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CHARACTERISTICS AND POTENTIAL NUTRITIVE VALUE OF SAGEBRUSH-GRASSLAND VEGETATION COLLECTED FROM SITES CONTINUOUSLY GRAZED, RESTED FOR ONE YEAR AND ONE YEAR POST-DISTURBANCE

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ABSTRACT: Objectives were to assess initial impacts of rangeland management practices on characteristics and nutritive value of native sagebrush-grassland vegetation. Plots were randomly assigned to one of three treatments in a split-block experiment: continually grazed by beef cattle from June through October (Grazed), rested from grazing for one year (Rested), and interseeded with yellow-flowering alfalfa (*Medicago sativa* ssp. *falcata*) and rested from grazing for one year (Disturbed-rested). Dominant plant species at peak production included Wyoming big sagebrush (*Artemisia tridentata*; ARTR), western wheatgrass (*Pascopyrum smithii*; PASM), prairie junegrass (*Koeleria pyramidata*; KOPY), Sandberg′s bluegrass (*Poa secunda*; POSE), rubber rabbitbrush (*Chrysothamnus nauseousus*; CHNA), and hood′s flox (*Phlox hoodii*; PHHO). Bare ground tended to be greater ($P = 0.07$) for the Disturbed-rested treatment. Aerial cover was less ($P = 0.03$) for Disturbed-rested because mean and relative cover of ARTR decreased ($P = 0.02$) and mean cover of POSE tended to decrease ($P = 0.09$) with this treatment. However, relative cover ($P < 0.001$) and DM yield ($P = 0.01$) of KOPY were greatest for Disturbed-rested. Although DM yield of PASM also increased ($P = 0.01$) with the Disturbed-rested treatment, total DM yield did not differ ($P = 0.42$) among treatments. Nutritive value was not influenced ($P = 0.22$ to 0.99) by treatment; however, nutritional value of new growth varied ($P < 0.001$) among the plant species. Relative feed value was greater for CHNA than ARTR, which was greater than the grasses but relative feed value did not differ among grass species. Crude protein was generally greater for shrubs than grasses. Within grasses, CP content was greater for KOPY and POSE than PASM. Disturbing rangelands by interseeding with yellow-flowering alfalfa resulted in greater quantities of grazable forage without major alterations in rangeland productivity.

Key Words: Rangelands, Nutritive value, Community characteristics

Introduction

Utilization of rangeland forage by grazing livestock is an integral component of agricultural systems in the western US. Rangelands are typically deficient in soil N, exhibit low productivity, and have poor forage quality throughout much of the year. The USDA-NRCS (1998) suggests that 67% of native rangelands could benefit from improved management or renovation. Resting rangelands from grazing has been proposed as a management strategy to increase native forage production and improve range condition (Gardner, 1950; Frischknecht and Plummer, 1955; Robertson, 1971). Due to the success experienced by a rancher in South Dakota (Smith, 1997), recent attention has focused on interseeding yellow-flowering alfalfa (*Medicago sativa* ssp. *falcata*) as a method to alleviate soil N deficiencies and increase forage production and quality on rangelands. Although most fixed N is tied up in the alfalfa plant biomass, N is leaked into the soil through root exudation and root turnover, making it available for the native rangeland vegetation (Schuman et al., 2002). Mortenson et al. (2004) demonstrated that interseeding yellow-flowering alfalfa increased total soil N and overall forage production of mixed-grass prairie. Crude protein content and in vitro digestibility of native forages were enhanced in range sites where yellow-flowering alfalfa had been established for longer than 15 years (Hess et al., 2004). Although information is emerging on the practice of interseeding yellow-flowering alfalfa into mixed grass communities of the Northern Great Plains, we are not aware of information on interseeding yellow-flowering alfalfa into sagebrush-grasslands. Therefore, our objectives were to assess initial impacts of interseeding yellow-flowering alfalfa into sagebrush-grasslands and one year rest from livestock grazing on rangeland characteristics and nutritive value of native vegetation.

Materials and Methods

General

The study site was established in 2003 within an 1,800 ha pasture on the University of Wyoming's McGuire Ranch, approximately 56 km northeast of Laramie. Elevation is 2,203 m with Bonjea sandy loam as the major soil type. Precipitation, temperature, and wind speed were recorded on site from May, 2003 to May, 2004 using a Vantage Pro Model WWN-WM2 weather station (Davis Instruments, San Francisco, CA).

