Effect of 2,4-D on Digestibility and Production of Subalpine Herbage

JOHN F. THILENIUS AND GARY R. BROWN

Highlight: *Treatment of forb-dominated subalpine cattle range in the Bighorn Mountains of Wyoming with 2,4-D did not change the in vitro dry matter digestibility coefficients of the grasses or surviving forbs. Forbs and grasses were equally digestible throughout the growing season. Production of total and digestible dry matter was not influenced by 2,4-D, but the proportion of both supplied by grasses was increased.*

The subalpine ranges of the Bighorn Mountains in northcentral Wyoming provide summer grazing for cattle, sheep, elk, and mule deer. Forbs are an important component of the vegetation on many of these ranges. Some range managers consider forbs to be undesirable forage, especially for cattle, and herbicidal control of forbs has been an accepted range management practice in this area.

Thilenius et al. (1975), have described the effects of herbicidal control of forbs on herbage production and on the diet and performance of cattle using subalpine ranges where forbs have been controlled with 2,4-D. They found forbs to be an important dietary constituent. This report provides additional information on the effects of 2,4-D on forb-dominated subalpine ranges, specifically on the in vitro dry matter digestibility of the herbage, an important determinant of forage quality (Van Dyne and Haug, 1968; Dietz, 1970).

Study Area and Methods

Herbage samples were collected from an ungrazed 120 X 120-ft exclosure adjacent to the Burgess Experimental Pasture on the Bighorn National Forest in northern Wyoming. This exclosure is at an elevation of approximately 8,500 ft and has a deep, well-drained soil developed from limestone. The site is mesic and the vegetation is representative of subirrigated subalpine meadow. Idaho fescue (*Festuca idahoensis*), the characteristic plant of most subalpine range in the Bighorn Mountains (Hurd, 1961), is uncommon and more mesophyllic species predominate.

The experimental design was a randomized complete block with sampling of the experimental units. There were three replications. Two treatments were used—an unsprayed control and a single sprayed application of the propylene glycol butyl ether ester of 2,4-D at a rate equivalent to 2 lb/acre of acid. Water at a rate of 25 gal/acre was used as the carrier. Herbicide was sprayed in late June, 1968.

Plant material for the digestibility tests was hand clipped at ground level. A random sample of ten 1 X 2-ft plots was clipped from each treatment replication in late June, mid-July, and late August of 1969, 1970, and 1971.

The clippings were separated by taxon, oven dried at 105°C for 12 hours, then weighed to the nearest 0.1 gram. Total dry matter (TDM) production was calculated from the combined weights of all taxa. Digestible dry matter (DDM) production was obtained by weighting the TDM produced by each taxon by its digestibility coefficient and summing these values.

Once weighed, the material from each taxon was composited and an aliquot with a minimum weight of 5 g was extracted for the digestibility tests. Because of the minimum weigh requirement, it was not always pos sible to obtain a measure of digest bility for all taxa at all collection date and years.

In vitro dry matter digestibility wa determined from triplicate 0.5-g sub samples of the aliquot using the tech nique of Tilley and Terry (1963) Inoculum was obtained from fistulate steers on a diet of high-quality alfalf hay and grain.

Statistical significance of treatmen differences ($\alpha = .05$) was determine by analysis of variance (Steel an Torrie, 1960) for those taxa where sufficient data base was available. A simple t test (Li, 1957) was used whe analysis of variance was not possible

Results and Discussion

In Vitro Dry Matter Digestibility

The 2,4-D was not particularly ef fective in eliminating forbs from th sprayed units; most forb taxa wer present in both treatments. The onl forb consistently absent on th sprayed units was *Geum triflorum* The most common forb on bot sprayed and unsprayed range wa *Geranium richardsoni; Potentill gracilis* and *Achillea lanulosa* were als common under both treatments.

The average digestibility co efficients (percent of dry matter di gested, Table 1) of 19 forbs and grasses formed a gradient of digesti bility which ranged from 81.0% fo *Aster foliaceous* at the earliest (lat June) collection period, to 48.6% fo *Epilobium angustifolium* at the las collection period in late August. A analysis of the frequency distributio of the digestion coefficients showe no pronounced peaks in either treat ment. Coefficients in the 60-75% range were most common.

The major forb taxa, *Achillea lanu losa, Epilobium angustifolium*

Thilenius is principal plant ecologist and Brown is range research technician at the Rocky Mountain Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service, at Laramie, in cooperation with the University of Wyoming; Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.

