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Late-summer forage on prairie sandreed dominated rangeland after spring defoliation

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Abstract

The potential of using spring defoliation to improve late-summer nutritive value of prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.] on rangeland was studied with a factorial array of replicated 1-year treatments that included clipping plots at ground level or at a 5 or 10 cm height on 1 April, 26 April, 20 May, or 14 June. Vegetative tillers accounted for 83% of prairie sandreed herbage on unclipped control plots. After spring treatments, late-summer crude protein content (CP) in vegetative tillers of prairie sandreed ranged from 5.0 to 7.9% and in vitro dry matter digestibility (IVDMD) ranged from 45 to 52% compared to 5.0% CP and 45% IVDMD for unclipped plots. Reductions in mean weight of prairie sandreed vegetative tillers after April and May treatments were offset by 20 to 30% increases in tiller density. Treatments that increased tiller density had little or no effect on forage nutritive value when applied more than 90 days before herbage was sampled. Nutritive value of prairie sandreed and total yield from all species in mid-September were unchanged after April treatments. After sandreed tillers began to emerge in early May, late-summer nutritive value improved as clipping was delayed and degree of defoliation increased during May and June, however, yield was inversely related to nutritive value. While mid-September nutritive value of prairie sandreed was comparable to mid-summer values after June treatments, clipping reduced projected, late-summer stocking rates by 58 to 100% compared to control. It may be possible to improve mid-September forage nutritive value with moderate stocking rates in June with less reduction of total late-summer herbage because of selective herbivory. Measurable increases in prairie sandreed yield after complete defoliation of associated species in late April indicated prairie sandreed populations might be increased by concentrating cattle in selected pastures during late April.

Key Words: *Calamovilfa longifolia*, clipping date, cutting height, yield, crude protein, in vitro dry matter digestibility, tiller demographics

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Resumen

Se estudio el potencial de utilizar la defoliación en primavera para mejorar el valor nutritivo a fines de verano del zacate "prairie sandreed" [*Calamovilfa longifolia* (Hook.) Scribn]. El estudio se condujo en un pastizal bajo un arreglo factorial de tratamientos repetidos 1-año que incluyeron parcelas defoliadas a nivel del suelo, o a 5 y 10 cm de altura. La defoliación se realizo el 1 de abril, 26 de abril, 20 de mayo o 14 de junio. En las parcelas sin defoliar (control), los hijuelos vegetativos aportaron el 83% del forraje producido por el "prairie sandreed". Después de los tratamientos de primavera, el contenido de proteína cruda (PC) de los hijuelos vegetativos a fines del verano fluctúo de 5.0 a 7.9% y la digestibilidad in vitro de la materia seca (DIVMS) estuvo en un rango de 45 a 52% comparado con 5.0% de PC y 45 % DIVMS de las parcelas sin defoliar (control). Las reducciones del peso promedio de los hijuelos vegetativos del "prairie sandreed" ocurrida después de aplicar los tratamientos de abril y mayo fueron compensados por un incremento del 20 al 30% de la densidad de hijuelos. Cuando los tratamientos que incrementaron la densidad de hijuelos vegetativos fueron aplicados 90 o más días antes del muestreo de forraje estos tuvieron poco o ningún efecto en el valor nutritivo del forraje. El valor nutritivo del "prairie sandreed" y el rendimiento total, a mediados de septiembre, de todas las especies no cambio después de los tratamientos de abril. Después de que los hijuelos de "prairie sandreed" comenzaron a emerger a inicios de mayo, el valor nutritivo a fines del verano mejoro conforme la defoliación se retrasó y el grado de defoliación incrementó durante mayo y junio, sin embargo, el rendimiento fue inversamente relacionado al valor nutritivo. Mientras el valor nutritivo del "prairie sandreed" a mediados de septiembre fue comparable al de mediados del verano después de los tratamientos de junio, la defoliación redujo la carga animal proyectada para fines del verano, la reducción fue del orden de 58 a 100% en comparación con el control. Puede ser posible mejorar el valor nutritivo del forraje de mediados de septiembre utilizando cargas animales moderadas en junio teniendo menos reducción de forraje total de fines de verano debido a la herbívora selectiva. Incrementos medibles en el rendimento de "prairie sandreed" después de completar la defoliación de las especies asociadas a fines de abril indica que las poblaciones de "prairie sandreed' podrían ser incrementadas por la concentración de ganado en potreros seleccionadas durante fines de abril.

