Mechanical and Chemical Control of Silverberry (Elaeagnus commutata Bernh.) on Native Grassland

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Silverberry, or wolf willow, is a shrub from about 2 to 12 feet tall which occurs from Quebec to Yukon, south to Minnesota, Nebraska and Utah (Gleason 1952). It is common in the aspen parkland of western Canada, particularly on lighter soils if moisture is adequate. In overgrazed pastures it can multiply rapidly from its vigorous root system (Budd 1957), and is also increased from seeds borne in mealy drupes (U.S.D.A. 1948). Wind may be their main dispersing agency by detaching them and rolling them over the surface of crusted snow. Dormancy and germination behaviour of the seeds has been studied by Corns and Schraa (1962) and the role of the species in hastening succession from prairie to aspen forest has been noted by Bird (1961).

In the apparent absence of scientific literature dealing with methods of control of silverberry, the relevant research reported here was undertaken in 1960 and continued for three years.

Materials and Methods

At the University Ranch near Kinsella, Alberta, about 100 miles east of Edmonton, plot areas were chosen in a field from which livestock were excluded throughout the experiments. The sites were uniformly infested with silverberry averaging about 3 feet in height in a population of approximately 25 of these shrubs per 100 square feet (Figures 1 and 2). The dominant grass was rough fescue *(Festuca scabrella* Torr.), associated with small and unevenly distributed amounts of Hooker's oat grass *(Helictotrichon hookeri* (Scribn.)) Henr., June grass, *(Koeleria cristata* (L.)) Pers., spear grass *(Stipa comata,* (Trin. and Rupr.)), blue grama grass *(Bouteloua gracilis* (HBK.) Lag.), bearded wheat grass *(Agropyron subsecundum* (Link) Hitchc.), bluegrasses *(Poa interior* Rydb., *P. secunda* Presl.), and certain other species. The sedge *(Carex heliophila)* was a common but inconspicuous component of the vegetation, Snowberry *(Symphoricarpos occidentalis* Hook.) was also present in part of the experimental area together with herbaceous broad-leaved plant species characteristic of aspen parkland. Poplar bluffs were not included in the plot sites. Sod of shallow black, light loam soil about 6 to 12 inches in depth, overlay gravelly subsoil. Average annual precipitation at Kinsella is about 15 inches, three-fourths of which occurs during the growing season and the fall.

Year 1960.—(1) During the third week of August, amitrol T, dalapon, dicamba, silvex, 2,4-D, and 2,4,5-T were each applied at 3 lb/A active ingredient in 25 gal/A of water from a portable-tank compressed-air sprayer, to duplicate 200 sq. ft. plots for each of the herbicides. Some details concerning names and formulations of products used in various tests are summarized below.[1]

Periodic evaluation of results was visual, including records of numbers of incompletely killed and of new silverberry stems.

(2) In another experiment a truck-mounted sprayer was used with 2,4-D at 1.5 and 3 lb/A and 2,4,5-T at

FIGURE 1. Flowering silverberry plant (Ca x ½) in native rangeland at Kinsella, Alberta. Fruit (Ca x ¾) in inset.