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Table 1. Average* in vitro digestible dry matter (%) of taxa of sprayed (2,4-D) and unsprayed subalpine cattle range, Bighorn Mountains, Wyoming, 1969–1971.

Taxa	Collection period		
	Late June	Mid-July	Late August
Forbs			
Achillea lanulosa	73.0	69.8	65.1
Agoseris glauca	77.0	58.6	
Aster foliaceus	81.0	74.0	65.0
Cerastium arvense	69.0	58.8	59.8
Collomia linearis		65.5	56.0
Epilobium angustifolium	56.3	50.9	48.6
Fragaria americana		59.0	50.2
Galium boreale	71.0	65.4	
Geranium richardsoni	66.0	59.7	59.5
Geum triflorum	58.0	58.5	55.0
Helianthella quinquenervis	79.5	70.5	69.7
Perideridia gairdneri	79.8	76.0	55.0
Lupinus sericeus	71.4	73.9	69.8
Myosotis alpestris	56.0	60.0	
Potentilla diversifolia	66.0	60.0	60.0
Potentilla gracilis	64.5	57.5	53.7
Taraxacum officinale	71.2	73.0	76.0
Valeriana occidentalis	75.7	70.0	79.5
Arnica fulgens	76.0		
Average, all forbs	70.1	64.5	61.5
Grasses			
Agropyron trachycaulum	67.0	64.8	61.5
Bromus pumpellianus	71.4	63.0	58.6
Carex spp.	63.3	59.1	55.9
Poa spp.	67.2	63.0	60.5
Stipa columbiana	69.8	60.4	56.8
Festuca idahoensis	64.0		
Agrostis idahoensis			62.0
Average, all grasses	67.2	62.0	59.2

*Standard error of 3 determinations are all less than 10% of mean.

Geranium richardsoni, and *Potentilla gracilis,* ranged from a high of 73.0% for *A. lanulosa* in late June to the low of 48.6% for *E. angustifolium* in late August. For grasses and sedges, the range was from 71.4% for *Bromus pumpellianus* in late June to 55.9% for *Carex* spp.[1] in late August. Treatment differences for individual forb or grass taxa and for forbs and grasses as a group were nonsignificant ($\alpha = .05$) at all collection periods.

Inter-taxa differences in digestibility were not statistically analyzed. Digestibility is an inherent attribute of a given taxon, and the differences in digestibility between two given taxa cannot be interpreted as being related to the herbicide treatment.

Small year-to-year differences were found in the digestibility coefficients of all taxa. These differences represent the uncontrolled influence of many factors (environmental, sampling, analytical, etc.) on the plants and cannot be directly related to the herbicide treatment. In most instances, these differences were quite small in relation to the mean value. Year-to-year variability is not unexpected and is probably a normal phenomenon.

The general trend was for the in vitro dry matter digestibility coefficients of both herbage groups to decrease as the growing season progressed. Forbs decreased 13.5% between late June and late August, while grasses decreased 8.0% between the first and last collections.

Production

Treatment with 2,4-D had no significant ($\alpha = .05$) effect on either the total dry matter (TDM) production or digestible dry matter (DDM) content of the total herbage (Table 2). On both treatments, average production of TDM exceeded 2,100 lb/acre in mid-July, the time of greatest herbage production. The average DDM at this time was 1,289 lb/acre (61% of the TDM) on sprayed units and 1,356 lb/acre (62% of the TDM) on unsprayed units. The percentage of DDM was highest (66 to 69%) on both treatments at the first sampling period in late June and declined 8 to 9% by late August. Considerably more actual DDM was available later in the growing season, however, because of the normal increase in production as the growing season progressed. A slight and insignificant reduction in both TDM and DDM was measured at the last sampling period, the result of normal drying and maturation processes.

Although the TDM and DDM of the total herbage was not altered by the herbicide treatment, the proportion of TDM and DDM produced by grasses did change significantly. On unsprayed units grasses produced only 9 to 20% of both TDM and DDM (Table 2), while on sprayed units they produced from 42 to 40% of the TDM and 44 to 49% of the DDM.