The feasibility of using spring grazing to reduce seasonal declines in forage nutritive value associated with plant maturity has not been reported for semi-arid rangeland. Some studies have examined the effects of defoliation on nutritive value in a following season, but initial dates of defoliation have been confounded with additional clipping dates between first cutting and final harvest (George and Obermann 1989, Willms 1991, Willms and Beauchemin 1991, Belsky and Fedders 1994, 1995). In early spring, seasonally low forage allowances of green herbage for livestock can cause severe defoliation of initial plant growth. Given the potential for a wide range in degree of spring defoliation, improvement in late-summer nutritive value could be caused by reduced stem development (Perry and Baltensperger 1979), reduced average age of tiller populations (George and Obermann 1989, Culvenor 1993, Bullock et al. 1994), and/or reduced composition of reproductive tillers (Cook and Stoddart 1953, Murray 1984, Ganskopp et al. 1992, Brummer 1994). In the semi-arid region of western Nebraska and adjoining states, the duration of temperature and soil moisture conditions required for rapid plant growth is relatively short. Studies of interactions between date and degree of spring defoliation are needed to understand the mechanisms by which end-of-season forage quality might be improved. Extensive rhizomes and deep roots enhance prairie sandreed's [*Calamovilfa longifolia* (Hook.) Scribn.] ability to tolerate drought and produce large quantities of herbage compared to associated plant species on sandy soils throughout the northern Great Plains (Lodge 1963, Welch 1968, White 1977). Our objective was to quantify the effects of spring defoliation on late-summer nutritive value of prairie sandreed and yield of all species on rangeland dominated by prairie sandreed.

Material and Methods

A 3 x 4 factorial array of 1-year spring clipping treatments was replicated on sandy range sites dominated by prairie sandreed at 2 locations in 1993 and 1994 (Table 1). Eight sites were selected at each location in March 1993 and ranked by relative abundance of prairie sandreed. Within comparable levels of abundance, sites were randomly assigned to years to include similar variation in species composition each year. All vegetation in 1.0 m^2 plots was clipped at ground level or at a 5 or 10 cm height on 1 April, 26 April, 20 May, or 14 June. This provided deferment periods of about 165, 140, 115 and 90 days between spring defoliation and late-summer harvest in mid-September. Current-year prairie sandreed tillers were counted and clipped from the interior 0.5 m^2 of plots when spring defoliation treatments were applied. All other herbage clipped in the spring was discarded. Prairie sandreed tillers harvested from plots clipped at ground level were cut into segments of 0–5, 5–10, and above 10 cm to estimate degree of spring defoliation at the 5 and 10 cm heights. In addition, each site included 3 control plots. Mean response of control plots for each site was used for analysis of variance. Late-summer, current-year herbage was harvested at ground level from the interior 0.5 m^2 of plots in mid-September, separated into prairie sandreed vegetative and reproductive tillers and other species, and oven dried at 60°C to a constant weight. Tillers with exposed seed heads were classified as reproductive. Plant composition at each location was estimated in late summer by clipping and weighing species individually from 12 control plots at each location on 1994 study sites.

Table 1. Average species composition based upon herbage biomass in control plots clipped in September, 1994.

Species[1]	Buffalo Creek	Wildcat Hills
	––––––(%)––––––	
Calamovilfa longifolia (Hook.) Scribn.	54	52
Stipa comata Trin. and Rupr.	29	4
Poa pratensis L.	0	22
Carex spp.[2]	3	11
Bouteloua gracilis (H.B.K.) Lag. ex Griffiths	4	9
Agropyron smithii Rydb.	2	1
Forbs	8	1

[1]Nomenclature follows The Great Plains Flora Association (1986).
[2]Carex species were predominantly *C. filifolia* Nutt. and *C. heliophila* Mack.

