Controlling Tall Larkspur on Snowdrift Areas in the Subalpine Zone[1]

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Highlight

Repeated annual applications of 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid] or silvex [2-(2,4,5-trichlorophenoxy) propionic acid] reduced the density of tall larkspur (*Delphinium barbeyi* (Huth) Huth) below a level that is potentially dangerous to grazing cattle. Killing tall larkspur and other forbs resulted in a plant community dominated by grasses. The dominant species of grass depended on whether the treated plot was grazed by cattle. Letterman needlegrass (*Stipa lettermanii* Vasey) dominated on grazed plots and mountain brome (*Bromus carinatus* Hook. & Arn.) dominated when plots were protected from grazing cattle. Reinvasion of treated areas by tall larkspur and the unpalatable weedy species occurred more rapidly on grazed plots than on ungrazed plots.

These studies were initiated for the purpose of developing effective methods of controlling tall larkspur (*Delphinium barbeyi* (Huth) Huth) on sites where the snowdrift persists and continue to melt for much of the growing season. These areas, relatively low in acreage, influence vast areas of subalpine rangeland in Western North America (Cronin, 1971).

Tall larkspur is the dominant species in the tall-forb communities of the subalpine vegetation of the Wasatch Plateau in central Utah. Tall-forb communities exist around running water and at the edge of wet meadows. These communities thrive on sites where deep and late-melting snowdrifts accumulate each winter (Ellison, 1954).

Grazing cattle are attracted by the superior palatable vegetation on sites where the late melting snowdrifts produce water for luxuriant growth. These sites are extremely dangerous for two reasons. First, the abundant tall larkspur contains the season's highest concentrations of poisonous alkaloids during this early growth (Marsh and Clawson, 1916; and Williams and Cronin, 1963). Second, relatively small amounts of tall larkspur can be lethal if it is eaten rapidly (Kingsbury, 1964). Cattle losses can be reduced by controlling densities of this poisonous plant. It is important that these sites with erosion prone soils not be stripped of their protective cover of vegetation. Methods of controlling tall larkspur other than the use of selective herbicides have proved to be either impracticable or prohibitive because of costs (Cronin, 1971). Current information indicates that chemical control is both practical and economically beneficial.

Selective control of both tall larkspur and duncecap larkspur (*D. occidentale* (S. Wats.) S. Wats.) with 4 & 8 lb. acid equivalent/acre (2,4, 5-trichlorophenoxy) acetic acid (2, 4,5-T) and 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) have been achieved by Hervey and Klinger (1961) and Torrel and Haas (1963). They applied effective treatments to vegetative plants of uniform development. Unfortunately these results cannot be directly applied to the subalpine zone because of the deep persisting snowdrifts. Melting more rapidly in the shallow areas and around the periphery, the receding snowdrifts create zones of different stages of development in the plant community. Some tall larkspur plants would be in flower before all the snow in the drift had melted. Thus all plants on a site are not at the most susceptible stage for treatment at the same time.

Materials and Methods

These studies were conducted at the head of Manti Canyon at an elevation of approximately 9,800 ft on the Wasatch Plateau in plots where deep snowdrifts accumulate each winter. Studies were divided into two experiments. The first experiment was initiated on a 4% slope at the head of South Fork of Manti Canyon in 1960. The second experiment was initiated in 1961

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[1] Cooperative investigations by the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture and Utah Agricultural Experiment Station, Logan, Utah. Utah Agricultural Experiment Station Paper 1105. Received June 3, 1971.

at the head of Hougaard Fork on a 3% slope.

A modification of the ocular point frame (Stanton, 1960) was used to sample the vegetation. The ocular point frame used was 1 m long and consisted of ten points. Ten readings of the frame were taken 3 ft apart along the axis of plots. Each plot was 8 ft by 33 ft. A total of 100 points were obtained on each plot for each sampling date.

Plots were sampled immediately before treatment and annually following treatment. The first object intercepting the line of sight was recorded. Each point was recorded under the species name or under the heading of bare ground which included all non-living objects.

Both herbicide and grazing treatments were applied in these studies. All levels of herbicide treatments were applied with a compressed-air sprayer in 40 gpa of spray solution. Designated plots were grazed according to the rest-rotation grazing schedule of the Manti Canyon Allotment. Ungrazed plots were protected from grazing by cattle by a 4-strand barbed wire enclosure.

Percent aerial cover of tall larkspur, the total percent aerial cover for all species of grasses and sedges, and the percent bare ground were subjected to analysis of variance and Duncans New Multiple Range Test for each year of sampling.