The shift toward a grass-dominated herbage after spraying is somewhat less than was recorded on adjacent units of similar composition that were sprayed at the same time with the same rate of 2,4-D, but were lightly grazed by cattle (Thilenius et al., 1975). On these units, the average grass to forb ratio (G-F) at TDM at mid-July on unsprayed range was 16:84, comparable to the 12:88 G:F of the unsprayed and ungrazed unit in this study. The average G:F of the sprayed and grazed units at mid-July was

Table 2. Average production (lb/acre oven dry) of digestible dry matter and total dry matter of the herbage on sprayed (2,4-D) and unsprayed subalpine cattle range in the Bighorn Mountains, Wyoming, 1969–1971.

Season and treatment	Digestible dry matter				Total dry matter			
	Grasses (G)	Forbs (F)	Total	G:F	Grasses (G)	Forbs (F)	Total	G:F
Late June								
Sprayed	270	339	609	44:56	385	538	923	42:58
Unsprayed	83	809	892	9:91	120	1,164	1,284	9:91
Mid-July								
Sprayed	549	740	1,289	43:57	871	1,242	2,113	41:59
Unsprayed	161	1,195	1,356	12:88	261	1,931	2,192	12:88
Late August								
Sprayed	564	584	1,148	49:51	966	1,003	1,969	49:51
Unsprayed	204	826	1,030	20:80	343	1,371	1,714	20:80

[1] *Carex* spp. are considered as "grass."

76:24, however, which is very different from the 41:59 recorded on the sprayed and ungrazed units in this study. The average mid-July productivity of TDM on the sprayed and grazed units was 552 lb/acre less than that of the sprayed and ungrazed units. TDM on the unsprayed and sprayed units was 381 lb/acre less. These lower TDM values may represent forage utilization by the cattle or they may represent normal variation in the productive capacity of the vegetationally similar units. The difference in the G:F ratios could be caused by an ineffective herbicide application, but both grazed and ungrazed units were sprayed similarly and it is possible the difference in G:F ratios was caused by the grazing treatment.

The diet of cattle using both sprayed and unsprayed units was 60% grasses and 40% forbs (Thilenius et al., 1975). The use of forbs to this extent, especially when they are relatively low in abundance, might result in decreased competition for the grasses, with a consequent increase in the grass proportion of the herbage. Thus, light grazing after herbicide treatment might be beneficial in keeping grasses as the predominant forage group. Smith (1969) and Thilenius and Brown (1974) found that deferment from grazing for as much as 3 years after spraying had no significant influence on herbage production on other ranges in the Bighorn Mountains.

The lack of significant differences between treatments indicates that, if a plant can survive the effects of 2,4-D, its in vitro dry matter digestibility coefficient will not be changed significantly. Furthermore, no change can be expected in the production of either TDM or DDM. However, the proportion of grasses and forbs in the herbage is altered by 2,4-D to favor grasses, and they will provide proportionally more DDM.

Because spraying with 2,4-D had no effect on DDM or TDM, the expense and effort of treatment was not repaid by either a more nutritious or a more plentiful herbage supply. The use of this treatment on forb-dominated subalpine cattle range in the Bighorn Mountains is, therefore, of doubtful utility.

Literature Cited

Dietz, Donald R. 1970. Animal production and forage quality. *In:* Range and wildlife habitat evaluation–a research symposium. U.S. Dep. Agr. Misc. Pub. 1147. p. 1-9.

Hurd, Richard M. 1961. Grassland vegetation in the Bighorn Mountains, Wyoming. Ecology 42:459-467.

Li, Jerome C. R. 1957. Introduction to statistical inference. Edward Bros. Ann Arbor, Mich. 553 p.

Smith, Dixie R. 1969. Is deferment always needed after chemical control of sagebrush? J. Range Manage. 22:261-263.

Steel, Robert G. D., and James H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, New York, N.Y. 481 p.

Thilenius, John F., and Gary R. Brown. 1974. Long-term effects of chemical control of big sagebrush. J. Range Manage. 27:223-224.

Thilenius, John F., Gary R. Brown, and C. Colin Kaltenbach. 1975. Treating forb-dominated subalpine range with 2,4-D: Effects on herbage and cattle diets. J. Range Manage. 28:311-315.

Tilley, J. M. A., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104-111.

Van Dyne, G. M., and P. T. Haug. 1968. Variables affecting in vitro rumen fermentation studies in forage evaluation: An annotated bibliography. Oak Ridge Nat. Lab., Oak Ridge, Tenn. 73 p.