Locations were the Buffalo Creek Wildlife Management Unit, 9 km southwest of Melbeta, Nebr. and the Wildcat Hills State Park, 11 km south of Gering, Nebr. Livestock had been excluded from both locations for 10 years or more. Soils at Buffalo Creek are mixed, mesic Entic Haplustolls. Soils at the Wildcat Hills location are a mosaic of mixed, mesic Typic Haplustolls and mixed, calcareous, mesic, shallow Typic Ustorthents. Precipitation during April to September 1993 was about 193 mm at both locations and 239 mm at Buffalo Creek and 282 mm at Wildcat Hills in 1994 compared to the long-term average of 293 mm for this 6-month period (NOAA 1994). Long-term average annual precipitation is 410 mm and the average frost-free period is 136 days.

Forage samples were analyzed to determine concentrations of crude protein (CP) and in vitro dry matter digestibility (IVDMD) by near infrared reflectance spectroscopy (NIRS) using the protocol described by Windham et al. (1989). Reflectance measurements (log 1/R) were collected for all samples from 1,100 to 2,500 nm and recorded in 4-nm intervals using a Pacific Scientific 6250 (NIRS Systems, Silver Spring, Md) scanning monochromator. Based upon spectral characteristics, a subset of 60 samples representing the entire range of H values (Mahalanobis distance) was selected for NIRS calibration (Shenk and Westerhaus 1991a). Estimates of CP and IVDMD were determined for calibration samples using the micro-Kjeldahl and rumen fermentation (Marten and Barnes 1980) procedures, respectively. All analyses were done in duplicate and averages of duplicate samples were used as analytical values. Calibrations were developed using modified partial least squares regression (Shenk and Westerhaus 1991b). Coefficients of determination and standard errors for calibration and cross validation were, respectively, 0.93, 1.47 and 1.86 for IVDMD and 0.99, 0.09 and 0.16 for CP. Calibration statistics were within acceptable limits for all variables (Windham et al. 1989).

Experimental units were 0.5 m^2 quadrats centrally placed in 1.0 x 1.0 m treated areas. Data were analyzed as a randomized complete block using the General Linear Models Procedure (SAS 1986). Level of probability selected for significance was $P \leq 0.05$. Single degree of freedom orthogonal contrasts were used to select variables for equations to describe significant main effects and interactions. Equations for main effects were fit to treatment means from both study years, and equations for spring clipping date by cutting height interactions were fit to factorial means averaged over years using the Regression Procedure (SAS 1986). Dunnett's test was used to compare control with each clipped treatment (Dunnett 1955). The Least-Squares Means Procedure within SAS was used for mean separation among defoliation treatments (Searle et al. 1980).

Results

Composition of prairie sandreed on control plots in mid-September ranged from 24 to 93% among study sites. While the mean composition of prairie sandreed was comparable between locations, differences in the composition of cool-season species occurred between locations. Needleandthread (*Stipa comata* Trin. and Rupr.) was the primary cool-season species at Buffalo Creek (Table 1). In contrast, the primary cool-season species at Wildcat Hills were kentucky bluegrass (*Poa pratensis* L.) and sedges (*Carex* spp.).

Prairie Sandreed Tiller Responses

All prairie sandreed tillers emerged after 26 April and growing points in reproductive tillers were elevated less than 5 cm above the soil surface on 14 June at both locations in both years. When growing-season precipitation was 34% below the long-term average in 1993, complete defoliation at Buffalo Creek increased the density of reproductive tillers by 82% after 1 April treatments and 29% after clipping on 26 April compared to control (28 m^{-2}). However, percent of late-summer herbage composed of reproductive tillers was unchanged after April treatments because of concurrent increases in vegetative tiller density. After prairie sandreed tillers emerged, complete defoliation in May or June at Buffalo Creek generally eliminated reproductive tillers which comprised about 25% of prairie sandreed herbage on control plots in mid-September. In the following year when growing-season precipitation was near average, spring defoliation had no effect on reproductive tillers regardless of cutting height.

