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Irrigated Birdsfoot Trefoil Variety Trial: Forage Yield

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Birdsfoot Trefoil Yield in Brief

Like alfalfa, birdsfoot trefoil is a deep-rooted legume that fixes its own nitrogen. However, it contains a small amount of tannin which means that cattle and sheep will not bloat, even when grazing birdsfoot trefoil in pure stands. In this bulletin, we report on the dry matter production of a number of cultivars of birdsfoot trefoil and find that it yielded about two-thirds as much as alfalfa in pure stands. Birdsfoot trefoil is finer stemmed, shorter and denser than alfalfa, and performs well in mixtures with forage grasses like meadow brome, tall fescue or orchardgrass. We recommend birdsfoot trefoil for perennial irrigated pastures used for ruminant grazing.

Introduction

This report summarizes the forage dry matter yields of 14 cultivars of birdsfoot trefoil (*Lotus corniculatus* L.), a non-bloating legume, and two cultivars of alfalfa (*Medicago sativa* L.) during 4 years of production in an irrigated small-plot trial at the Utah Agricultural Experiment Station Greenville Farm in North Logan (Cache Co.) Utah. 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 (Fall Dormancy 2 and 4, respectively), were used as checks in this trial.

Planting

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. Each 3- by 20-ft plot had five drill rows spaced 6 in apart, with a 1-ft gap between adjacent plots. Outer rows of perimeter plots were bordered by a plot of Norcen birdsfoot trefoil, and ends of plots were bordered by alleys and headlands seeded with Houndog 5 turf-type tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.] (Fig. 1). Plots were sprinkler-irrigated with an average of 1.8 in of water/week applied every 7-10 days from mid-May through mid-September.

Initial soil test levels in the surface 12 in were pH 7.8, organic matter (OM) 2.9%, and 35, 295, and

8 ppm of phosphorus (P), potassium (K), and sulfate-sulfur (SO_4-S), respectively. In June 2007, levels were pH 7.5, OM 1.7%, and 26, 188, and 4 ppm of P, K, and SO_4-S, respectively. Adequate soil levels for perennial legumes such as alfalfa and birdsfoot trefoil are 15-30 ppm P, 150-250 ppm K, and 8 or more ppm SO_4-S. Levels in 2009 were pH 7.1, OM 2.7%, and 13, 136, and 4 ppm of P, K, and SO_4-S, respectively, all of which were low, underscoring the high nutrient removal rates of productive forage stands.

Management

Birdsfoot trefoil and alfalfa plots were harvested three times each year, in early June, mid-July, and late August-early September, providing a regrowth period of approximately 6 weeks between harvests. Maturity stages at harvest ranged from late vegetative to late bloom and were usually at the early- to late-bloom stage. Birdsfoot trefoil should be allowed to regrow without grazing or harvesting for 4-6 weeks from early September until the first killing frost so carbohydrates and proteins can accumulate in the crown and root for winter survival and spring regrowth.

Yield

Yields were determined by direct harvest in 2006 and 2007. All forage was removed above a 3-in stubble height from trial plots on each harvest date, and the fresh weight/acre of the harvested forage was calculated. A 0.5-lb (0.23-kg) subsample of fresh forage was oven-dried at 131 ºF (55 ºC) for 2 days to determine the dry matter (DM) content of each cultivar.

The timing of harvest, regrowth period, and cutting height were those recommended for commercial hay production, but the forage was not windrowed, dried, or baled on the plots. Therefore, loss of DM from respiration during drying in the windrow and from leaf shatter during mechanical baling was nearly eliminated, so forage yield of both alfalfa and birdsfoot trefoil will be 10-15% higher than would be expected for farm-scale hay production.

Figure 1. Variety trial plots of birdsfoot trefoil (yellow flowers) and alfalfa (darker green) in the seeding year 2005 (above) and the establishment year 2006 (below).

In 2008 and 2009, forage DM yield was determined using a non-destructive rising plate meter (RPM) calibrated separately for birdsfoot trefoil and alfalfa. Five RPM readings were taken in each plot, and then a calibration sample was cut from the area under the RPM in the same plot. Calibration samples were oven-dried and a calibration curve was developed to predict the DM yield of birdsfoot trefoil. The same process was used to develop a RPM calibration curve for alfalfa. All forage was removed above a 3-in stubble height from plots on each harvest date.