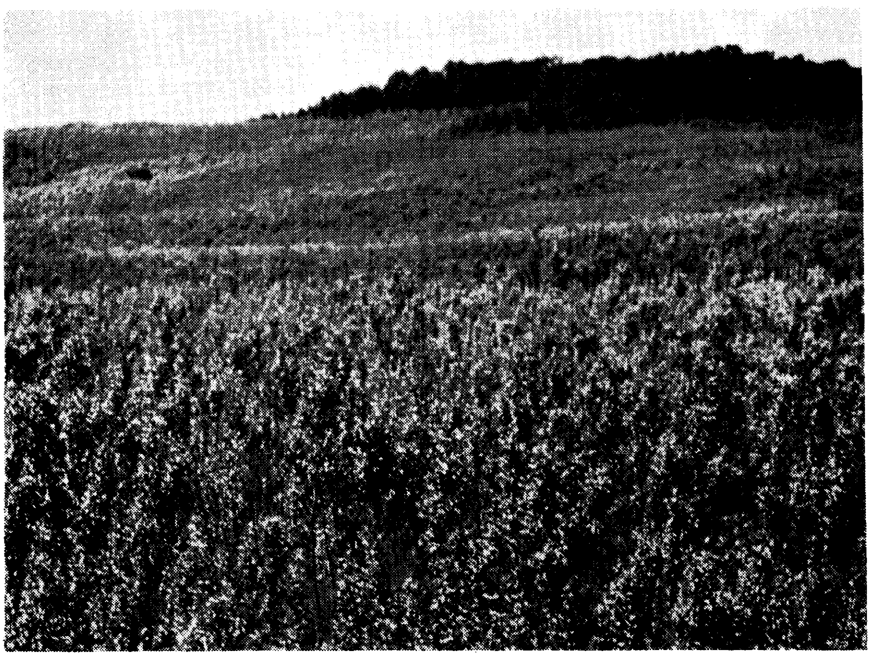

FIGURE 2. Representative silverberry and grass vegetation in the experimental area.

2 and 4 lb/A applied to three one-tenth-acre strips for each treatment. The inequality of the lower and of the higher rates of the two chemicals was due to failure to maintain exactly the same speed of travel over the respective areas. Comparable strips (16′ x 272′) were left untreated or cleared by means of a heavy-duty rotary-cutter operated by tractor power take-off.

Year 1961.—A supplementary comparison of a number of chemicals was made in addition to commencement of more intensive experiments with 2,4-D and rotary mowing separately or in combination with 2,4-D. This herbicide was emphasized in the later work because of its unsurpassed performance in the exploratory trials and its relatively low cost.

(1) On June 15, when the silverberry was in early full-leaf stage, dicamba, silvex, 2,4-D, 2,4,5-T, MCPA, barban, and DATC, were sprayed using plots and procedures comparable to those noted under 1960 (1). The rates of application of the chemicals, however, were 1.5 and 3 lb/A for all except barban and DATC, each of which was applied at 3 and 10 lb/A.

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[1] *Technical data concerning herbicides used: Amitrol T (3-amino-1,2,4-triazole plus ammonium thiocyanate—Amchem Products Inc.);*

Dalapon (sodium salt of 2,2,dichloropropionic acid—Dow Chemical Co.);

Dicamba (dimethylamine salt of 2-methoxy-3,6-dichlorobenzoic acid—Velsicol Chemical Corp.);

Silvex (propylene glycol butyl ether ester of 2,(2,4,5-trichlorophenoxy) propionic acid—Dow);

2,4-D (low volatile isooctyl ester of 2,4-dichlorophenoxyacetic acid—Chipman Chemical Co.);

2,4,5-T (low volatile isooctyl ester of 2,4,5-trichlorophenoxyacetic acid—Chipman);

MCPA (butyl ester of 2-methyl-4-chlorophenoxyacetic acid—Green Cross Products);

Barban (4-chloro-2-butynyl N-(3-chlorophenyl) carbamate—"Carbyne", Spencer Chemical Co.);

DATC (emulsifiable 2,3-dichloroallyl diisopropylthiolcarbamate—"Avadex", Monsanto Chemical Co.);

Ammate (ammonium sulfamate—Du Pont Chemical Co.);

MH (maleic hydrazide amine—Naugatuck Chemical Co.);

CCC (2-chloroethyl-trimethylammonium chloride—American Cyanamid Co.).

(2) The large strips of vegetation involved in the 1960 experiments with 2,4-D were, in mid-June 1961, subdivided into square rod plots for further treatments each in quadruplicate. They included 2,4-D at 0, 1, 1.5, 2, 3, and 4 lb/A in 25 gal/A water applied from a portable-tank sprayer. Thus each rate was replicated on silverberry which in 1960: (a) had no treatment or (b) had been mowed or (c) had been treated with 1.5 or 3 lb. 2,4-D/A. In this way there was provision for some comparisons of results of previous late August treatments with those of subsequent early summer treatments and with combinations of these seasonal treatments.