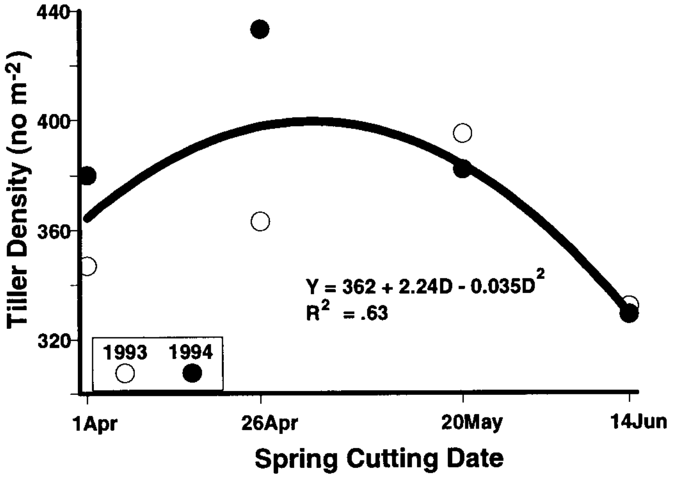

Fig. 1. Effects of spring clipping date (D = days after 31 Mar) on late-summer density of prairie sandreed vegetative tillers.

Clipping in April or May increased late-summer density of vegetative tillers by 20 to 30% (Fig. 1) compared to 300 m^{-2} for control. Changes in vegetative tiller density diminished as the amount of herbage removed from prairie sandreed increased from May to June (Fig. 1, Table 2). Mean weight of vegetative tillers in mid-September was reduced by about 15%, compared to control, when plots were clipped in April (Fig. 2a). After prairie sandreed tillers emerged in May, reductions in tiller weight increased as the degree of spring defoliation increased and clipping date was delayed (Fig. 2a, Table 2). Removing 53 to 100% of the herbage from prairie sandreed in mid-June reduced late-summer mean tiller weight by 32 to 55%, compared to control.

Levels of CP content in vegetative tillers within comparable weights were higher under drought conditions in 1993 than in 1994 when near average precipitation occurred (Fig. 3a, Table 3). Crude protein declined rapidly as tiller weight increased with about 75% of the change occurring between the low and mid-range tiller weights. Average IVDMD of prairie sandreed vegetative tillers was not different between years, but the rate at which IVDMD declined with increasing tiller weight was about 2 times greater when precipitation was near

Table 2. Percent defoliation of prairie sandreed in the spring, crude protein (CP) content and digestibility (IVDMD) of vegetative tillers of prairie sandreed in mid-September, and projected late-summer stocking rate after clipping at 0, 5, or 10 cm on 20 May or 14 June.

	Spring Cutting Height[1]		
Spring Clipping Date	0 cm	5 cm	10 cm
20 May			
Spring Defoliation (%)	100	61	29
Late-summer[2]			
CP (%)	6.0	(5.4)	(5.1)
IVDMD (%)	46.7	(45.4)	(45.0)
Projected Stocking Rate (AUD ha^{-1})	15	23	31
14 June			
Spring Defoliation (%)	100	78	53
Late-summer[2]			
CP (%)	7.9	6.1	5.6
IVDMD (%)	52.2	48.9	47.2
Projected Stocking Rate (AUD ha^{-1})	0	5	17

[1]Values in parentheses are not significantly different from control based on Dunnett's test, P>0.05.
[2]Late-summer values for control were 5% CP, 45% IVDMD, and 40 AUD ha^{-1}. Projected stocking rate was calculated by dividing herbage available for livestock consumption by 11.8 kg to estimate potential animal unit days (AUD).

