil. As forages continue growth into maturity, stem DM increases and leaf DM decreases, because leaves near the ground senesce. In this Iowa study, leaf loss by the end of each growth period was greater for alfalfa than for birdsfoot trefoil, and crude protein (CP) was the same for both forages.

In a study carried out in Minnesota between 10 May and 28 June, the DM digestibility of Norcen and Leo birdsfoot trefoil were compared with Iroquois alfalfa, and it was demonstrated that birdsfoot trefoil had higher DM digestibility than alfalfa during this first growth period (McGraw and Marten, 1986). Again in this study, leaf DM digestibility was higher for alfalfa than for birdsfoot trefoil, and stem DM digestibility was lower for alfalfa than for birdsfoot trefoil. Crude protein was not statistically different between the two legume species.

In a third study (Hall and Cherney), Pennsylvania State University reported a total digestible nutrient (TDN) concentration of 63% for birdsfoot trefoil compared with 54% for alfalfa. They related their findings to a 21% higher heifer average daily gain and 10% higher cattle production/acre reported for birdsfoot trefoil compared with alfalfa in Minnesota (Marten et al.,1987).

In our trial, which was harvested three times/year during 2006 through 2009, the forage nutritive value of the averages of birdsfoot trefoil and alfalfa cultivars were compared at 6-week harvest intervals in 2008. Maturity at harvest ranged from early- to late-bloom stage. Because we evaluated two alfalfa cultivars and 14 birdsfoot trefoil cultivars, data are less precise for alfalfa. We saw no differences in *in vitro* true DM digestibility (IVTDMD, 48-hour incubation in rumen fluid) between average values for cultivars of alfalfa and birdsfoot trefoil (Fig. 1), but IVTDMD levels increased in early autumn.

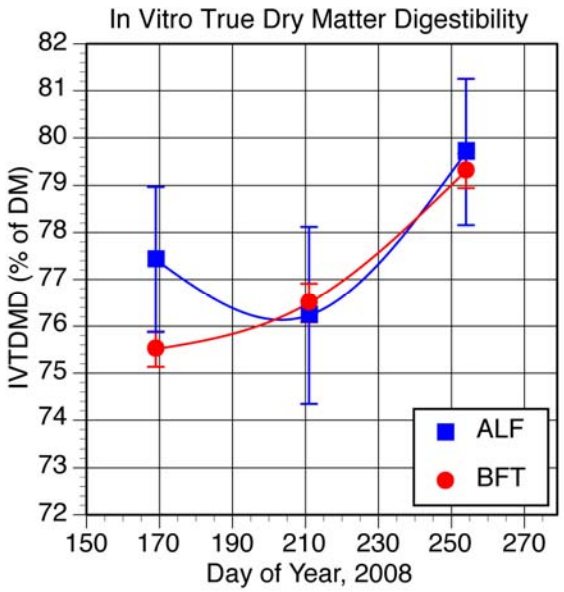

Figure 1. Digestibility of birdsfoot trefoil and alfalfa in 2008 (± confidence interval; P=0.05).

Crude protein was similar for birdsfoot trefoil and alfalfa at the second harvest, in mid-July, but the CP content of birdsfoot trefoil was lower at both the spring and autumn harvests (Fig. 2A). The CP content of birdsfoot trefoil fluctuated between 17-20%, while the CP of alfalfa fluctuated between 19-22%. As we noted in the variety trial yield publication, harvested forages were oven-dried and therefore may be higher in quality than would be expected for field-dried and baled hay.

Alfalfa had higher neutral detergent fiber (NDF; total forage fiber) concentrations at all harvests than birdsfoot trefoil (Fig. 2B), and levels decreased through the season. Forage fiber varies widely in digestibility due to differences in lignification and other factors. Alfalfa NDF was less lignified (data not shown) and significantly more digestible than birdsfoot trefoil NDF (NDFD, 48-hour incubation in rumen fluid; Fig. 2C). We did not analyze leaf and stem samples separately, but leaves are low in fiber and highly digestible compared with stems. Stems have a high proportion of fiber so digestibility decreases as the proportion of stem increases. Birdsfoot trefoil had less fiber than alfalfa, but the birdsfoot trefoil fiber was less digestible than alfalfa fiber. Dry matter digestibility (IVTDMD) was similar in the two forages because alfalfa had higher fiber which was more digestible while birdsfoot trefoil had less fiber which was less digestible.