The 14 cultivars of birdsfoot trefoil did not differ significantly in yield, and mean 3-year yield was 6.38 tons/acre (Table 1). Data for each year can be seen in Table 2. Yield data for 2006 are republished from Grabber et al. (2014). In 2009, plots were sampled by replication at 2-week intervals so DM accumulation during regrowth could be illustrated. Therefore, yield data for 2009 in Table

2 are from one replication only, and were not included in the calculation of mean values reported in Table 1. All cultivars have persisted beyond the 4 years reported here.

Table 1. Mean annual yield of birdsfoot trefoil and alfalfa cultivars over the 3 years from 2006 through 2008. Means sharing the same letter are not significantly different at P=0.05.

Cultivar	Tons DM/Acre	
WL 326 GZ alfalfa	8.65	a
Spredor 4 alfalfa	8.48	a
NC83-HT BFT	6.61	b
Lotanova BFT	6.30	b
Georgia 1 BFT	6.24	b
AU Dewey BFT	6.19	b
NC83-BT BFT	6.12	b
Lotar BFT	6.11	b
Viking BFT	6.11	b
Grasslands Goldie BFT	6.09	b
Exact BFT	5.97	b
Oberhaunstadter BFT	5.94	b
Norcen BFT	5.93	b
Pardee BFT	5.84	b
Rodeo BFT	5.80	b
Bokor BFT	5.68	b
Mean 3-year yield, all BFT cultivars	6.07	

In trials carried out at Rosemount, MN, that included five of these same birdsfoot trefoil cultivars, mean annual yield for 3 years was 3.7 tons/acre (Ehlke and Vellekson, 2010), about 60% of the mean 3-year Utah DM yield. In Utah, in the establishment year (2006), mean birdsfoot trefoil yield was 5.73 tons/acre, while alfalfa yield was 8.09 tons/acre (Table 2). Yield peaked for both birdsfoot trefoil (7.77 tons/acre) and alfalfa (11.66 tons/acre) in 2007, the year following establishment. The yield of birdsfoot trefoil was about two-thirds that of alfalfa in the first 2 years, but the trend over time was toward more similar yields for the two species (Table 2).

Regrowth

In 2009, RPM readings were taken from one replication 4 weeks before each harvest, a second replication 2 weeks before each harvest, and a third replication on each harvest date. Fig. 2 shows the mean yield of all birdsfoot trefoil cultivars on each sampling date.

The DM accumulation rates for the three 6-week growth periods are 64 lb/acre-day from mid-April through early June; 54 lb/acre-day from early June through mid-July, and 39 lb/acre-day from mid-July through the end of August. The June and July growth rates don't differ from one another (P=0.20), but June and July growth rates differ from the August rate (P=0.002). July and August growth rates also differ from one another (P=0.05). For half the cultivars, maximum forage DM was reached after 4 weeks of regrowth during the mid-summer regrowth cycle. This figure demonstrates that DM accumulation in birdsfoot trefoil slows under the higher temperatures and evapotranspiration rates of summer compared with spring.

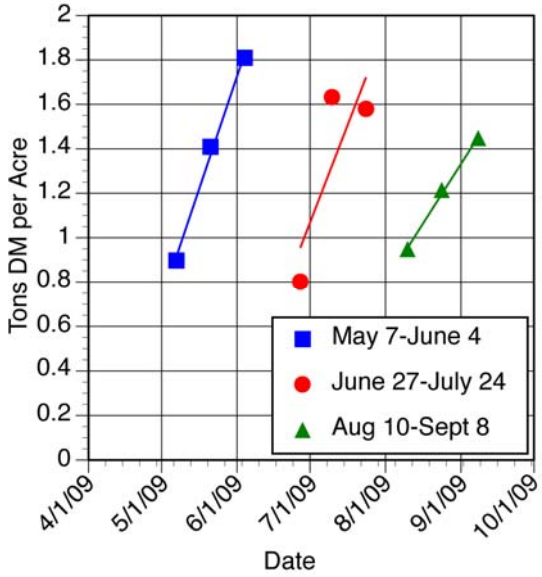

Figure 2. Regrowth of birdsfoot trefoil in 2009.

