

Standing Crop and Vigor of Defoliated Russian Wildrye in Southeastern Colorado

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Abstract

Russian wildrye plants were clipped at all possible combinations of three clipping dates (April 15, May 15, June 15) at two intensities (35 and 65% harvest of current year's growth). From 1974-1977 increasing frequency and intensity of defoliations increased total biomass removed over the 4-year period. There was no trend for reduced yield over time with any clipping treatment. However, percent plant crown alive (1976-1978) and end-of-season standing crop (1978) both indicated that increasing frequency and/or intensity of defoliation decreased plant vigor.

There are few native grasses capable of providing early spring forage in southeastern Colorado. Of species tested in seeding trials, Russian wildrye (*Elymus junceus* Fisch.) was found to be the only introduced cool-season grass adapted to the area (Cook et al. 1974). The value of Russian wildrye to ranchers in the South Central Great Plains will depend on its ability to withstand defoliation. A dearth of information on grazing adaptability at this latitude exists.

Russian wildrye is a long-lived bunchgrass used primarily for range and pasture seedings. This grass is capable of early spring growth (Heinrichs et al. 1976), generally 3-6 weeks earlier than native species. It is very drought tolerant and has an extensive root system, which often reaches 3 m (Rogler and Schaaf 1963). The species is very palatable (Lang et al. 1975) and has a high leaf component (Kilcher 1975). Smoliak and Bezeau (1967) and Heinrichs and Carson (1956) compared important forage species in Canada and found Russian wildrye to have one of the highest crude protein levels throughout all stages of development. Smoliak (1968) noted that 30-year-old stands of Russian wildrye remained productive despite many years of heavy grazing.

Frequency, intensity, and season of defoliation are all factors important to the well being of a grass. Generally, grass yields decrease with increasing frequency of defoliation (Buwai and Trlica 1977, Owensby et al. 1974, Everson 1966). However, Cook et al. (1958) found that under favorable conditions crested wheatgrass [*Agropyron desertorum* (Fisch.) Schult] yielded more from multiple clippings than from a single autumn clipping. Yields may also decrease as defoliation intensity is increased (Krall et al. 1971, Everson 1966, Neiland and Curtis 1966, Albertson et al. 1953). However, Frame and Hunt (1971) obtained higher production from perennial ryegrass (*Lolium perenne* L.) swards as intensity of clipping was increased. Cook et al. (1958) reported that spring harvested crested wheatgrass plants produced a lower 5-year total yield than plants clipped in early summer, but were producing more at the end of the experiment. Similarly, Drawe et al. (1975) found that of various clipping treatments, Russian wildrye plants clipped early produced the least forage, but maintained the highest vigor.

The objective of this study was to evaluate the effect of defolia-

tion (simulated grazing) on standing crop and vigor of Russian wildrye.

Study Area

This study was conducted at the Southeastern Colorado Research Center, located 16 km southwest of Springfield in Baca County, Colo. Soils on the study site are Ustollic Haplargids belonging to the Wiley series. The upper 20 cm are typically silty clay loam in texture, and both wind and water erosion are considered problems on this soil (Woodyard et al. 1975). The climate and vegetation are typical of the South Central Great Plains. The shortgrasses, blue grama [*Bouteloua gracilis* (H.B.K.) Lag.] and buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] dominate the native vegetation. Average annual precipitation between 1957 and 1978 was 38.8 cm. Annual precipitation was 25.7, 39.1, 40.8, 56.6, and 33.9 cm for 1974 through 1978, respectively. Average pan evaporation and wind speed during the study were 187.5 cm and 6.2 km per hour, respectively.

The study site was used for sorghum [*Sorghum bicolor* (L.) Moench] research prior to the first Russian wildrye planting in 1968. Russian wildrye was seeded into sorghum stubble in early spring each year from 1968 through 1971; however, unfavorable climatic conditions caused the 1970 planting to be unsuccessful.