Total digestible nutrients (TDN) is an estimate of feed energy availability based on summation of digestible fractions of total DM, including non-structural or non-fibrous carbohydrates (NFC), which is part of the highly-digestible portion of DM. Our data for the TDN of alfalfa and birdsfoot trefoil (Fig. 2D) demonstrated there were no measurable differences between the two species at 6-week harvest intervals, and that levels increased by early autumn. Partly as a consequence of lower NDF concentration, birdsfoot trefoil had significantly higher NFC than alfalfa when both forages were harvested at 6-week intervals (Fig. 2E), and levels increased as the season advanced.

Relative forage quality (RFQ; Undersander and Moore, 2002) is an index used to rank the value of different forages on the basis of potential daily digestible DM intake. The RFQ of full-bloom alfalfa hay, the reference forage for this index, is 100, so values greater than 100 reflect higher nutritive value than full-bloom alfalfa. Calculation of RFQ is based on digestible levels of non-fiber constituents (NFC, CP, and fatty acids), plus fiber and fiber digestibility, and is more strongly correlated with cattle performance than relative feed value (RFV), which does not account for differences in fiber digestibility among forage sources. The RFQ of birdsfoot trefoil in our variety trial in 2008 followed a seasonal pattern similar to those of IVTDMD and TDN, but was not statistically different from that of alfalfa (Fig. 2F).

In 2009, to provide insight into the development of forage quality during the growth of forages between harvests, cultivars of birdsfoot trefoil and alfalfa were sampled at 2-week intervals, and forage was harvested and removed from all plots at 6-week intervals. The data for 2009 are averages from one replication of all cultivars of birdsfoot trefoil or alfalfa. Data for samples taken after 6 weeks of regrowth are circled in green to facilitate comparison with 2008 data.

The decline in digestibility (IVTDMD) and RFQ with increasing maturity during regrowth for both species can be seen in Figs. 3A and 3B, respectively. While very immature alfalfa was significantly higher in quality than birdsfoot trefoil, alfalfa quality decreased rapidly as stem dry matter accumulated. At the first harvest, in spring, both digestibility and RFQ were lower for alfalfa than for birdsfoot trefoil, but at the mid-summer and autumn harvests, there were no differences between the two species in these characteristics. Values for NFC were higher for birdsfoot trefoil than for alfalfa during regrowth in 2009, but at the summer and autumn harvests there were no significant differences between alfalfa and birdsfoot trefoil (Fig. 3C). For each 6-week harvest date, IVTDMD followed a similar pattern as in 2008, but NFC and RFQ were more similar among harvests than in 2008.

Birdsfoot trefoil has proven to be persistent in the Mountain West region (MacAdam and Griggs, 2006), and we are continuing to study the performance of cattle grazing birdsfoot trefoil (MacAdam et al., 2011). Birdsfoot trefoil is of particular interest because it contains a low concentration of tannin that prevents bloat and allows it to be grazed in pure stands. The birdsfoot trefoil tannin is unique in that it increases the efficiency of ruminant protein use. Birdsfoot trefoil is a high-quality, nitrogen-fixing, deep-rooted perennial legume that can increase the nitrogen- and water-use efficiency of pastures compared with grasses alone or grass-clover pastures. The birdsfoot trefoil tan-

nin also reduces ruminant methane and ammonia emissions compared with other feeds, an increasingly important trait for cattle production systems.

References

• Buxton, D.R., J.S. Hornstein, W.F. Wedin, and G.C. Marten. 1985. Forage quality in stratified canopies of alfalfa, birdsfoot trefoil, and red clover. Crop Science 25: 273-279.

• Hall, M., and J. Cherney. (undated) Birdsfoot trefoil. Agronomy facts 20. Penn State Univ. http://extension.psu.edu/cmeg/facts/agronomy-facts-20

• MacAdam, J.W., and T.C. Griggs. 2006. Performance of birdsfoot trefoil, white clover, and other legume-grass mixtures under irrigation in the Intermountain West U.S.A. Proc. N.Z. Grassl. Assoc. 64: 355-359.

• MacAdam, J.W., R.E. Ward, T.C. Griggs, B.R. Min, and G.E. Aiken. 2011. Average daily gain and blood fatty acid composition of cattle grazing the non-bloating legumes birdsfoot trefoil and cicer milkvetch in the Mountain West. Prof. Anim. Sci. 27:574-583.