Nine, 100 m^2 plots were randomly assigned to one of three treatments in a replicated, split-block designed experiment. Treatments included continuous season-long (June through October) grazing by beef cattle (Grazed), rested from grazing for one year before collection (Rested), and interseeded with yellow-flowering alfalfa (*Medicago sativa* ssp. *falcata*) and rested from grazing for one year (Disturbed-rested). On April 23, 2003, a Truax no-till drill modified with a chisel opener was used to under cut native sod and prepare an opening 5 cm deep and 15 cm wide for

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interseeding yellow-flowering alfalfa at a rate of 0.5 kg/ha. Permanent enclosures were constructed around plots that included a resting period to prevent disturbance associated with grazing by livestock and indigenous ungulates. Schuman et al. (2002) suggested that three years may be required for establishment of yellow-flowering alfalfa. Therefore, data reported herein may serve only as initial or baseline information.

Rangeland Assessment and Vegetation Collection

Sampling occurred during peak production from one of the three blocks (each treatment was represented in each block) spanning a three week period (June 28 to July 14, 2004). Using a modified Daubenmire (1959) approach, three transects (80 m) were randomly located within each plot and permanently established using steal rebar. Each transect consisted of 10, 0.25 m^2 quadrats systematically located for a total of 30 sampling quadrats per plot. Percent species canopy cover, frequency, above-ground biomass, litter, bare ground, and rock were determined within each 0.25 m^2 quadrat. Above-ground biomass for each species was determined by clipping each quadrat at ground level and combining quadrat samples within each transect. Mean cover of all species and relative cover by species were calculated on a quadrat basis from the individual species data. Dominant species included Wyoming big sagebrush (*Artemisia tridentata*; ARTR, shrub), western wheatgrass (*Pascopyrum smithii*; PASM, cool-season perennial grass), prairie junegrass (*Koeleria pyramidata*; KOPY, cool-season perennial grass), Sandberg's bluegrass (*Poa secunda*; POSE, cool-season perennial grass), rubber rabbitbrush (*Chrysothamnus nauseousus*; CHNA, shrub), and hood's flox (*Phlox hoodii*; PHHO, perennial forb). Only the recent meristematic growth was collected from shrubs.

Laboratory Analyses

Pooled vegetation samples (by transect) were dried in a 50^{o}C forced air oven, and ground through a 1 mm screen (Wiley Mill, Arthur H. Thomas Co., Philadelphia, PA). Samples were analyzed for DM and ash (AOAC, 1990), NDF and ADF (ANKOM 200 fiber analyzer, ANKOM Technology Fairport, NY), and N (LECO model FP-528 Nitrogen Determinator, LECO, St. Joseph, MI). Nitrogen was further fractionated into NDF-associated N (**NDIN**), ADIN, and B_3 (Sniffen et al., 1992). Relative feed value and DMD were estimated from fiber content using equations of Linn and Martin (1989).

Statistics

Mean canopy cover, relative cover, DM yield per individual species, and nutritive values were analyzed as a 3 (treatment) × 6 (dominant plant species) factorial arrangement in a split-block design. Data were analyzed using PROC MIXED of SAS (SAS Institute, Cary NC) with block and the block × treatment interaction included in the RANDOM statement. Total DM yield and data for other rangeland characteristics were analyzed as a randomized complete block design using PROC MIXED with block as a random effect. Following a significant preliminary F-test, the LSMEANS option was used to separate means.

Results and Discussion

Vegetation and Non-vegetation Community Characteristics

There were no differences (P = 0.12 to 0.96) in mean cover, relative cover, and yield for all plant species collected from the Grazed and Rested treatments (Table 1). Although it is probable that yield will increase after one year's rest (Frischknect and Plummer, 1955), Rice and Westoby (1978) demonstrated that production of dominant shrubs and perennial grasses of semiarid shrublands was not affected by resting from grazing for up to 15 years. The Disturbed-rested treatment tended to increase (P = 0.07) the proportional area of bare ground by decreasing (P = 0.03) vegetation cover (Table 2), as indicated by a decrease in mean (P = 0.02) and relative cover (P = 0.02) of ARTR and a trend toward decreased (P = 0.09) mean cover of POSE. Reduced cover of ARTR and POSE also seemed to be associated with increased (P < 0.001) relative cover of KOPY and greater (P = 0.01) DM yield of KOPY and PASM in the Disturbed-rested treatment. This may be explained by the competitive nature of range plants. Köchy and Wilson (2000) suggested that shrubs suppress grass production by reducing available soil N and their secondary growth creates greater biomass and height, eventually displacing grasses. Therefore, when ARTR is removed an increase in production of perennial grasses is anticipated (Frischknecht and Plummer, 1955). However, the lack of difference in DM yield of ARTR (P = 0.42) and POSE (P = 0.25) suggests that a reduction in cover of these species was offset by increased production. This is consistent with Köchy and Wilson (2000) who suggest that competition exists between plant species as well as among individual plants of the same species. The initial disturbance associated with interseeding of yellow-flowering alfalfa may therefore increase production of perennial grasses without altering sagebrush productivity.