Materials and Methods

Clipping treatments imposed on Russian wildrye from 1974 through 1977 involved three clipping dates (4-15, 5-15, 6-15) and two intensities (35 and 65% harvest of current year's growth). Plants were clipped at the seven possible combinations of the three clipping dates within each intensity (Table 1). Thus, plants were clipped either once, twice, or three times during the season (frequency 1, 2, and 3, respectively), or in the case of controls were left unclipped. These dates correspond to the potential defoliation periods of various grazing regimes. Plants were clipped at 35 or 65% of current year's growth at the time of clipping (light and moderate clipping, respectively). Clippings of individual plants were oven dried at 65°C for 24 hours, and weighed.

Measurements considered indicative of plant vigor were taken during the third week in August of 1976, 1977, and 1978. The measurements consisted of two perpendicular diameters of each plant and a rating of degree of plant crown alive. The rating was on a scale from zero to four, where 0 = 0%, 1 = 25%, 2 = 50%, 3 = 75%, and 4 = 100% live plant crown. During 1978 all plants were allowed to grow unhindered until the end of August, when they were clipped to ground level to determine total standing crop as affected by previous year of treatment.

Russian wildrye stands planted in 1968, 1969, and 1971 were used as replications. Each planting consisted of five drill rows, with row spacings of 35 cm. Transects were taken across the drill rows, and the plant in each drill row closest to the transect was assigned to an experimental unit. Thus, there were 5 plants per experimental unit. There were two complete sets of treatments within each replication. Treatments were randomly assigned within replica-

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Table 1. Clipping treatments imposed on Russian wildrye during 1974 through 1977. Dashes indicate plants were clipped on that date.

Treatment number ¹	April 15	May 15	June 15
	35% Removal		
1	—		
2		—	
3			—
4	—	—	
5	—		
6		—	—
7	—	—	—
	65% Removal		
9	—		
10		—	
11			—
12	—	—	
13	—		—
14		—	—
15	—	—	—

¹Treatment number 8 was a control and was not clipped.

tions. Once assigned plants were clipped at the same time and intensity each year.

The study was designed as a repeated measure experiment, with cutting year the repeated measure. Clipping data from 1974 through 1977 and vigor data from 1976 through 1978 were analyzed as split plots over time using analysis of variance (Steel and Torric 1960). Factorial analysis of variance was used for 1978 standing crop data.

Results

Plants clipped once a year yielded 40.2 and 83.4% more standing crop ($p < 0.05$) on May 15 (1.37 g/plant) and June 15 (1.79 g/plant), respectively, than on April 15 (0.98 g/plant) (Table 2). Large differences ($p < 0.01$) in biomass removed were measured among

Table 2. Standing crop (g/plant) removed on April 15, May 15, or June 15 and various combinations of these dates at two intensities (35 vs 65%). Values represent 4 years of clipping (1974–1977).

Clipping intensity (%)	Clipping date			Total
	April	May	June	
35	0.76 ± 0.69 ¹			0.76
65	1.19 ± 0.64			1.19
Average	0.98 ± 0.69			0.98
35		1.36 ± 1.13		1.36
65		1.38 ± 0.97		1.38
Average		1.37 ± 1.03		1.37
35			1.39 ± 1.15	1.39
65			2.18 ± 2.00	2.18
Average			1.79 ± 1.66	1.79
35	0.64 ± 0.51	1.12 ± 0.79		1.76
65	1.01 ± 0.62	1.08 ± 0.96		2.09
Average	0.82 ± 0.59	1.10 ± 0.87		1.92
35	0.54 ± 0.38		0.93 ± 0.70	1.47
65	1.00 ± 0.74		1.39 ± 1.70	2.39
Average	0.77 ± 0.62		1.16 ± 1.31	1.93
35		0.99 ± 0.92	0.59 ± 0.55	1.58
65		1.94 ± 1.30	1.01 ± 0.83	2.95
Average		1.46 ± 1.21	0.80 ± 0.73	2.26
35	0.46 ± 0.39	0.74 ± 0.61	0.70 ± 0.94	1.90
65	1.46 ± 0.70	1.28 ± 1.13	0.84 ± 0.72	3.58
Average	0.96 ± 0.76	1.01 ± 0.93	0.77 ± 0.83	2.74

¹±one Standard Deviation (includes year variation).

years (Table 3). Rapid early growth in 1976 and an unusually high seasonal growth rate in 1977 resulted in a significant ($p < 0.01$) cutting year × clipping date interaction.

