Seasonal Changes in Yield, Digestibility, and Crude Protein of Vegetative and Floral Tillers of Two Grasses

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Abstract

The seasonal change of dry matter (DM) yield, estimated in vivo dry matter digestibility (DMD), and crude protein content of the vegetative and floral tillers of 'Rosana' western wheatgrass (*Agropyron smithii*) and 'Lodorm' green needlegrass (*Stipa viridula*) was determined on forage harvested April through October on 10 dates during 1973 and on 11 dates during 1974. Vegetative tillers on both grasses were comparable in seasonal DM yield, DMD, and crude protein for both years. Floral tillers of western wheatgrass produced only 20% as much forage as did floral tillers of green needlegrass; however, they contained on the average 2 and 4 percentage units more crude protein and DMD, respectively, than floral tillers of green needlegrass. On an average, floral tillers contained 4 and 8 percentage units less crude protein and DMD, respectively, than companion vegetative tillers. When floral tillers are harvested before DMD decreases below 50%, they are most valuable for maintenance of mature animals. Preventing development of floral tillers would increase DMD but decrease DM yield.

Range managers, planning their grazing management for native rangeland in the northern Great Plains, should consider more than dry matter (DM) yield and forage quality of whole plants. They should also consider DM yield and quality of floral and vegetative tillers. Their ratio can be manipulated by management (Lawrence 1973, Hyder and Sneva 1963, Field and Whitford 1980). Damage or removal of floral primordia prevents floral tiller development and the tiller remains vegetative. Lawrence (1973) showed that cutting Russian wildrye (*Elymus junceus*) during late May or early June prevented floral tiller development. Hyder and Sneva (1963) proposed heavy livestock grazing of crested wheatgrass (*Agropyron desertorum*) when the shoots were in the boot stage to remove floral primordia. Application of growth regulators can also change the ratio of floral to vegetative tillers (Field and Whitford 1980). Timing of management practices to prevent floral tiller development will depend on time of floral primordia initiation. Some species such as western wheatgrass (*Agropyron smithii*), prairie junegrass (*Koeleria cristata*), Russian wildrye, and other temperate-origin grasses initiate floral primordia in the fall (Lawrence and Ashford 1964, Johnston and MacDonald 1967, and Hodgson 1966). However, those species that require vernalization for floral induction initiate the floral primordia in the spring (Evans 1964).

Preventing development of floral tillers could reduce forage yield, yet increase forage quality if the tillers remained culmless. Knowledge is needed of seasonal DM yield and quality of both vegetative and floral tillers of major forage species before management systems are formulated that will prevent development of floral tillers.

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This study is a contribution from USDA, Agricultural Research Service, in cooperation with Montana Agr. Exp. Sta., Sidney, Mont. Journal Series No. 1295.

Manuscript received June 1, 1982.

The in vitro digestibility of whole plants of western wheatgrass or green needlegrass (*Stipa viridula*) have been studied (Bezeau and Johnston 1962, Kamstra 1973, Lawrence 1978, White and Wight 1981). Still needed is information on the seasonal change of DM yield and DMD of vegetative and floral tillers of western wheatgrass and green needlegrass.

The objective of this study was to determine the seasonal change of DM yield, DMD, and crude protein content of vegetative and floral tillers of western wheatgrass and green needlegrass.

Materials and Methods

The study was conducted on a Shambo soil (fine-silty, mixed Typic Haploborolls) 7 km southeast of Sidney, Mont., at an elevation of 610 m. Average annual precipitation at this site is 345 mm, with 21% received from October through March, 44% from April through June, and 35% from July through September. Precipitation from October 1972 through March 1973, April through June, and July through September 1973 was 73, 134, and 129% of normal, respectively. Precipitation from October 1973 through March 1974, April through June, and July through September 1974 was 103, 104, and 81% of normal, respectively. January and July long-term mean temperatures are -13 and 20°C, respectively, and the average frost-free is 125 days.