Management Recommendations

Soil Testing. The ideal time to address soil nutrient deficits is before new perennial pastures are seeded. A soil test should be taken at least 2

weeks before fertilizer needs to be ordered. Instructions for soil sampling are available from Utah State University at http://www.usual.usu.edu/forms/index.html.

Fertilization. For fertilizer recommendations for pure stands of birdsfoot trefoil, specify alfalfa as the crop to be grown, because birdsfoot trefoil resembles alfalfa in its growth habit and fertility requirements. Fertilizer recommendations based on soil test results can be found at http://www.usual.usu.edu/about/next/index.html ('Fertilizer management for alfalfa'). Fertilizers higher in P and K and lower in nitrogen (N) are recommended. Birdsfoot trefoil is a legume, so it will supply its own N from the atmosphere if the correct strain of fresh bacterial inoculant is properly applied at planting. Inoculant may be included as a seed coating or applied separately, but it must be the strain specific to birdsfoot trefoil; alfalfa inoculant is incompatible and will be ineffective.

Planting. Birdsfoot trefoil may be planted in the spring after the last frost or in late summer at least 6 weeks before the first frost (i.e., the first week of August), if sufficient irrigation is available. A seeding rate of 6 lb PLS/acre is commonly recommended for pure stands of birdsfoot trefoil; higher seeding rates will result in higher yields and fewer weeds in the establishment year. A spring oat companion crop at a rate of 1 bu/acre will reduce weeds, but should be clipped once or twice before heading stages in the seeding year to reduce competition with birdsfoot trefoil.

It is especially important to use certified seed of a named variety for perennial pastures to achieve persistent stands and high sustained yields. The birdsfoot trefoil cultivar Norcen has proven to be winter hardy and persistent in northern Utah. Leo is another cultivar available locally. Seed costs currently range from $3-$7/lb depending on the previous year's harvest.

Weed Control. Birdsfoot trefoil does not compete well with weeds or established forages during the seeding year. To effectively remove an established grass pasture with an herbicide before planting birdsfoot trefoil, irrigate and apply glyphosate (e.g., Roundup®) as soon as possible. Cultivate after plant death, in approximately 14 days. EPTC (e.g., Eptam®) may be disked into soil immediately before planting, and 2,4-DB may be applied to birdsfoot trefoil seedlings. Additional chemical weed control options for birdsfoot trefoil are presented in the 2006-2007 Montana, Utah, Wyoming Weed Management Handbook (Dewey et al., 2007). Check herbicide labels for legality of use, rates, and recommended adjuvants, such as crop oil concentrate, non-ionic surfactant and sprayer-grade ammonium sulfate. For low-input or organic seeding, an oat companion crop as mentioned earlier can be used to displace weeds in the seeding year. Clip oats or weeds at early growth stages to reduce competition with birdsfoot trefoil seedlings for water and sunlight.

Grazing Management. Birdsfoot trefoil should be grazed using rotational stocking. Late summer-planted birdsfoot trefoil should not be grazed the following year until it has begun to flower (i.e., late June). It is important to leave a stubble of at least 3 in following grazing, because birdsfoot trefoil regrows from buds on stems above the soil surface, rather than from crown buds below the soil surface, which is the case for alfalfa. Even after establishment, birdsfoot trefoil should not be grazed between early September and the first killing frost. This is a critical period for stand persistence, when birdsfoot trefoil stores nutrients required for spring regrowth in the crown and root.

Livestock Production

Birdsfoot trefoil is a dense, high-quality forage better suited to grazing and silage than to hay production when planted in pure stands. However, birdsfoot trefoil performed well in binary mixtures with tall fescue and meadow bromegrass (*Bromus riparius* Rehmann), while in orchardgrass (*Dactylis glomerata* L.) mixtures, the proportion of all perennial legume companions decreased over time (MacAdam and Griggs, 2006). In pure stands of birdsfoot trefoil, cattle average daily gains were 2.9-3.4 lb/day, with the higher gains accruing to a higher-tannin cultivar (MacAdam et al., 2011).

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PERENNIAL LEGUME PASTURES

Table 2. Forage dry matter yield of 14 birdsfoot trefoil (BFT) and 2 alfalfa (ALF) cultivars over 4 years. For 2006-2008 mean yield, see Table 1.