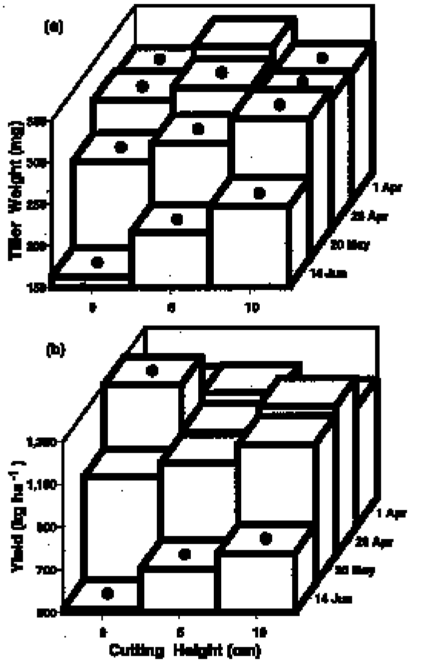

Fig. 2. Spring cutting height by clipping date interaction effects on (a) mean tiller weight and (b) yield of prairie sandreed vegetative tillers in mid-September. Columns with dots (•) are different from control, P<0.05.

average in 1994 compared to drought conditions in 1993, e.g. 5.5 compared to 2.8 percentage points decline in IVDMD per 100 mg increase in mean tiller weight (Fig. 3b, Table 3). While CP content was generally higher in vegetative than in reproductive tillers, the range in treatment means for IVDMD of each tiller type was comparable in both years. Mean weight, CP content and IVDMD of reproductive tillers ranged from 465 to 1,970 mg tiller^{-1}, 3.2 to 4.6%, and 45 to 51%, respectively.

Herbage Responses

Vegetative tillers accounted for 77 to 98% of prairie sandreed herbage after spring clipping compared to 83% for control. Yield of herbage from vegetative tillers in mid-September ranged from 520 to 1,330 kg ha^{-1} (Fig. 2b) compared to 1,080 kg ha^{-1} for control. Late-summer yield from vegetative tillers was unchanged by clipping at any cutting height in April or May except for complete defoliation in late April (Fig. 2b). Complete defoliation of plots on 26 April, before prairie sandreed tillers emerged, increased prairie sandreed yield by 23% compared to control. Removing 53 to 100% of the current-year herbage from prairie sandreed in mid-June (Table 2) reduced mid-September yield of prairie sandreed herbage from vegetative tillers by 35 to 52% (Fig. 2b).

About 75% of herbage from other species was produced by cool-season grasses or sedges (Table 1). Mean yield of herbage from other species on control plots was 610 kg ha^{-1}. When averaged over spring clipping dates, little change occurred in late-summer yield of herbage from other species after clipping at 5 compared to 10 cm (Fig. 4a). However, predicted late-summer yield declined rapidly as cutting height decreased from 5 to 0 cm. Late-summer herbage from species other than prairie sandreed also declined about 26 kg ha^{-1} for each week that spring clipping was delayed after 1 April (Fig. 4b).

Average, current-year herbage from all species that occurred on control plots in mid-September was about 1,900 kg ha^{-1}. Projected, late-summer stocking rates were based on leaving 950 kg ha^{-1} (half of control herbage) for ecosystem functions and utilizing 50% of the remaining herbage (Table 2). The balance, 50% of herbage beyond the target level of 950 kg ha^{-1} in remaining herbage, was an estimate of losses by factors other than cattle. Herbage available for livestock forage was divided by 11.8 kg to calculate projected animal unit days (AUD). The average projected stocking rate in mid-September for control was about 40 AUD ha^{-1}. Removing an average of 29 and 61% (10 and 5 cm height) of current-year herbage from prairie sandreed in mid-May reduced projected, late-summer stocking rates by 22 and 43%, respectively, but did not improve nutritive value of prairie sandreed (Table 2). Clipping prairie sandreed in mid-June at 10 or 5 cm heights increased mean defoliation to 53 and 78% causing measurable increases in late-summer nutritive value of prairie sandreed, but reduced projected stocking rates by 58 and 88%, respectively.