The study was conducted during 1973 and 1974 on adjacent fields of 'Rosana' western wheatgrass and 'Lodorm' green needlegrass seeded during early September 1971. The land had been summer-fallowed during 1970 and 1971. Both species were seeded at 30 live seeds per meter of row with a double disc drill with openers spaced 18 cm apart.

Clipping plots were arranged in a randomized, complete-block design with 4 replications (each 6 by 20 m) per grass species. Forage was harvested from different 0.36-m by 4-m clipping plots with a 0.4-m border between plots in the western half of each replication on 10 dates during 1973 and from the eastern half on 11 dates during 1974. Plants were sampled on a biweekly interval from April through July and then monthly through October. At each sampling date, plants on a previously unharvested plot were clipped 5 cm above ground and separated into vegetative and floral tillers. Plant material was dried at 70°C and ground to pass through a 1-mm screen before analyses.

A modified Tilley and Terry (1963) two-stage method was used to determine in vitro DMD as previously described by White et al. (1981). To overcome random week-to-week variation, standard forage with a known high, medium, and low in vitro DMD were included in each run and their deviations from a long-term average were used to correct all values. The resulting in vitro DMD values were converted to estimated in vivo DMD by using a regression equation previously reported by White and Wight (1981):

$$\text{Estimated in vivo DMD} = 10.78 + 0.767 (\text{in vitro DMD}); R = 0.87$$

This equation was previously determined as the regression of in

vivo DMD of 8 forages, fed to sheep, upon the in vitro DMD of these same forage samples determined by the above procedure.

Nitrogen was determined with an auto analyzer (Schuman et al. 1973) after forage samples had been wet digested on a block digester. Nitrogen concentration was multiplied by 6.25 to estimate crude protein.

A two-way analysis of variance was performed on DM yield, DMD, and crude protein of vegetative and floral tillers of each species in each year. All differences discussed in this paper are significant ($\alpha < 0.05$) unless otherwise stated. Linear regression analysis was used on DMD and crude protein data for the period May-July, when values were declining linearly, to determine the average decrease per day.

Fig. 1. Seasonal dry matter (DM) yield [veg. plus floral (A & B), veg. and floral separately (C & D)] estimated in vivo DM digestibility (E & F), and crude protein (G & H) (all means of 4 replications) of vegetative (veg.) and floral tillers of western wheatgrass (AGSM) and green needlegrass (STVI) during 1973 and 1974. Dates when first heading (FH), first anthesis (FA), first seed rip (FSR), and 100% seed ripe (SR) was reached are noted on the top of Fig A & B for green needlegrass and on the bottom for western wheatgrass each year.

Dry Matter Yield

Green needlegrass produced nearly twice as much DM (veg. plus floral) as western wheatgrass both years (Fig. 1A & B). Green needlegrass completed initial DM production when the first seeds ripened (late June-early July) each year, whereas western wheatgrass did so at first anthesis (early July) the first year and just after first heading (late June) the second year. The difference in DM production between the 2 grasses was due to the larger amount of DM production by the floral tillers of green needlegrass (Fig. 1C & D). DM production by the vegetative tillers was nearly the same for both grasses.

Western wheatgrass vegetative tillers completed major growth by first anthesis (early July) the first year and just after heading (late June) the second year. Green needlegrass vegetative tillers completed major growth when the first seed was ripe (late June-early July). Following a 10-cm rain in early September 1973, vegetative tillers of both species produced an additional 0.5 metric tons/ha of DM. When first sampled in late April 1974, DM yield of vegetative tillers from both species was the same (Fig. 1D). Green needlegrass produced significantly more DM than western wheatgrass during May (1974) and reached maximum yield 1 week earlier than western wheatgrass. The DM yield of vegetative tillers fluctuated only slightly during the remainder of the 1974 season.

Floral tillers of western wheatgrass produced about 20 and 30% as much DM as the companion vegetative tillers in 1973 and 1974, respectively. Floral tillers of green needlegrass produced about the same DM as the companion vegetative tillers at the time of maximum DM production in 1973 and twice as much in 1974 (Fig. 1D). Floral tillers of green needlegrass produced maximum DM when the first seeds were ripe (late June-early July). Floral tillers of western wheatgrass produced maximum DM near first anthesis (early July) in 1973 but not until after first anthesis (late July) in 1974. The DM yield of floral tillers of green needlegrass decreased significantly after maximum DM was reached, whereas that of western wheatgrass decreased only slightly. This initial DM loss was due to seed loss but later it was due to leaf loss plus plant respiration. Floral tillers of western wheatgrass did not lose DM from seed loss because seeds do not disseminate until late fall or early winter.

