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Feasibility of grazing sainfoin on the southern Great Plains

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Abstract

Forage is often in short supply on southern Great Plains grasslands during spring because warm-season grasses are dormant or just beginning to grow. Sainfoin (*Onobrychis viciifolia* Scop.), a non-bloat-inducing legume, can provide forage in semiarid regions during spring when irrigated. A study was conducted to investigate yield, quality, and persistence of sainfoin in a subhumid region of the southern Great Plains without irrigation. Sainfoin was established in 1989 and grazed with steers at early or late bloom growth stages in 1990 and 1991 to remove 50 or 75% of the forage height. Forage yield averaged 2,480 and 4,110 kg ha^{-1}, respectively in 1990 and 1991. Fifty to 80% of sainfoin's forage yield occurred prior to average stocking dates on warm-season pastures for summer grazing. Crude protein concentration averaged 15 and 19% and in vitro digestible dry matter averaged 57 and 62% in 1990 and 1991, respectively. Sainfoin survival was unaffected by grazing treatment through July 1991. After a severe drought from late July through August 1991, sainfoin stands were reduced 22% across treatments ($P > 0.05$). Sainfoin has potential to complement warm-season pastures in the southern Great Plains, but additional effort is needed to improve plant persistence.

Key Words: growth stage, *Onobrychis viciifolia*, persistence, production, quality

Native grasslands of the southern Great Plains are dominated by warm-season grasses. These grasslands are typically grazed during the summer or deferred from grazing until winter and do not provide an adequate amount of forage in the spring. Sainfoin (*Onobrychis viciifolia* Scop.), a non-bloat-inducing legume, can provide spring forage in semiarid regions when grown under limited irrigation (Bolger and Matches 1990, Mowrey and Matches 1991).

Sainfoin exhibits poor persistence under some management practices (Carleton et al. 1968, Dietterline and Cooper 1975, Melton 1973, Smoliak and Hanna 1975, Townsend et al. 1975). Even when the seed were inoculated with the appropriate rhizobia there have been reports of N deficiency (Smoliak and Hanna 1975, Burton and Curley 1968, Sims et al. 1968, Walsh et al. 1983, Karnezos and Matches 1991, Mowrey and Matches 1991).

Grazing intensity affects sainfoin persistence (Mowrey and Matches 1991). Under irrigated conditions, N fertilized sainfoin grazed to remove 50%, 75%, or nearly all of the plant standing height averaged 98, 85, and 31% plant survival, respectively, after 2 years of grazing. The sainfoin was not storing nonstructural carbohydrate in the root-crown mass except during fall growth. Depletion of nonstructural carbohydrate may explain the decrease in persistence of heavily grazed sainfoin.

The potential of sainfoin to provide spring forage in subhumid areas of the southern Great Plains under natural rain-fed conditions is unknown. Our objective was to investigate yield, quality, and persistence of N fertilized sainfoin when grazed to remove 50 or 75% of the forage height.

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Methods

The experiment was conducted during 1990 and 1991 at the USDA-ARS Grazinglands Research Laboratory in Canadian County, Okla. (98°0′ W 35°40 N′; elevation = 450 m). Mean annual precipitation is 762 mm of which 520 mm (68%) is received from April through September. Annual precipitation in 1990 and 1991 was 879 and 742 mm, respectively. A severe hailstorm occurred in April 1990 that destroyed early-spring forage production. Severe drought and heat occurred during July and August 1991. During a 47-day period daily high temperatures were consistently above 32°C with 9 consecutive days of 37°C or above. During these 47 days only 11 mm of rain was received in various low volume events.

Soil type on 2 replicates was a Norge silt loam (fine-silty, mixed, thermic, Pachic Haplustolls). Soil type on 1 replicate was a Dale silt loam (fine-silty, mixed, thermic, Udic Paleustolls). Generally, Norge soils are less productive than Dale soils which occur in lower topographic position (Soil Survey 1976).

Plots (5 × 25 m) were planted with 35 kg ha^{-1} pure live seed of unhulled 'Renumex' sainfoin in rows 50 cm apart to a depth of 20 mm on 19 Sept. 1989. All plots received 75 kg N ha^{-1} as ammonium nitrate on 27 Mar. 1990 and on 21 Feb. 1991.

Four treatments were imposed by grazing with yearling steers (*Bos taurus* L.) beginning in the spring of 1990 and repeated on the same plots in 1991. Grazing intensities removed either 50 or 75% of the forage height when plants were either at early or late bloom growth stage.

Forage height was determined by measuring the average unextended canopy height with a meter rule before grazing. Stubble height was measured just before removing steers from the plot. Sainfoin was considered to be at the early bloom growth stage when 10 out of 100 randomly selected tillers had at least 1 flower. Late bloom growth stage was attained when 80% of the tillers had at least 1 bloom. Plots were stocked with steers to attain the desired grazing intensity within 48 hours. Electric wire fencing was placed around each plot to confine steers during the grazing period.

Herbage mass was measured in 4 randomly selected 0.25-m^2 quadrats per plot before and after each grazing event. Herbage was cut to ground level with hand shears then dried in a forced-air oven at 60° for day days. Yield was calculated as mean herbage mass before grazing minus mean herbage mass after grazing and is referred to as a forage yield.