Discussion

While crude protein content was lower in reproductive compared to vegetative tillers of prairie sandreed, the occurrence of reproductive tillers had little effect on average IVDMD of late-summer herbage. Density of reproductive tillers was also affected by spring clipping at only one location in a single year. Consequently, the risks of reduced livestock performance in May or June, damage to associated plant species, and reduced infiltration and site stability caused by the severe defoliation needed to reduce density of reproductive tillers can not be justified. Additionally, carbohydrates from the relatively large photosynthetically active surface areas of

Table 3. Polynomial equations for spring cutting height (H) by clipping date (D = days after 31 Mar) interaction effects on late-summer vegetative tiller weight and yield of prairie sandreed from vegetative tillers and regression equations for the effects of late-spring cutting height and late-summer tiller weight (W) on crude protein (CP) content and digestibility (IVDMD) of late-summer herbage from vegetative tillers of prairie sandreed in mid-September.

Late-summer Dependent Variable	Equation[1]	R^2
	Spring Cutting Height by Date (Figure 1)	
Tiller Weight	$Y = 315 + 0.55 D - 0.032 D^2 - 1.018 H + 0.12 DH$	.94
Yield	$Y = 1090 + 8.54 D - 0.203 D^2 + 0.27 DH$	.91
	Spring Cutting Height (Table 2)	
CP	$Y_{May} = 6.04 - 0.18 H + 0.0082 H^2$	.45
	$Y_{Jun} = 7.90 - 0.49 H + 0.0262 H^2$	.75
IVDMD	$Y_{May} = 46.7 - 0.34 H + 0.017 H^2$	.63
	$Y_{Jun} = 52.2 - 0.82 H + 0.032 H^2$	.99
	Late-summer Tiller Weight (Figure 2)	
CP	$Y_{93} = 15.3 - 0.055 W + 7.6 \times 10^{-5} W^2$	.93
	$Y_{94} = 16.3 - 0.077 W + 12.7 \times 10^{-5} W^2$	.89
IVDMD	$Y_{93} = 55.6 - 0.028 W$	.81
	$Y_{94} = 59.9 - 0.055 W$	.84

[1]Cutting height by clipping date treatment means (n=12) were used to compute equations for Figures 1 and 2. Year by cutting height treatment means within clipping dates (n=6) were used to compute equations for May and June.

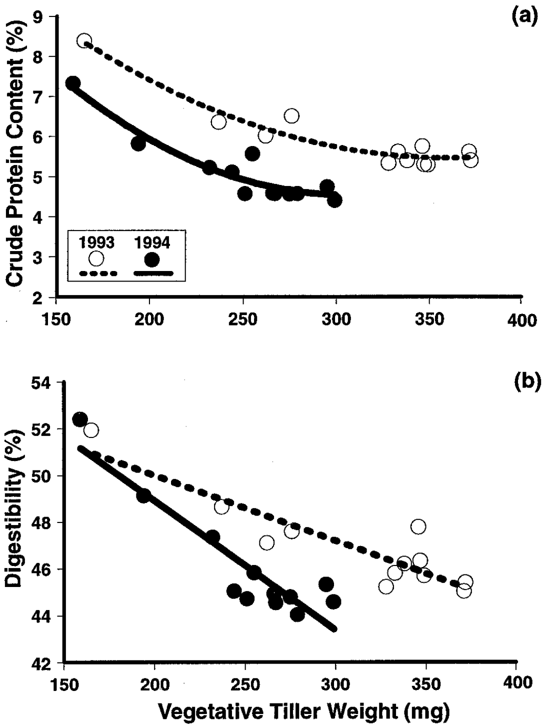

Fig. 3. Relationship between mean weight of prairie sandreed vegetative tillers and (a) crude protein (CP) and (b) digestibility (IVDMD) in mid-September.

reproductive tillers not grazed in late summer may be a significant source of energy for root, rhizome, and/or bud development (Brejda et al. 1989, Nixon 1993, Reece et al. 1996).