Nutritive Value

Nutritive value of sagebrush-grassland species were not influenced (P = 0.22 to 0.99) by treatment (data not shown); however, nutritional value varied (P < 0.001) among individual plant species (Table 3). Crude protein content was generally greater for shrubs than grasses. Within the grasses, CP was greater (P< 0.001) for KOPY and POSE compared with PASM. Lyons et al. (1996) reported that native perennial grasses ranged from 2 to 25% CP during the growing season. Cook and Harris (1950) observed that CP of grasses on Utah summer range was about 6% and leaf CP material (~ 12%) was greater than stem CP (~ 4%). Initiation of growth for cool-season perennial grasses typically starts in May and June when temperatures are approximately 12 ^{o}C (Toole, 1976). High temperatures recorded on site reached 12 ^{o}C during April; however, average temperature did not reach 12^{o}C until late June which corresponded with the sampling period. Accumulation of leaf material was most likely limited until late June, which may explain CP content of perennial grasses within the lower range reported by Lyons et al. (1996). Although shrubs generally had greater CP than grasses, ADIN was often greater for shrubs compared with grasses.

Fiber-associated CP (Van Soest et al., 1991) has been used to describe CP fractions that are slowly degraded in the rumen and unavailable to ruminants (NRC, 1996). The NDIN fraction represents CP that is not degraded in the rumen. The bound fraction (fraction C) is estimated by ADIN, which is not available for digestion. The B_3 fraction is determined by the difference between NDIN and ADIN and assumed to have an intestinal digestibility of 80%. Within the grass species, NDIN was less ($P < 0.001$) for PASM compared with POSE and KOPY; however, the B_3 fraction was greatest ($P \leq 0.001$) for KOPY. Although fractionation of CP using the fiber-associated determinations does not completely account for the dynamics of ruminal fermentation and postruminal digestion (Sniffen et al., 1992), strategic protein supplementation for grazing cattle may be justified due to apparent differences in CP availability.

Due to less ($P < 0.001$) fiber, relative feed value was greater ($P = 0.001$) for CHNA than ARTR. Relative feed value of shrubs was greater ($P < 0.001$) than grasses. However, relative feed value did not differ ($P = 0.41$ to 0.88) among the perennial grass species. Bhat et al. (1990) also reported that shrubs have relatively high nutrient content. Greater relative feed value estimates for shrubs is likely attributed to higher cell soluble contents in actively growing plant material of shrubs compared with perennial grasses (Lyons et al., 1996). Greater nutritional values for shrubs, however, must be interpreted with caution. For example, the actual nutritive value of big sagebrush is greatly reduced (Ngugi et al., 1995) because substances in sagebrush cause deleterious effects on digestibility (Johnson et al., 1976).

In summary, the process of interseeding yellow-flowering alfalfa (*Medicago sativa* ssp. *falcata*) results in reduced aerial cover of dominant shrub species without impacting productivity. Reduced competition from shrub species promotes increased production of less dominant cool-season perennial grasses. Resting a site from grazing for a period of one year did not alter plant community characteristics or productivity of native rangeland.

Implications

Disturbing sagebrush-grassland rangelands by interseeding with yellow-flowering alfalfa altered the physical structure of sagebrush-grasslands, but forage production was largely unaffected because of compensatory responses by some perennial grasses. Livestock managers should be aware of differences in potential digestibility of crude protein among the various prominent grasses when designing feed supplements.

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Table 1. Characteristics of dominant plant species collected from the McGuire Ranch in southeastern Wyoming, 2004

	Mean aerial cover, %					Relative aerial cover, %					Yield, kg/ha				
Item[a]	G[b]	R[c]	DR[d]	SE[e]	*P*	G	R	DR	SE[e]	*P*	G	R	DR	SE[e]	*P*
ARTR	10.7^{z}	9.3^{z}	6.2^{y}	1.3	0.02	29.6^{z}	29.3^{z}	20.7^{y}	4.6	0.02	156.5	170.1	202.0	42.0	0.52
CHNA	3.5	3.6	3.1	0.9	0.75	9.5	10.6	11.0	2.1	0.72	65.7	96.9	86.2	25.4	0.28
KOPY	2.5	2.6	3.0	0.5	0.24	6.8^{y}	7.9^{y}	10.6^{z}	1.2	< 0.01	35.4^{y}	40.3^{y}	65.1^{z}	10.7	0.01
PASM	2.9	2.5	2.7	0.3	0.43	7.8	8.0	9.6	0.7	0.17	103.5^{y}	93.7^{y}	147.9^{z}	23.5	0.01
PHHO	3.0	2.8	2.8	0.3	0.75	8.3	8.6	10.1	1.1	0.22	48.0	46.2	54.0	7.0	0.60
POSE	9.5^{z}	8.3^{z}	6.4^{y}	1.7	0.09	25.2	25.4	21.3	3.0	0.33	135.3	156.0	159.8	13.8	0.25