Plants clipped moderately in the three possible combinations of frequency 2, i.e., April and May, April and June, and May and June, yielded greater ($p < 0.01$) cumulative biomass per plant per year (2.48 g) than lightly clipped plants (1.60 g). Although not significant ($p > 0.05$), plants clipped in May and June tended to yield more than plants clipped in April and May or April and June (Table 2).

When plants were clipped 3 times a year, the average yield per harvest varied only among years ($p < 0.01$). No other significant main effects ($p > 0.05$) were detected. Opportunity for regrowth varied among years, greatly influencing yield on individual harvest dates.

Data from all plants clipped in April, regardless of treatment (see Table 1) were analyzed separately to determine if clipping altered early-season yield. Moderate clipping resulted in greater ($p < 0.01$) biomass yield (1.17 g/plant) than light clipping (0.60 g/plant). There were no adverse effects of any frequency or intensity of defoliation from 1974 through 1977 on April yield.

There were no differences ($p < 0.05$) in crown diameter of Russian wildrye with varying intensities or frequencies of clipping. However, crown diameters of control plants were significantly ($p < 0.05$) larger (12.1 cm) than those of clipped plants (10.0 cm). Control plants had a higher ($p < 0.01$) percentage crown alive (68%) than clipped plants (50%).

Plants clipped lightly had more ($p < 0.01$) living plant crown (54%) than did plants moderately clipped (46%). Plants clipped once had greater ($p < 0.05$) live plant crown (55%) than either those clipped twice (49%) or three times (45%). Average percentage live plant crown for all treated plants was lower ($p < 0.01$) in 1977 (36%) than in either 1976 (61%) or 1978 (60%). The trend among years for control plants was similar to that for clipped plants. Control plants had greater absolute crown loss between 1976 (87% plant crown alive) and 1977 (36% plant crown alive) than clipped plants (61% vs 36, respectively); however, control plants made a greater recovery in 1978 than treated plants (i.e., 78% vs 60% plant crown alive, respectively).

End-of-season standing crop in 1978 should have reflected the cumulative effects of treatments over time (Table 4). Plants clipped once had greater ($p < 0.05$) end-of-season standing crop (2.81 g/plant) than those clipped twice (1.77 g/plant), which in turn had more than those clipped three times (1.24 g/plant). Plants previously clipped at the light intensity yielded more ($p < 0.01$) end-of-season standing crop (2.63 g/plant) than those moderately clipped (1.65 g/plant). Control plants produced more ($p < 0.01$) standing crop (5.12 g/plant) than treated plants (1.94 g/plant).

Discussion

Clipping studies have indicated that growth rates of grasses were influenced by defoliation (Cook et al. 1958, Albertson et al. 1953). Under semi-arid range conditions the trend has generally been for decreased production under defoliation (Trlica 1972). In the study being reported, increasing the frequency of clipping at either inten-

Table 3. Average total biomass removed each year (g/plant) from different cutting frequencies¹, averaged over cutting intensities.

Frequency of cut	1974	1975	1976	1977	Average
1× ²	1.02 ^b	0.62 ^a	1.42 ^c	2.02 ^d	1.27
2× ³	1.36 ^a	1.06 ^a	2.08 ^b	2.82 ^c	1.83
3× ⁴	1.41 ^a	1.98 ^a	2.67 ^b	3.89 ^c	2.49

¹Means within rows followed by different letters are significantly different at the 0.05 level of probability.

²Plants clipped April, May, or June.

³Plants clipped April–May, May–June.

⁴Plants clipped April, May, and June.

Table 4. Average end-of-season standing crop (g/plant) harvested in 1978 from plants clipped at various intensities and frequencies between 1974 and 1977.