• Marten, G.D., F.R. Ehle, and E.A. Ristau. 1987. Performance and photosensitization of cattle related to forage quality of four legumes. Crop Science 27: 138-145.

• McGraw, R.L., and G. C. Marten. 1986. Analysis of primary spring growth of four pasture legume species. Agronomy Journal 78: 704-710.

• National Research Council. 2001. Nutrient requirements of dairy cattle. 7th revised ed. National Academy Press, Washington, DC.

• Undersander, D., and J.E. Moore. 2002 Relative forage quality. Focus on Forage, Vol. 4, No. 5. University of Wisconsin Cooperative Extension.

PERENNIAL LEGUME PASTURES

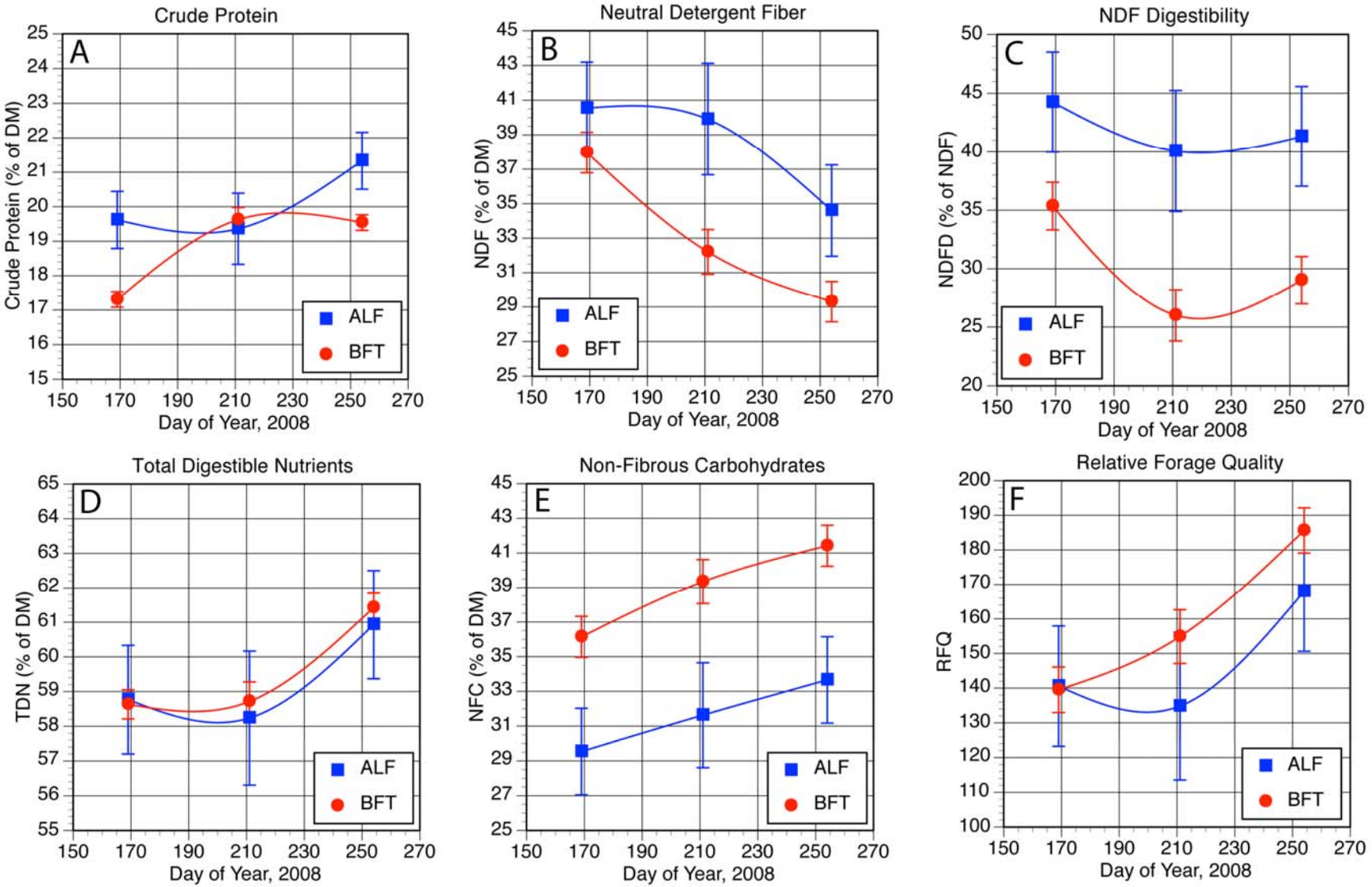

Figure 2. Forage nutritive value parameters of birdsfoot trefoil (BFT) and alfalfa (ALF) determined at harvest intervals of 6 weeks in 2008 (± confidence interval; P=0.05). *In vitro* true DM digestibility and neutral detergent fiber digestibility are from 48-hour incubation in rumen fluid. Total