Digestibility

From late April through mid-May, estimated *in vivo* DMD of vegetative tillers of both species in both years increased slightly or remained nearly the same (Fig. 1E & F). From mid-May to late August 1973, DMD of vegetative tillers of both species decreased an average of 0.16 percentage units/day from a high of 70% to near 56%. In 1974, the DMD of vegetative tillers of western wheatgrass and green needlegrass decreased 0.25 and 0.22 percentage units/day, respectively, from mid-May until mid-July. Both years the DMD of vegetative tillers remained above 50% during September and October, which should be adequate to maintain the weight of a dry mature cow during the middle third of pregnancy (NRC 1970). The DMD of vegetative tillers of western wheatgrass averaged 2 percentage units more than the DMD of green needlegrass until early July and was nearly the same or slightly higher until September both years. New growth during September 1973 increased the DMD of vegetative tillers of western wheatgrass but not that of green needlegrass.

The DMD of floral tillers of both grasses decreased much more rapidly than did that of vegetative tillers. The DMD decreased below 50% sometime during July or August, depending upon species and year. This percentage is below the level established as the minimum for maintaining the weight of a dry mature cow (NRC 1970). From late June through October, floral tillers of green needlegrass averaged nearly 9 percentage units less DMD than vegetative tillers. Floral tillers of western wheatgrass, though more digestible than those of green needlegrass, averaged nearly 7 percentage units less DMD than vegetative tillers. The DMD of

floral tillers of green needlegrass and western wheatgrass was nearly 5 percentage units less during the fall of 1973 than 1974.

Crude Protein

Crude protein in vegetative tillers of both grasses reached nearly 25% during late April and early May in both 1973 and 1974 (Fig. 1G & H). Crude protein then decreased rapidly until mid-July and remained between 10 and 12% during late summer and fall in 1973 and between 5 and 10% in 1974. Soil water and nutrient accumulation from summer-fallowing before seeding probably combined to cause greater nitrogen uptake during 1973, thus the higher crude protein content in both grasses during 1973 as compared with 1974. New growth during August of 1974 apparently increased crude protein in vegetative tillers of green needlegrass but not in those of western wheatgrass. Crude protein of vegetative tillers for both grasses remained adequate (>5.9%) for dry mature cows (NRC 1970) until October of both years.

By early to mid-July, crude protein in floral tillers of green needlegrass fell below the 5.9% level recommended for cows by NRC (1970). Crude protein in floral tillers of western wheatgrass fell below the recommended 5.9% level in mid-September 1973, and in mid-July 1974.

Conclusions

Vegetative tillers of green needlegrass and western wheatgrass were comparable in DM yield and forage quality in this 2-year study. Floral tillers of western wheatgrass produced only 20% as much forage as did floral tillers of green needlegrass; however, they contained about 2 and 4 percentage units more crude protein and DMD, respectively, than floral tillers of green needlegrass.

Floral tillers are most valuable when they are properly managed. For weight maintenance of dry mature cows in the middle third of pregnancy, DMD should not go below 50%; therefore whole plants of western wheatgrass could be harvested any time before fall for animal maintenance. However, whole plants of green needlegrass would need to be harvested no later than mid- to late July (White and Wight 1981). Green needlegrass could be grazed after July because animals prefer vegetative tillers and would avoid the low quality floral tillers.

Green needlegrass could be a more nutritious forage during late season if development of floral tillers was prevented by either early spring grazing or application of growth regulators. Preventing floral tiller development in green needlegrass could extend the period when livestock could gain weight from grazing the whole plants. Future research is needed to determine whether the trade-off in increased forage quality from preventing floral tiller development would offset the decreased DM yield.

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