(3) A separate triplicate randomized block experiment with 20 x 20 ft. plots enabled evaluation of treatments repeated during the same growing season in comparison with results after a longer interval between the treatments. It included assessment of effects of control of silverberry upon forage yield of various plots.

The schedule was:

(a) Spray in June (June 15, 1961). Spray treatments were 1, 2, 3, 4 lb. 2,4-D/A, throughout.
(b) Spray in June and respray regrowth in August (August 10, 1961).
(c) Spray in June and respray in August of the following year (August 8, 1962).
(d) Spray in June, mow in August of same year and August of the following year. A 7 h.p. garden tractor with front mounted 26" rotating brush cutter blade was used for mowing.
(e) Mow in June.
(f) Mow in June, August, and in August of the following year.
(g) Mow in June and spray in August.
(h) Mow in June and spray one year later (June 13, 1962).

Records concerning the initial control and the amount of regrowth of silverberry were kept during 1961, 1962 and 1963. Final data were recorded on July 3, 1963. Grass yields were determined on selected sets of plots as noted in Table 4, later. Five individual square yard samples were clipped closely from each plot for determination of oven-dry weights on the pooled samples for each plot prior to analysis of variance.

Year 1962.—An additional experiment was designed to investigate the possibility that certain additives with 2,4-D might improve the ability of a single spray application to curtail subsequent "suckering" of the silverberry plants. Triplicate square rod plots for each treatment were sprayed on June 14. The silverberry was in full leaf and flowering. Weather and growth conditions were considered to be ideal.

Treatments included:

(1) 2,4-D at 2 and 3 lb/A alone in 25 gal. water/A.

(2) 2,4-D at 2 lb/A in a separate mixture with each of the following chemicals and amounts of chemical:

— sodium chlorate, 2, 5 lb/A.
— ammate, 2, 5 lb/A.
— MH, 0.5, 2 lb/A.
— CCC, 0.5, 2 lb/A.

(3) each of the above additives alone at its respective two rates; and untreated controls.

It was considered appropriate to mention the trial with the mixtures without giving detailed results since they were essentially the same as those presented later for 2,4-D by itself.

In the ensuing discussion the treatments will be referred to by year and number, e.g. Experiment 1960 (1), etc.

Results and Discussion

Initial evaluation of herbicides, Experiments 1960 (1) and 1961 (1).—In the fall of 1960 during the month after the August treatments, only 2,4-D, 2,4,5-T and silvex caused visible and virtually complete "top-kill" of the silverberry plants. Amitrol and dalapon were ineffective.

In the summer of 1961 during the month after commencement of the new experiment comparing 2,4-D, 2,4,5-T and silvex as well as MCPA, dicamba, barban and DATC, the apparent superiority of the "phenoxy-acid" compounds was again evident. 2,4-D was at least equal in toxicity to 2,4,5-T, silvex and MCPA. Dicamba was slower in expression of injury through top-killing but as indicated by later results it joined the category of superior herbicides (Table 1).

Efficiency of 2,4-D and mechanical treatments, Experiments 1960 (2); 1961 (2); 1961 (3).—In the fall of 1960 and in the spring of 1961 comparisons of the sprayed one-tenth acre strips of silverberry showed that the 2,4-D treatments were as effective as the somewhat higher rates of 2,4,5-T. As noted above, part of this experimental area was sub-divided for more intensive experiments 1961 (2). Representative results are summarized in Table 2. These results

Table 1. Mean numbers on June 20, 1962, of living branch parts and of new stems from roots of silverberry per duplicate 400 sq. ft. plot treated June 15, 1961.

Rate lb/A	Br[1]	St[1]	Br	St	Br	St	Br	St
	Dicamba		Silvex		2,4-D		2,4,5-T	
1.5	8	0	6	0	1	1	1	2
3.0	0	0	2	0	0	3	1	7
	MCPA		Barban		DATC		Check	
1.5	4	0	58	11	52	6	0	rate
3.0	3	1	52	14	75	6	103	9

[1] Br="Branches"; St="Stems."