	2006				2007				2008				2009			
	Harv. 1	Harv. 2	Harv. 3	**Total**	Harv. 1	Harv. 2	Harv. 3	**Total**	Harv. 1	Harv. 2	Harv. 3	**Total**	Harv. 1	Harv. 2	Harv. 3	**Total**
Cultivar	6/7/06	7/13/06	8/25/06	**2006**	6/5/07	7/18/07	8/24/07	**2007**	6/17/08	7/30/08	9/10/08	**2008**	6/4/09	7/24/09	9/8/09	**2009**
	Forage DM (tons/acre)															
AU Dewey BFT	2.90	1.84	1.30	**5.70**	3.68	2.93	1.98	**8.60**	1.91	1.50	1.11	**4.52**	1.64	1.46	1.49	**4.59**
Bokor BFT	2.51	1.91	1.22	**5.56**	3.11	2.91	1.90	**7.92**	1.88	1.41	0.81	**4.10**	2.12	1.59	1.03	**4.73**
Exact BFT	2.78	1.62	0.92	**4.72**	3.66	2.84	1.73	**8.23**	2.57	1.75	0.90	**5.23**	1.73	1.78	1.58	**5.09**
Georgia 1 BFT	3.16	1.83	1.09	**5.94**	3.78	2.83	1.67	**8.28**	2.59	1.42	0.93	**4.94**	2.13	1.20	1.35	**4.67**
Grasslands Goldie BFT	3.15	1.86	1.32	**6.31**	3.06	2.66	1.70	**7.42**	2.12	1.81	1.17	**5.10**	1.48	2.17	1.67	**5.33**
Lotanova BFT	2.88	1.69	0.90	**5.47**	3.21	2.58	1.49	**7.27**	2.93	2.25	0.97	**6.15**	1.67	1.83	1.37	**4.87**
Lotar BFT	2.78	1.79	1.04	**5.61**	3.22	3.09	1.98	**8.28**	1.76	1.69	0.97	**4.43**	1.79	1.21	1.55	**4.55**
NC83-BT BFT	3.24	1.83	0.95	**6.00**	3.80	2.70	1.76	**8.25**	2.41	1.25	0.77	**4.43**	1.62	1.43	1.35	**4.40**
NC83-HT BFT	3.33	1.99	1.12	**6.44**	3.54	2.89	1.71	**8.13**	2.95	1.50	0.82	**5.27**	1.67	1.41	1.48	**4.57**
Norcen BFT	2.85	1.69	1.09	**5.77**	3.62	2.56	1.47	**7.65**	2.96	1.19	0.74	**4.90**	2.25	1.42	1.25	**4.92**
Oberhaunstadter BFT	2.75	1.92	1.24	**5.91**	2.91	2.84	1.89	**7.64**	1.72	1.34	1.21	**4.28**	1.48	1.77	1.67	**4.92**
Pardee BFT	2.54	1.70	1.16	**5.79**	2.91	2.40	1.48	**6.80**	2.84	1.75	1.13	**5.73**	1.97	1.48	1.46	**4.90**
Rodeo BFT	2.14	1.82	1.04	**5.01**	3.23	2.72	1.82	**7.76**	2.16	1.41	1.05	**4.63**	1.72	1.58	1.66	**4.95**
Viking BFT	2.96	1.74	0.81	**5.50**	3.58	2.65	1.42	**7.66**	2.97	1.36	1.13	**5.46**	2.00	1.73	1.32	**5.04**
Spredor 4 ALF	4.26	2.00	1.80	**7.67**	4.86	3.85	2.75	**11.46**	1.61	2.73	2.22	**6.56**	1.54	2.05	1.50	**5.09**
WL 326 GZ ALF	4.21	2.24	2.06	**8.51**	4.44	4.19	3.23	**11.86**	1.65	1.86	2.07	**5.58**	2.16	1.87	1.78	**5.81**
BFT mean yield	2.86	1.80	1.09	**5.70**	3.38	2.76	1.71	**7.85**	2.41	1.55	0.98	**4.94**	1.81	1.58	1.45	**4.82**
ALF mean yield	4.24	2.12	1.93	**8.09**	4.65	4.02	2.99	**11.66**	1.63	2.30	2.15	**6.07**	1.85	1.96	1.64	**5.45**
Ratio of BFT to ALF yield	0.67	0.85	0.56	**0.70**	0.73	0.69	0.57	**0.67**	1.48	0.67	0.46	**0.81**	0.98	0.80	0.88	**0.89**