Degree of defoliation of associated species increased and opportunity for cool-season species to recover before rapid growth of prairie sandreed declined as clipping date was delayed from 1 April to 20 May. However, increases in density of prairie sandreed vegetative tillers after clipping in April or May appeared to be caused primarily by micro-environmental changes (Briske and Richards 1995), rather than release from competition, because yield of prairie sandreed increased only after complete defoliation in late April.

The inverse relationship of nutritive value to mean weight of vegetative tillers and measurable declines in mid-September mean tiller weight when clipping treatments improved nutritive value indicated that the average age or maturity of tiller populations was reduced (Hendrickson et al. 1997, Northup and Nichols 1998). In our study, CP content and IVDMD of tiller populations with improved nutritive value in mid-September were comparable to levels reported for prairie sandreed tillers harvested from ungrazed pastures in mid-June to mid-July (Northup 1993, Hendrickson et al. 1997). Rapid decline in nutritive value during early development of new cohorts of prairie sandreed tillers reported by Hendrickson et al. (1997) would explain the declining differences in nutritive value between progressively earlier spring clipping treatments and control when measurable increases in tiller recruitment occurred.

The sum of late-summer herbage from prairie sandreed plus herbage from other species was not affected by defoliation in April at any cutting height. In contrast, total yield of herbage in mid-September declined after clipping in mid-May because of 30 and 20% yield reductions in other species after complete defoliation and clipping at 5 cm, respectively. Increases in prairie sandreed tiller density compensated for up to 15% reductions in mean weight of vegetative tillers. After clipping in mid-June, total late-summer yield was about 30 to 70% below control because of reductions in herbage from prairie sandreed and other species. All reductions in the yield of prairie sandreed corresponded to 20% or more reductions in mean weight of vegetative tillers.

While the largest increases in nutritive value of prairie sandreed occurred after complete defoliation, projected stocking rates for mid-September after clipping at ground level in May were 30% below control and complete defoliation in June precluded projected grazing until the following growing season because of inadequate herbage (Table 2). Clearly, defoliation at ground level in mid-May or mid-June was not a sustainable practice when repeated in consecutive years (Reece et al. 1996). However, this level of defoliation documents the physiological upper limits in mean CP and IVDMD levels in prairie sandreed in late summer after spring defoliation. Additionally, complete defoliation in mid-May is unnecessary because deferring until mid-June and removing only 50% of current-year herbage from prairie sandreed would provide similar nutritive value and mass of forage in mid-September with reduced risks (Fig. 2b, Table 2).

Differences in yield and quality responses to spring defoliation may occur between clipping and grazing because of selective herbivory. Seasonal changes in preferred plant species, which correspond to plant maturity (Northup 1993), and selection for current-year versus carry-over herbage may reduce the magnitude of changes to micro-environment and plant competition caused by clipping. Defoliation of current-year herbage by livestock should be similar to clipping in April because cool-season species are in vegetative stages and highly palatable while prairie sandreed tiller emergence would be limited. Selection for cool or warm-season species may also be similar in mid-May because most cool-season species are in vegetative or boot stages and warm-season grass tillers are in early vegetative stages. In contrast, most cool-season species will initiate inflorescences in mid-June and cattle will selectively graze prairie sandreed and other warm-season grasses thus removing less herbage from cool-season species than removed by clipping (Streeter et al. 1968, Northup 1993). Consequently, competition from cool-season species may reduce growth of prairie sandreed and reduce the relative value of improved late-summer forage quality in prairie sandreed after grazing in June.