Table 2. Effects of mowing and/or 2,4-D treatments in August, and in June of the following year on survival of silverberry.

Treatments		Mean no. of live shoots per 1 sq. rod plot		
8-9-60	6-15-61	8-10-61 Br + St[1]	8-9-62 Br	St
Control	D, 0[2]	22	14	34
	D, 1	1	2	8
	D, 2	1	0	6
	D, 4	1	1	10
	Mowed	—	—	48
Mowed	D, 0	60		68
	D, 1	9		19
	D, 2	15		16
	D, 4	14		20
	Mowed	—		140
2,4-D, 1.5 lb/A	D, 0	24	7	32
	D, 1	4	1	7
	D, 2	2	1	4
	D, 4	5	1	9
	Mowed	—	—	57
2,4-D, 3.0 lb/A	D, 0	20	3	23
	D, 1	3	1	5
	D, 2	6	0	7
	D, 4	2	0	3
	Mowed	—	—	83

[1]Old branches with new twigs (Br), and new stems or "suckers" (St).
[2]D, 0 etc.=2,4-D, lb/A.

indicate that late summer treatment by mowing in 1960 led to a marked increase in new growth from the root system during the following years.

Late summer treatments with either 1.5 or 3 lb. 2,4-D/A in 1960 were superior to mowing and were essentially equal to one another with regard to top-killing and extent of inhibition of regrowth during the following two years. Single early-summer treatments in 1961 with rates of 2,4,-D of 1-4 lb/A were more effective than late summer treatments with 2,4-D in 1960 and were just about as effective alone as when preceded by mowing or 2,4-D treatment the previous August. The lowest rate of 2,4-D used in early summer was as effective as the highest. All were remarkably good but none completely prevented new growth from roots within the ensuing year.

Proceeding now to the results of experiment 1961 (3), relative to repeated summer treatments, some of the data are presented in Table 3. The data for 2 and 3 lb/A, 2,4-D treatments and for an entire additional set of observations recorded on June 15, 1962, are omitted because they were virtually the same as those given here. It seems clear from these results that repeated treatments with rates of 2,4-D from 1 to 4 lb/A applied to intact plants in June and to the limited re-growth in August were no more effective than single early summer treatments.

Mowing either before or after applications of 2,4-D brought about no detectable improvement over results from 2,4-D alone. Mowing as many as three times was less effective than a single 1 lb/A application of 2,4-D in early summer. The most successful treatments were 2,4-D applications of 1 to 4 lb/A on June 15, 1961, followed by comparable repeated applications to re-growth present in August of the next year. Two treatments of 1 lb/A were as effective as two 4 lb/A applications.

Table 3. Effects of mowing and/or 2,4-D within two successive summers on survival of silverberry in the following years.

				Number of live stems per 400 sq. ft.	
6-15-61	8-10-61	6-13-62	8-8-62	8-9-62	7-3-63
Control D, 0[1]	—	—	—	100	118
D, 1	—	—	—	5	10
D, 4	—	—	—	4	6
D, 1	D-1	—	—	6	9
D, 4	D-4	—	—	4	5
D, 1	—	—	D-1	7	1
D, 4	—	—	D-4	7	0
D, 1	Mowed	—	Mowed	—	4
D, 4	Mowed	—	Mowed	—	4
Mowed 0	—	—	—	95	120
Mowed	Mowed	—	Mowed	—	29
Mowed	D-1	—	—	8	11
Mowed	D-4	—	—	12	13
Mowed	—	D-1	—	9	10
Mowed	—	D-4	—	6	10

[1]D, 0 etc.=2,4-D, lb./A.

Grass yields

Table 4 summarizes some data for grass yields in 1962 and 1963 from selected plots in experiment 1961 (3). Despite the confusing variability among yields from different replicates there appears to have been a tendency for yields in 1962 to be higher for the treated plots than for the controls while the reverse is suggested by the 1963 data. It may be that in some years at least, silverberry populations of this density offer no significant competition in the grass sod, the bulk of whose roots are above many of those of the shrub.