Table 1. Aerial cover (ft^2/rod^2) of tall larkspur on plots before treatment in 1960 and changes in the cover 1 and 3 years after treatment.[1]

Treatment date	Herbicide applied	Aerial cover: Before treatment	Change from 1960 to: 1961[2]	Change from 1960 to: 1963[2]
July 14	2,4,5-T	76	–49 ab	–60 a
July 14	silvex	79	–63 b	–60 a
July 14	2,4-D	68	–33 ab	–46 a
July 14	sesone	82	–38 ab	–49 a
August 2	2,4,5-T	90	–52 ab	–65 a
August 2	silvex	71	–44 ab	–52 a
August 2	2,4-D	74	–30 a	–52 a
Check	(no treatment)	87	–22 a	–49 a

[1] Each value represents an average for four replications of three rates of each herbicide (2, 4, and 8 lb./acre). Differences due to the rates of herbicide application were not significant.

[2] Means in the same column followed by the same letter are not significantly different at the 5% probability level as determined by Duncan's New Multiple Range Test.

1960 Treatments

Plots were located in two adjacent snowdrift areas supporting tall larkspur. A checkered pattern of experimental plots mixed with plots unsuitable for experimental work because of too few tall larkspur plants resulted on both snowdrift areas. The treatments were replicated 4 times and completely randomized among the experimental plots. All plots were available to grazing animals.

Herbicide treatments were applied on July 14 while tall larkspur was in its late vegetative stage of development. A second group of plots was treated on August 4 when the lowest flowers on the plants had opened. The propylene glycol butyl ether esters of silvex, sodium 2-(2,4,5-trichlorophenoxy) ethyl sulfate (sesone) and the propylene glycol butyl ether esters of 2,4-D were applied at 2, 4, and 8 lb./acre.

1961 Treatments

Most tall larkspur plants were in early bud stage when treatments were applied. This coincided with the period when silky lupine (*Lupinus sericeus* Pursh), Porter ligusticum (*Ligusticum porteri* Coult. & Rose), and tansy mustard (*Descurainia pinnata* (Walt.) Britton) had produced abundant flowers but before any had withered. The perianth on the flowers on Nuttall violet (*Viola nuttallii* Pursh) had disappeared. Date of treatment was July 19.

The dimethylamine salt of 2,4,5-T, the butoxy ethanol ester of 2,4,5-T, and the butoxy ethanol ester of silvex were applied at rates of 2, 4, or 8 lb./acre. Four additional treatments were included in this experiment. These treatments consisted of two series of repeated applications of the ester formulations of 2,4,5-T or silvex. They are referred to as "repeated treatments" in the following discussion, but for purposes of statistical analyses each are considered as "a treatment." One "repeated treatment" consisted of an application of 4 lb./acre in 1961 followed by a second application of 8 lb./acre in 1962. The other "repeated treatment" consisted of an application of 2 lb./acre in 1961, an application of 4 lb./acre in 1962, and a final application of 4 lb./acre in 1963.

A total of 14 treatments, including untreated checks, were replicated 3 times each on an area open to grazing and on an adjoining ungrazed area in an exclosure.

Results

1960 Treatments

A general decrease in the aerial cover of tall larkspur occurred on both treated and untreated plots from 1960 through 1963 (Table 1). We attribute this general decrease in aerial cover of tall larkspur to the relatively early snow melt in 1961 and 1962. The early snow melt resulted in warm dry spring weather. We also suspect that grazing cattle may have contributed to the reduction in the cover of tall larkspur. Statistically significant changes in the percent aerial cover of tall larkspur due to silvex treatments occurred from 1960 to 1961. Differences due to the rate and date of applications were not significant. Differences in change in aerial cover between treatments and checks were not significant in 1963.

Increases in the percent bare ground from 1960 to 1961 were significant only on plots treated with silvex on July 14. Increases from 1960 to 1963 were significant on plots treated with 2,4,5-T or silvex on August 2. Differences due to the date and rate of application were not statistically significant.

The aerial cover of the grasses and sedges increased about two-fold on most herbicide treated plots from 1960 to 1961. The increases remained significant through 1963 on plots treated with 2,4,5-T or 2,4-D on July 14. The largest increases of grasses and sedges resulted from applications of 2,4,5-T and silvex. Differences due to the rate of herbicides were not significant. Date of application had little influence on the aerial cover of grasses and sedges.

We believe excessive grazing occurred on these plots beginning soon after the herbicides were applied in 1960 and continued through 1963. Heavy grazing appeared to be centered around those plots where the herbicides killed most of the broad-leaved plants. Grazing overlapped into adjacent plots. This pattern of grazing resulted in ever increasing differences between replications, and the standard error of the mean ($S_{\bar{x}}$) increased each year the vegetation was sampled. We abandoned these plots in 1963 because we could not evaluate the interaction between grazing and herbicide treatments.