Frequency of cutting	Intensity of cutting (%)		Average
	35	65	
1X ¹	3.45 ± 1.47 ⁴	2.18 ± 1.14	2.81 ± 1.45
2X ²	2.27 ± .88	1.27 ± .50	1.77 ± .87
3X ³	1.25 ± .29	1.23 ± .92	1.24 ± .65
Average	2.63 ± 1.36	1.65 ± .98	2.14 ± 1.28

¹Plants clipped April, May or June.

²Plants clipped April–May, April–June or May–June.

³Plants clipped April, May and June.

⁴±one standard deviation.

sity resulted in increased cumulative standing crop removed (Table 2). The natural growth rate of Russian wildrye would be best represented by yield of plants clipped once during the season; i.e., in this case one set of plants was allowed to grow until April, then clipped, a second set until May and clipped, and the third set grew until June. This approach ignored growth after June 15. Seasonal (month of clipping) effects could have altered growth rate; however, no seasonal effects were detected for plants clipped once. Plants clipped in both April and June followed a growth pattern similar to that of plants clipped once (Fig. 1). The April–May and May–June clipping combinations resulted in increased yield over a single May or June clipping, respectively. Thus it would appear the initial clipping had a stimulatory effect for the two-cut combinations. Two months of rest between clippings (April–June clipping combination) did not increase yield over that of the April and May clipping combination, which received only 1 month of rest between clippings. Allowing unhindered growth in April (May and June combination) increased total yield over the other combinations of two clippings. Plants clipped 3 times yielded more cumulative biomass by May 15 or June 15 than any other treatment, although the cumulative yield of the first two cuttings was similar to that of the April and May combination (Fig. 1). Yearly variations in growth curves existed; however, the relationships among treatments were similar throughout the four years of clipping; i.e., plants clipped three times yielded the most and plants clipped once the least (Table 3).

Several factors may help explain the increasing yield with more rigorous clipping treatments: (1) decrease in losses to the litter layer (Kelley et al. 1974), (2) change in spectral quality of light reaching the plant's crown (McKee 1963), (3) increase in water use efficiency as area of transpiring plant tissue decreases (Baker and Hunt 1961), and (4) plant hormone shifts (Trlica 1972).

While both frequency and intensity of cut influenced yield, there was no statistical evidence of beneficial or adverse seasonal effects of defoliation over the period of this study. Regardless of defoliation date, no treatments caused yield to decline in successive years. Apparently, no defoliation date corresponded to any single critical stage of Russian wildrye growth or treatments were discontinued before effects could be expressed. There was no tendency for decreasing yield in successive years; in fact, the opposite was generally found to be true (Table 3). Thus, the clipping data from this study tend to support the suggestions of Smoliak (1968) and Johnson (1959) that weather may be more important than defoliation regimes in managing Russian wildrye.

Production of standing crop was closely linked ($r^2 = 0.66$ to 0.98) to annual rainfall. Seasonal distribution of rainfall was also important to plant production. For example, during 1976 plants clipped 3 times per year yielded the most biomass from the April cutting and least from the June cutting, with May intermediate. The fall and winter preceding the 1976 growing season received more rainfall than those preceding any other cutting year; however, there was below-average growing season precipitation. Consequently, there was high initial growth in 1976. But soil moisture was probably heavily used for growth, reducing subsequent monthly clipping

yields. There was little fall and winter precipitation preceding the 1977 season, but spring precipitation was unusually high. The result was much higher production in May and June than in April.

In the study being reported spring standing crop for the various treatments was inversely related to percent plant crown alive. Yearly variation in plant crown alive was greatly influenced by rainfall. There was a decrease in live plant crown alive from 1976 to 1977, and subsequent recovery in 1978. Control plants followed the same trend and, in fact, exhibited a greater decrease in plant crown alive from 1976 to 1977 than did clipped plants (51 and 25% decrease in live crown for control and clipped plants, respectively). The lowered "vigor" was possibly a result of excessive use of carbohydrate reserve for plant production during 1977 when rainfall was high. Trlica and Cook (1972) found that watering Russian wildrye during the growing season lowered plant carbohydrate levels in the fall. Unlike percent live plant crown, crown diameter did not vary significantly ($p > 0.05$) among treatments, so was of no value in assessing vigor.