Moreover, as another potential part of the interaction there might be an interesting possibility of some beneficial effect of silverberry roots on grass through fixation of nitrogen. Elaeagnus is known to have such capability (Gardner 1958). *Shepherdia,* another member of the *Elaeagnaceae* and certain other non-leguminous species in e.g. the *Alnus* genus, may, in association with mycorrhiza, accumulate an appreciable quantity of nitrogen under field conditions (Crocker and Major 1955). If this is of significance with *Elaeagnus commutata* the maintenance of an appropriate balance in the population of silverberry rather than its complete eradication would be important. A further avenue of research is therefore suggested.

Despite the inconclusive results regarding effects on grass yields of treatments outlined above, there nevertheless appears to be justification for removal of stands of silverberry which have replaced desirable forage or which interfere mechanically with proper utilization of the grass crop. The data in Table 4 for hand-clipped plots do not, of course, show the relative increase in grazing capacity resulting from removal of most of the interference with grazing on the chemically treated plots. While we have no precise information relative to this point and to maximum tolerable density of silverberry plants, it was evident that the silverberry areas had previously been grazed less than half as much as were adjacent grassed areas having no silverberry population. The shrub therefore may exert a dual natural influence involving interaction of various factors. It may gradually lead to replacement of grass in the plant succession, yet if land is overstocked the silverberry can meanwhile reduce by interference with animal grazing, the rate of loss of desirable forage species. This, of course, is merely a limited temporary benefit. Balanced control measures for the silverberry must obviosuly include proper grazing management. It seems clear that chemical control with 2,4-D can be a feasible part of such an overall program.

Table 4. Grass yields in pounds of dry matter per acre after indicated treatments of rangeland infested with silverberry.

Treatment	Replication 1	2	3	Mean
	Yields (Aug. 8, 1962)			
D, 2				
6-15-61	2222	2085	2797	2368
Control	2083	1455	2418	1985
	L.S.D. (5%):	610 lb/A		
	Yields (July 24, 1963)			
D, 2[1]				
6-15-61				
8-8-62	2168	2253	2305	2242
Mowed				
6-15-61	2277	2141	2483	2300
Mowed				
6-15-61				
D, 2				
6-13-62	2104	2748	2087	2313
Control	2285	2741	2660	2562
	L.S.D. (5%):	467 lb/A		

[1]D, 2 etc.=2,4-D, lb/A.

Summary

A number of chemicals including amitrol T, dalapon, dicamba, silvex, 2,4-D 2,4,5-T, MCPA, barban, and DATC ("Avadex"), were used in exploratory trials to compare their effectiveness against silverberry vegetation on rangeland. Of these, 2,4-D, 2,4,5-T, MCPA, silvex and dicamba seemed to be equally and highly effective but dicamba was somewhat slower in producing visible effects. Because of its efficiency and relatively low cost 2,4-D ester was emphasized in a variety of subsequent experiments. These involved single and repeated applications of the chemical in different seasons and years and in combination with mowing of the silverberry at different times before or after herbicidal application.

The most successful treatments, which brought about near eradication of the silverberry were 2,4-D ester applied at 1 to 4 lb/A in early summer, followed by a second application to new growth during the summer of the following year. The relatively inexpensive treatments at the lower rates were as effective as those at higher rates.

Mowing as many as three times was much less effective than a single 1 lb/A application of 2,4-D in early summer. Mowing either some time before or after the 2,4-D treatments did not improve their results apart from some possible improvement in availability of the forage for grazing.

Addition of small amounts of certain chemicals in mixture with 2,4-D did not increase the degree of suppression of new growth from roots of treated plants.

There was no definite improvement in forage yield associated with control of the silverberry in the open stands. There is little doubt, however, that improved availability of the grass to livestock together with prevention of multiplication of silverberry population would with proper grazing management be beneficial in the long run.

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