[a]ARTR = Wyoming big sagebrush (*Artemisia tridentata*), CHNA = rubber rabbitbrush (*Chrysothamnus nauseousus*), KOPY= prairie junegrass (*Koeleria pyramidata*), PASM = western wheatgrass (*Pascopyrum smithii*), PHHO = hood's flox (*Phlox hoodii*),and POSE = Sandberg's bluegrass (*Poa secunda*).
[b]G = continuous season-long (June through October) grazing by beef cattle.
[c]R = rested from grazing for one year before collection.
[d]DR = interseeded with yellow-flowering alfalfa then rested from grazing for one year before collection.
[e]n=27.
[zy]Means within a row lacking a common superscript differ ($P < 0.05$).

Table 2. Effect of treatment on rangeland characteristics

	Treatment[a]				
Item	Grazed	Rested	Disturbed-rested	SE	*P*
Yield, kg/ha	544.36	603.2	714.91	87.0^{b}	0.42
Vegetation cover, %	36.4^{z}	32.2^{zy}	29.1^{y}	2.6^{c}	0.03
Rock, %	6.8	8.1	7.7	1.1^{c}	0.62
Litter, %	15.1	16.4	15.7	0.8^{c}	0.44
Bare ground, %	41.6^{y}	43.2^{y}	47.5^{z}	2.0^{c}	0.07

[a]Continuous season-long (June through October) grazing by beef cattle (Grazed), rested from grazing for one year before collection, and interseeded with yellow-flowering alfalfa (Rested), then rested for one year before collection (Disturbed-rested)
[b]n = 9
[c]n = 27
[z,y]Means within a row lacking a common superscript differ ($P < 0.05$)

Table 3. Nutritional indices of dominant plant species collected from the McGuire Ranch in southeastern Wyoming, 2004

	Species[a]							
Item	ARTR	CHNA	KOPY	PASM	PHHO	POSE	SE[b]	*P*
Ash, %DM	8.31^{w}	13.28^{y}	9.82^{xw}	8.02^{w}	26.53^{z}	11.15^{yx}	1.1	<0.0001
NDF, %DM	41.58^{x}	37.92^{w}	66.81^{z}	65.72^{z}	59.32^{y}	64.78^{z}	1.1	<0.0001
ADF, %DM	32.19^{w}	29.72^{v}	42.82^{y}	39.05^{x}	55.13^{z}	40.92^{yx}	2.7	<0.0001
CP, %DM	11.29^{y}	12.82^{z}	10.92^{yx}	9.28^{w}	7.84^{v}	10.62^{x}	0.2	<0.0001
NDIN[c], %CP	42.20^{y}	34.27^{x}	49.79^{z}	26.88^{w}	38.11^{yx}	35.95^{x}	1.9	<0.0001
ADIN, %CP	17.75^{y}	14.67^{yx}	12.26^{xw}	7.35^{v}	21.94^{z}	10.42^{wv}	3.9	<0.0001
B_3[d], %CP	24.45^{y}	19.60^{yx}	37.53^{z}	19.53^{yx}	16.16^{x}	25.53^{y}	3.7	<0.0001
DMD[e], %	63.83^{y}	65.75^{z}	55.55^{w}	58.48^{x}	45.95^{v}	57.02^{xw}	2.1	<0.0001
RFV[f]	143.06^{y}	165.59^{z}	77.62^{x}	82.91^{x}	72.30^{x}	81.95^{x}	7.2	<0.0001

[a]ARTR = Wyoming big sagebrush (*Artemisia tridentata*), PASM = western wheatgrass (*Pascopyrum smithii*), KOPY = prairie junegrass (*Koeleria pyramidata*), POSE = Sandberg's bluegrass (*Poa secunda*), CHNA = rubber rabbitbrush (*Chrysothamnus nauseousus*), and PHHO = hood's flox (*Phlox hoodii*).
[b]n=54
[c]NDIN = neutral detergent insoluble N.
[d]B_3 = protein fraction assumed to be available for digestion in the lower digestive tract.
[e]DMD = dry matter disappearance [88.9 – (0.779 x ADF %)].
[f]RFV = relative feed value [(DMD x DMI)/1.29].
[z,y,x,w,v]Means within a row lacking a common superscript differ ($P < 0.05$).