digestible nutrients are calculated according to the NRC 2001 Dairy summative equation (NRC, 2001). Relative forage quality, an index of potential daily digestible DM intake, is calculated with respect to full-bloom alfalfa hay, for which RFQ=100.

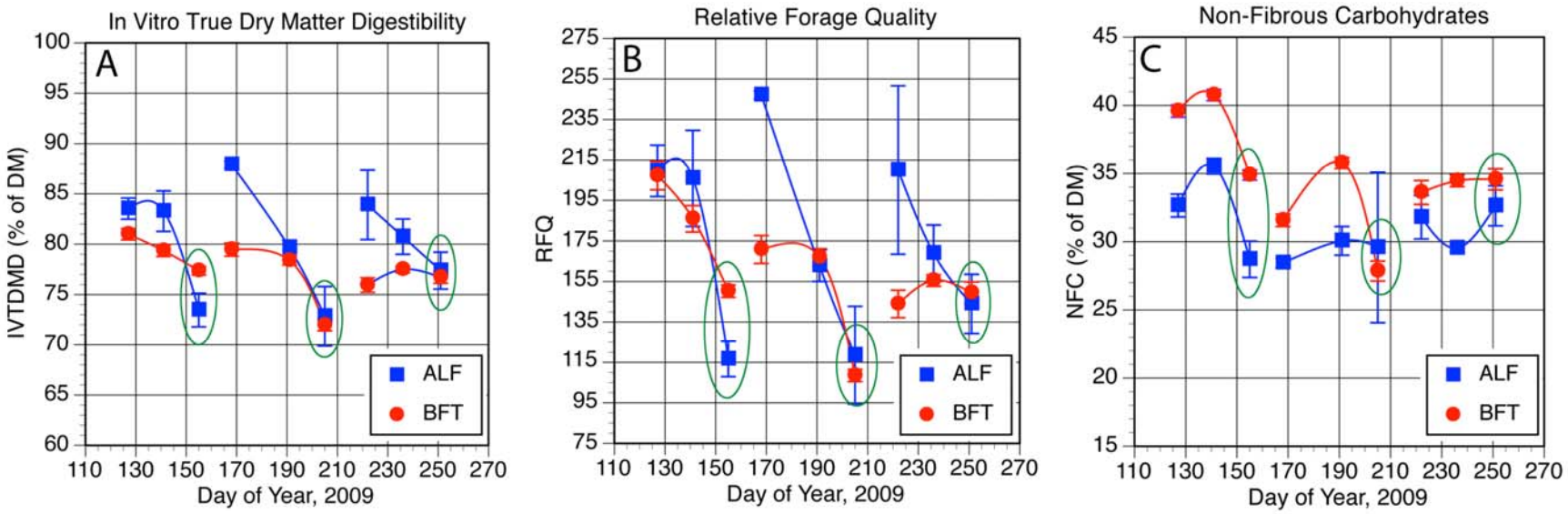

Figure 3. Forage nutritive value parameters of birdsfoot trefoil (BFT) and alfalfa (ALF) sampled at 2-week intervals in 2009 (± standard error of the mean). Data are the mean of 14 cultivars of birdsfoot trefoil or 2 cultivars of alfalfa. One replication of the variety trial was sampled at each 2-week interval, and all forage was harvested and removed at 6-week intervals. Sampling dates corresponding to data for 2008 in Fig. 2 are circled in green. *In vitro* true DM digestibility is from 48-hour incubation in rumen fluid. Relative forage quality, an index of potential daily digestible DM intake, is with respect to full-bloom alfalfa hay, for which RFQ=100.