Detrimental effects of clipping could have delayed initiation of growth in years subsequent to clipping, thereby decreasing April yield. However, moderate clipping in April yielded more biomass than light clipping during all years of the study. No significant differences ($p > 0.05$) among frequencies were detected. There was no trend for decreasing April yield over time; in fact, 1974 and 1977 production was not statistically different ($p > 0.05$).

Allowing a growing season of unhindered growth, then clipping to ground level to determine standing crop should provide an indication of cumulative clipping effects (Wilson et al. 1966, Trlica 1972). In this study plants previously defoliated at the light intensity yielded 37% more end-of-season standing crop in 1978 than those moderately defoliated ($p < .01$). Two and three defoliations decreased end-of-year standing crop 37 and 56%, respectively, over a single defoliation ($p < .01$). Any clipping treatment decreased ($p < .01$) end-of-year standing crop compared to the control. Controls yielded 48% more end-of-year standing crop than even the

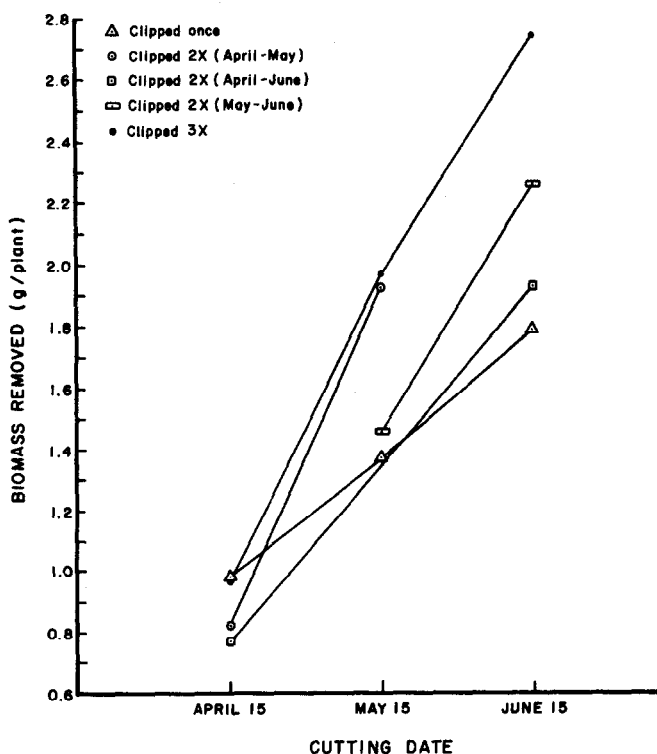


Fig. 1. Growth rates of Russian wildrye as represented by cumulative biomass removed for the various clipping treatments. Values are averaged over 2 intensities (35 and 65% removal of current year's growth) and 4 years (1974-1977).

least detrimental clipping regime, i.e., a single clipping at 35% harvest. Although multiple clippings at the moderate intensity yielded more biomass yield than other treatments, 1978 end-of-season standing crop suggested the moderate clipping resulted in some physiological drain on the plant.

Conclusions

Increasing frequency of monthly defoliations during April, May, or June increased growing season yield of Russian wildrye (1974-1977), regardless of intensity. Harvesting 65% of the standing crop on April 15, May 15, June 15, or any combination thereof resulted in greater seasonal yield of Russian wildrye than harvesting at 35%.

Defoliation reduced end-of-year standing crop (1978) and percent live crown (1976-1978) of Russian wildrye compared to unclipped plants. The decrease was greater with increasing frequency and/or intensity of cut. However, there were no cumulative effects of either frequency or intensity of cutting which tended to reduce April growth. Thus the response seems somewhat contradictory in that yield of all treatments increased each successive year (apparently in response to rainfall), yet measurements thought to be representative of vigor indicated the more rigorous a clipping treatment the more detrimental.

Russian wildrye should be suited to spring grazing in southeastern Colorado, thus having the potential to reduce the length of time during which supplemental feeds are necessary. Although apparently hardy under variable rainfall conditions, grazing management to maintain vigor would be recommended.

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