Conclusion

Precipitation, which occurs primarily during the summer for much of the rangeland dominated by prairie sandreed, will have a measurable effect on how vegetation responds to spring defoliation. Soil moisture deficits will reduce or stop plant growth after spring grazing (Dahl 1963, Ganskopp 1998). Drought is a common and unpredictable component of semi-arid ecosystems. Regional drought has occurred in about 20% of the years since 1940 in the northern Great Plains (Holechek et al. 1989). Shortages in the quantity of herbage are

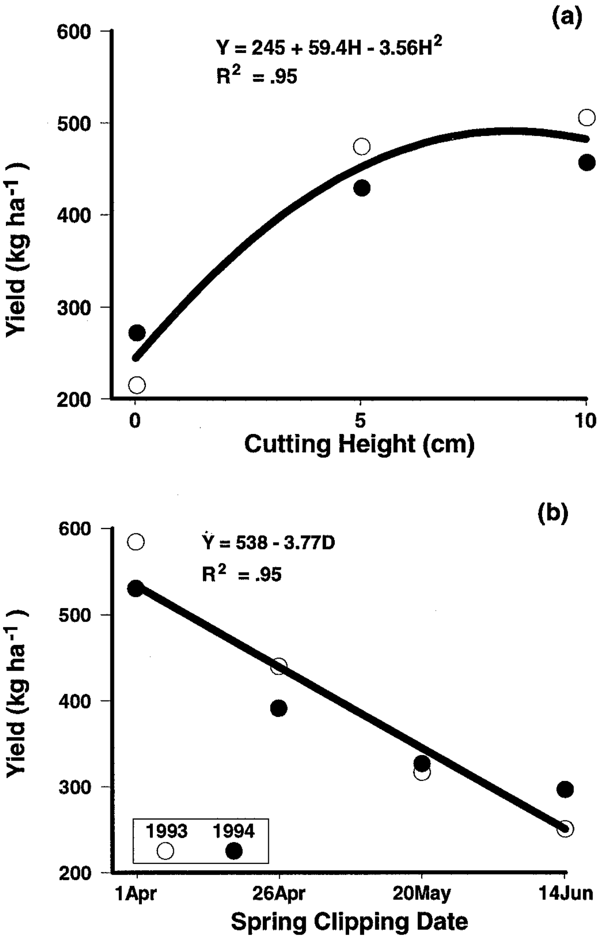

Fig. 4. Effects of (a) spring cutting height and (b) clipping date on yield of current-year herbage from species other than prairie sandreed in mid-September.

generally of greater economic importance than nutritive value under drought conditions. Additionally, CP content was higher when drought occurred in our study than when near average precipitation occurred.

A limited opportunity may exist in June for some improvement in late-summer nutritive value of prairie sandreed with minimal risk to livestock performance and rangeland resources. Small but measurable increases in CP content and IVDMD after 50% defoliation of prairie sandreed in mid-June would not fully meet nutritional requirements of growing and/or lactating cattle (NRC 1984) and less than half of the potential number of animal unit days (AUD) of grazing would be available in late summer compared to ungrazed control. However, the sum of AUDs or gain in livestock weight from mid-June and mid-September grazing periods may equal or exceed the total from a single mid-September grazing period. Conversely, if late-summer forage quality is the primary concern, it may be possible for cattle to select a diet of equal quality for an equal number of AUD's in pastures that are deferred until late summer with no risk to rangeland resources.

Prairie sandreed is commonly more abundant on spring-grazed compared to summer-grazed pastures on sandy range sites throughout the northern Great Plains. Heavily grazing pastures in late April before prairie sandreed tillers emerge may be an effective method of maintaining or increasing prairie sandreed populations. Cattle will selectively graze cool-season species in the spring (Streeter et al. 1968). Feeding relatively large numbers of cattle on selected pastures during late April should provide adequate nutrition for livestock and allow cattle to defoliate cool-season species to the physical limit of their foraging ability. Excluding livestock from these pastures from the time of tiller emergence to the end of the growing season should allow prairie sandreed to fully benefit from late-April grazing when average or above average precipitation occurs. Herbage in these pastures could then be used for dormant-season grazing, or left for watershed or wildlife habitat management objectives.

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