

Comparison of Perennial and Biennial Legume Forages Production with Different Harvest Regimes

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Introduction

Legume forage species are of interest to producers because of their high protein content and production as well as their function of fixing nitrogen in the soils. Legumes have been used historically as hay and rangeland improvement species worldwide. In North Dakota, more than half of the hayland is occupied by alfalfa alone and in mixture with other species. Despite its characteristics as a superior forage legume species, alfalfa is not the best for every purpose such as early or late season grazing. Local interest in Canada milkvetch, northern sweetvetch, and crown vetch demonstrate the need to study other species as well as alfalfa for forages in our region.

Research has been conducted on legume forage species regarding their distribution, cultivars, management, and seed production on sites in a variety of climatic and soil conditions. We hope to expand our knowledge of legume varieties best suited for North Dakota, their response to varying harvest dates, and their effect on soil health.

A long-term study of perennial and biennial legumes was initiated in 2010 at CGREC as a starting point for the forage program.

Specific objectives are to:

1. Build a database of perennial and biennial forage legume species/varieties morphology, physiology, phenology, nutrition, productivity, stability, and longevity in our region.
2. Determine the soil health under different legume species/varieties, including but not limited to, soil organic matter, soil nitrogen, soil infiltration, and soil aggregate stability.

Materials and Methods

Forty-two legume species/varieties were seeded in 2010: alfalfa (5 varieties), cicer milkvetch (2), birdsfoot trefoil (5), sainfoin (3), Canada milkvetch, silver mountain lupine, black medic, white clover, alsike clover, red clover, strawberry clover, kura clover, thermopsis Montana, white prairie clover, purple prairie clover, northern sweetvetch, crown vetch, yellow sweetclover, white sweetclover, hairy vetch, crimson clover, berseem clover, chickling vetch, field pea, forage pea (2), cow pea, red cow pea, mung bean, lentil, and sunn hemp. Among these 30 species, 17 species are perennials, two species are biennials, and the remaining 11 species are annuals. The completely randomized block design is employed to design the field plots layout.



Each of the 42 treatments serves as a block and is replicated three times in the field, totaling $42 \times 3 = 126$ plots. Each plot is 20 feet \times 20 feet, with a 20-foot buffer zone between them seeded with crested wheatgrass. Seeding of legumes was done in late May 2010 without fertilizer application. Generic Select (Volunteer) herbicide (6-8 oz./acre) was applied to the plots to control undesirable grasses in the late growing season of 2010. In 2011, 12 annual legume species/varieties were replaced by perennial legume species/varieties: alfalfa (6 varieties), birdsfoot trefoil (1), white clover (2), and red clover (3).



Alfalfa – ‘Rugged’

Each plot of perennials and biennials planted in 2010 was split into four strips. In 2011, the first strip was harvested on July 7 and again on August 23 in a multi-cut system. The second and third strips were harvested in a single-cut system on August 23 and September 23, and the last strip will be cut in early May of 2012, also in a single-cut system. The multi-cut system demonstrates the common forage harvest regime in this region with the August 23 single-cut as a comparison baseline. The September 23 single-cut system will demonstrate bioenergy or late season grazing regimes and the early May single-cut system will demonstrate early season grazing regimes. All forage samples will be ground through a

1 mm screen for lab analysis of nutrition levels.



Alsike clover

Soil samples were collected in August 2010 and August 2011 at depths of 0-6 inches and 6-12 inches. The soil samples were air-dried, passed through a 2 mm soil sieve and sent to the laboratory for analysis of soil organic matter, soil total nitrogen, soil sulfur, and soil phosphorus.



Birdsfoot trefoil – ‘Pardee’

Results

Twenty-one out of thirty plots of perennial and biennial legumes were established from the 2010 growing season and grew well in the 2011 spring. These species were: alfalfa, alsike clover, birdsfoot trefoil, cicer milkvetch, crown vetch, red clover, sainfoin, white clover, white sweetclover, and yellow

sweetclover. In the spring of 2011, nine plots were reseeded: Canada milkvetch, silver mountain lupine, black medic, strawberry clover, kura clover, thermopsis Montana, white prairie clover, purple prairie clover, and northern sweetvetch.