The 50 and 75% grazing intensities removed an average of 54 and 72% of the herbage mass, respectively, and were similar for the 2 growth stages. Stubble heights following grazing averaged 20 and 12 cm for the 50 and 75% grazing intensities, respectively.

Regrowth period between harvests was similar between years. Regrowth periods averaged 36 and 44 days for early bloom and late bloom growth stages, respectively.

Herbage samples harvested before grazing were ground in a shear mill to pass a 2-mm screen. A 100-g subsample of the herbage sample was ground again in a centrifugal mill to pass a 1-mm screen then analyzed for digestibility according to an in vitro rumen fermentation procedure developed by Tilley and Terry (1963) as modified by Monson et al. (1969). Crude protein concentration was determined on the same samples by the Dumas dry combustion method (Nelson and Summers 1980) using a Leco FP-428 nitrogen analyzer[1].

Plant persistence was determined by stand counts in March, July, and October of 1990 and 1991 using a modified point quadrat system (Pasto et al. 1957, Mowrey and Matches 1991). All living plants were counted along a diagonal line placed across each plot. Data analyzed were survival percentages. Stands were uniform at the beginning of the study.

The experimental design was a randomized complete block. Soil type was the basis for blocking in the experiment (Steel and Torrie 1980). Components of the model were blocks, growth stages, grazing intensities, and years. Growth stages and grazing intensities were in a factorial arrangement. Years were treated as a split plot in time.

Results and Discussion

Forage Yield

Growth stage, grazing intensity, year, and growth stage by year affected forage yield ($P\leq0.05$). Other interactions were not significant (Table 1). The growth stage by year interaction occurred

Table 1. Main effect and interaction P-values over years for sainfoin when 50 or 75% of the standing forage was removed by grazing at the early or late bloom stages of growth.

	P-value		
Main effect	Forage yield	CP[a]	IVDMD[b]
Growth stage (GS)	.045	.001	.001
Grazing intensity (GI)	.001	.173	.149
GS × GI	.854	.123	.073
Year (Y)	.001	.001	.001
Y × GS	.001	.073	.076
Y × GI	.103	.101	.155
Y × GS × GI	.161	.083	.094

[a]CP = Crude protein
[b]IVDMB = In vitro dry matter digestibility.

because environmental conditions affected grazing frequency between years. The hailstorm in April, 1990, destroyed most of the early spring growth. The early bloom treatments in 1990 on the Norge and Dale soils were grazed twice and 3 times, the late bloom treatments were grazed once and twice on the 2 soil types, respectively. Apparently the Dale soil had adequate soil water to produce a July harvest for each treatment. In 1991, all treatments were grazed 3 times (Table 2). Forage yield averaged 2,480 kg ha^{-1} in 1990 and 4,110 in 1991.

Sainfoin production occurred from late March through July. Across treatments, the first and second harvests averaged 71 and 26% in 1990 and 51 and 34% in 1991, respectively, of the total harvest. Because of the 1990 hailstorm, yield by harvest percentages differed between years. Forage yields were significantly ($P\leq0.05$) greater under the 75% grazing intensity at both stages of

[1]Mention of trade names, propriety products or specific equipment does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

Table 2. Dates when sainfoin was grazed at early or late bloom growth stages.

	Date	
Treatment	1990	1991
Early bloom	14 May, 19 Jun., 24 Jul.[a]	22 Apr., 28 May, 9 Jul.
Late bloom	5 Jun., 24 Jul.[a]	7 May, 18 Jun., 29 Jul.

[a]Only the replicate on the Dale soil was grazed 24 Jul. because the replicates on Norge soil did not reach the appropriate growth stage.

growth than at the 50% grazing intensity (Table 3). Data from 1991 were similar to other data reported under irrigation (Mowrey and Matches 1991).

Forage Quality

Growth stage and year affected crude protein and in vitro digestibility concentrations ($P<0.05$; Table 4), but interactions were not significant ($P\geq0.05$). Sainfoin when at the early bloom growth stage was consistently higher in protein and digestibility concentrations than the late bloom stage (Table 4). When averaged across harvests, protein and digestibility concentrations were higher in 1991 than in 1990 ($P\leq0.05$). Grazing intensity did not affect protein or digestibility concentrations ($P>0.05$). The hailstorm in 1990 that destroyed most of the early spring growth may have influenced protein and digestibility concentrations in succeeding harvests; thus these parameters for the 2 years are difficult to compare. Within years, the first harvest usually exhibited the highest digestibility. Protein concentration was not as consistent. Mowrey and Matches (1992) reported similar digestibility values across harvests in an irrigated grazing experiment. Vough and Marten (1971) report that higher digestibility occurred in alfalfa when grown under moisture stress. They also stated that soil moisture did not affect protein consistently.

Across treatments, protein averaged 15% in 1990 and 19% in 1991. Compared to NRC (1984) guidelines, protein was above levels required for immature, mature, or lactating beef cattle. Quality of sainfoin forage does not appear to decline as rapidly with maturity as that of most forages. Carleton et al. (1968) reported that maximum accumulation of dry matter and protein occurred between 2 and 45% flower for alfalfa and at 100% flower for sainfoin.