Varieties of same species had minimal differences in productivity (Table 1). There was no significant difference in production between the different varieties of alfalfa



Cicer milkvetch – ‘Monarch’

Table 1 Perennial and biennial legume production (pounds/acre) with different harvest regimes at CGREC in 2011.					
Species/Varieties	Multi-cut System			Single-cut System	
	07-July First Cut	23-August Second Cut	Two Cuts Total	23-August First Cut	23-September First Cut
Alfalfa/PGI427	2452	2431	4883	3491	3402
Alfalfa/Pioneer	2512	2322	4834	3828	4065
Alfalfa/Rugged	2594	2208	4802	3672	3555
Alfalfa/TS4002	2408	2190	4598	3597	3251
Alfalfa/Vernal	2406	2394	4800	3921	4271
Alsike Clover	3110	2306	5416	2819	1481
Birdsfoot Trefoil/Empire	2376	2945	5321	4343	4349
Birdsfoot Trefoil/Leo	3162	3005	6167	6544	5378
Birdsfoot Trefoil/Norcern	2840	3773	6613	6008	4998
Birdsfoot Trefoil/Pardee	3604	3140	6744	6439	5695
Birdsfoot Trefoil/Viking	3228	3036	6264	6382	5726
Cicer Milkvetch/Lutana	1815	2988	4803	5349	5839
Cicer Milkvetch/Monarch	1576	2740	4316	4858	4730
Crown Vetch	2310	2511	4821	6717	5874
Red Clover/Medium	4833	3270	8103	4890	3961
Sainfoin/Eski	2864	1816	4680	3794	3311
Sainfoin/Remont	2398	2082	4480	3497	2875
Sainfoin/Shoshone	1926	1760	3686	3055	3116
White Clover/New Zealand	1513	1806	3319	1996	1074
White Sweetclover	4888	2171	7059	6040	5078
Yellow Sweetclover	5205	2220	7425	5195	5097

Detailed statistical analysis will be shown on the web at: www.ag.ndsu.edu/CentralGrasslands REC/

(PGI427, Pioneer, Rugged, TS4002, and Vernal), birdsfoot trefoil (Empire, Leo, Norcern, Pardee, and Viking), cicer milkvetch (Lutana and Monarch), and sainfoin (Eski, Remont, and Shoshone) across all the harvest regimes except birdsfoot trefoil/Leo production was higher than birdsfoot trefoil/Empire for the August

23 single-cut system. Production varied by species for each harvest regime as shown in Table 1. For the total production in the multi-cut harvest system, yellow sweetclover, white sweetclover, and red clover/Medium production was the highest at over 7,000 pounds/acre. For the August 23 first cut, crown vetch, birdsfoot trefoil,

white sweetclover, yellow sweetclover, cicer milkvetch yields were the highest at over 5,000 pounds/acre. For the September 23

first cut, production was the highest (>4,000 pounds/acre) for the same species as of August 23.



Crown vetch



Red Clover - Medium



Sainfoin - 'Remont'



White sweetclover

Discussion

Nine perennial legume species did not establish from 2010 and were reseeded in 2011. Several reasons can be found for these failures in establishment: climatic factors, such as a hard winter and a wet spring; soil factors, some species grow well in sandy soils and some not; seeding factors and seedling factors such as weed control. It is hard to find which factor is more related to these failures. If 2012 establishment is still poor, the species will be dropped and replaced by other species.

It is not surprising to find there is no difference between all the varieties within each species. Similar results were found in other studies. Some varieties were developed for specific growing conditions with an ability to tolerate salt, grazing, drought, pests, or cold temperatures. Our test plots included common situations such as similar soils, no grazing, similar water regime, and similar pest problems for all varieties. In 2012, more new species instead of varieties will be tested because of the similarity of different varieties.

All the perennial and biennial legumes tested here could be classified into different groups based on seasonal growth pattern. Yellow sweetclover, white sweetclover, and sainfoin are early-season growers with poor regrowth after first cut in July, and less loss in the late season harvest. Producers should harvest them a little earlier to improve the regrowth; furthermore, the weeds after first cut should be controlled in order to improve the regrowth. Red clover, alsike clover, and white clover are season-long growers with good regrowth after first cut, and less productive in the late season harvest. A more frequent harvest regime should be employed to obtain greater production and quality from these forages. They are not a good choice for bioenergy use. Cicer milkvetch and crown vetch are late season growers with great regrowth after first cut, and even more gain in late season harvest. They are good choices for bioenergy production and late season grazing. Producers should harvest them a little later to maximize their growth. Alfalfa and birdsfoot trefoil are all-season growers with almost equal growth rate all season long, and less loss in the late season harvest.

CGREC Annual Report - December 2011

Photos by Rick Bohn

This perennial and biennial legume trial initiated in 2010 will be comprehensive, dynamic and long-term. The selection of perennial and biennial legumes should not be based only on production, but also on nutrition and effects on soil health. Higher production doesn't assure higher quality; lower production doesn't assure less effect on soil health, and so on. As more data become available through the study, a better picture about perennial and biennial legumes will be presented. The process of screening and evaluating all the available legume species/varieties will continue and some which cannot fit our region's soil and climate will be replaced. One year's production data is not enough to compare species/varieties stability and longevity related to the fluctuation of weather from year to year.



Yellow sweetclover