Persistence

Growth stage or grazing intensity did not affect plant persistence ($P\geq0.05$). These results differ from those of Mowrey and Matches (1991), who reported that growth stage and grazing intensity affected stand persistence on irrigated sainfoin. Persistence of sainfoin was excellent through early summer 1991 because 94% of the plants were still alive in July. Prolonged drought and heat during July and August 1991 contributed to reduce persistence. Sainfoin began to regrow following rain in September, but by October, 22% of the plants were dead. However, 30% of the plants in the replicates on the Norge soil were dead compared to only 8% in the replicate on the Dale soil. Root and crown-root pathogens did not appear responsible for plant death.

Although it was not measured, we suspect the replicate on the Dale soil had enough available water that plant mortality was reduced during the July and August drought. Bolger and Matches (1990) observed sudden plant death after harvests followed by dry, hot weather. In a gradient-irrigated experiment they observed improved stand survival under high or medium irrigation treatments as compared to low irrigation treatments.

Summary and Conclusions

Sainfoin could complement warm-season pasture systems in

Table 3. Forage yield of sainfoin when 50 or 75% of the standing forage was removed by grazing at the early or late bloom stages of growth.

Treatment	Grazing intensity	Year	Forage yield First harvest	Second harvest	Third harvest	Total harvest
			kg ha^{-1}			
Early bloom	50%	1990	1490 ± 70[a]	860 ± 40	90 ± 40[c]	2440 ± 110
Early bloom	75%	1990	1760 ± 60	1300 ± 80	130 ± 100[c]	3200 ± 200
Late bloom	50%	1990	1750 ± 70	135 ± 100[b]	—[c]	1880 ± 130
Late bloom	75%	1990	1970 ± 80	190 ± 160[b]	—[c]	2160 ± 210
L.S.D.[d]			250	290	110	275
Early bloom	50%	1991	1790 ± 200	1120 ± 70	470 ± 30	3380 ± 250
Early bloom	75%	1991	2180 ± 160	1460 ± 70	650 ± 30	4290 ± 100
Late bloom	50%	1991	1930 ± 30	1270 ± 70	530 ± 30	3730 ± 100
Late bloom	75%	1991	2500 ± 50	1770 ± 100	760 ± 30	5020 ± 130
L.S.D.			280	105	120	520

[a]Standard error.
[b]High standard errors are a result of forage not being harvested from the replicates on the Norge soil.
[c]Forage not harvested from all replicates.
[d]Least significant difference ($P<0.05$).

Table 4. Crude protein (CP) and in vitro dry matter digestibility (IVDMD) concentrations of sainfoin forage when 50 or 75% of the standing forage was removed by grazing at early or late bloom stages of growth.

Treatment	Grazing intensity	Year Year	CP First harvest	CP Second harvest	CP Third harvest	IVDMD First harvest	IVDMD Second harvest	IVDMD Third harvest
			%					
Early bloom	50%	1990	14 ± 1[a]	20 ± 2	17[b]	66 ± 2	58 ± 2	57[b]
Early bloom	75%	1990	15 ± 1	19 ± 1	16[b]	64 ± 2	60 ± 1	58[b]
Late bloom	50%	1990	11 ± 1	15 ± 1	14[b]	54 ± 2	52 ± 1	54[b]
Late bloom	75%	1990	11 ± 2	16 ± 1	15[b]	55 ± 4	52 ± 2	52[b]
L.S.D.[c]			2	3		6	4	
Early bloom	50%	1991	18 ± 1	24 ± 1	22 ± 2	69 ± 2	64 ± 1	59 ± 2
Early bloom	75%	1991	18 ± 1	22 ± 1	21 ± 1	69 ± 1	64 ± 1	60 ± 1
Late bloom	50%	1991	16 ± 1	18 ± 1	19 ± 1	63 ± 1	59 ± 2	56 ± 2
Late bloom	75%	1991	15 ± 1	17 ± 1	19 ± 1	64 ± 2	58 ± 2	54 ± 1
L.S.D.			3	3	2	3	4	3

[a]Standard error.
[b]Values are for the replicate on the Dale soil only.
[c]Least significant difference ($P<0.05$).

subhumid areas of the southern Great Plains because it is productive in spring and the forage is high quality even at advanced maturity. In this region, new spring growth on native range generally begins in late April with grazing beginning about 1 Jun., depending on environmental conditions and management (Svejcar 1989). In a normal year, sainfoin when harvested at early bloom should supply 2 harvests prior to stocking warm-season pastures. Because of sainfoin's period of production, 50 to 80% of its forage yield would occur before native range should be grazed. Overlap in forage production between sainfoin and warm-season grasses could be beneficial from a forage supply standpoint because both components of the grazing system are at lower production levels when overlap occurs. If sainfoin could withstand defoliation at a vegetative growth stage it would be of greater benefit as a complementary pasture to warm-season pastures. The persistence of sainfoin over various soil types in subhumid regions will require further investigation.

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