Table 2. Aerial cover (ft²/rod²) of tall larkspur on plots before treatment in 1961 and changes in cover after treatment on plots grazed by cattle.[1]

Treatments				Aerial cover				
Herbicides applied		Rate (lb./acre)	Year	Cover in 1961	Change from 1961 to:[2] 1962	1963	1964	1967
2,4,5-T	(ester)	2	1961	49	– 5a	–25bc	–35bc	–33a
"	"	4	1961	35	–13ab	–16ab	–27abc	–16a
"	"	8	1961	57	–43de	–49de	–54d	–52a
"	"	4	1961[3]	65	–24bc	–57de	–60de	–57a
"	"	8	1962[3]					
"	"	2	1961[4]					
"	"	4	1962[4]	76	–49ef	–65e	–76e	–73a
"	"	4	1963[4]					
2,4,5-T	(amine)	2	1961	44	–28bc	–28bc	–33bc	–36a
"	"	4	1961	46	–38cde	–24b	–35bc	–38a
"	"	8	1961	35	–32cd	–24bc	–30abc	–32a
Silvex	(ester)	2	1961	35	–13ab	– 2a	–19a	–27a
"	"	4	1961	65	–54f	–57de	–51d	–51a
"	"	8	1961	82	–63f	–71e	–71e	–74a
"	"	4	1961[3]	76	–27bc	–68e	–75e	–62a
"	"	8	1962[3]					
"	"	2	1961[4]					
"	"	4	1962[4]	44	– 6a	–39cd	–41cd	–41a
"	"	4	1963[4]					
Check	(no treatment)			52	0a	–22bc	–25ab	–30a

[1] Each datum represents an average for 3 replications.
[2] Means in the same column followed by the same letter are not significantly different at the 5% probability level as determined by Duncan's New Multiple Range Test.
[3] Treatments were applied to the same plots in 1961 and 1962.
[4] Treatments were applied to the same plots in 1961, 1962, and 1963.

1961 Treatments

All herbicide treatments, especially at the higher rates of application resulted in a reduction of the aerial cover of tall larkspur 1 year after application. Grazed plots (Table 2) treated with 8 lb./acre of the esters 2,4,5-T or silvex had significantly less tall larkspur through 1964 but statistical differences did not persist after 1964. Significant reductions of tall larkspur resulting from single applications did not last beyond 1962 on the plots protected from grazing cattle (Table 3). Differences between the untreated check plots, and plots treated with single applications of amine salt of 2,4,5-T at 4 and 8 lb./acre, were again evident in 1967 on the ungrazed plots.

The reduction of the aerial cover of tall larkspur was highly significant in 1963 on plots retreated in 1962 on both the grazed and ungrazed plots. Differences persisted through 1964. On the ungrazed plots, the differences in tall larkspur cover remained highly significant through 1967 on plots retreated for 2 or 3 years in succession. Differences due to the number of repeated herbicide applications (2 or 3), or to the herbicides were not significant.

We have noted an increased intensity of grazing by cattle following herbicide treatments. Similar herbicide treatments usually resulted in greater reductions on grazed plots than on plots in the exclosure protected from grazing cattle. Differences were highly significant from 1963 through 1967. The significant differences must be due to grazing cattle which suggests they consume significant amounts of tall larkspur. An interaction between herbicide treatments and grazing cattle may exist because tall larkspur usually increases under heavy grazing (Ellison, 1954). However, in these experiments there was a trend toward decline in stand on check plots that were grazed (Table 2) that was greater than on the ungrazed (Table 3).

Tall larkspur densities decreased sharply on both grazed and ungrazed plots from 1962 to 1963. This decrease was still evident in 1967 on most treated plots and control plots. This decrease may have been initiated by the dry summer of 1962 and an exceptionally high

Table 3. Aerial cover (ft^2/rod^2) of tall larkspur on plots before treatment in 1961 and changes in cover after treatment on plots protected from grazing cattle.[1]

Treatments			Aerial cover				
			Cover in 1961	Change from 1961 to:[2]			
Herbicides applied	Rate (lb./acre)	Year		1962	1963	1964	1967
2,4,5-T (ester)	2	1961	41	–22b	–24abc	–16abc	–11abc
" "	4	1961	46	– 8a	–11a	–22abc	–11abc
" "	8	1961	63	–49c	–30abc	–33abc	–14abc
" "	4	1961[3]	71	–11a	–68e	–68e	–52def
" "	8	1962[3]					
" "	2	1961[4]					
" "	4	1962[4]	57	–22b	–41bcd	–54de	–52def
" "	4	1963[4]					
2,4,5-T (amine)	2	1961	46	– 3a	–11a	–24abc	–16abcd
" "	4	1961	46	– 3a	–11a	–24abc	–35cdef
" "	8	1961	35	–33c	–33abc	–35abcd	–35cdef
Silvex (ester)	2	1961	41	–16ab	–19abc	–11ab	–30bcde
" "	4	1961	41	–38c	–16ab	–19abc	+ 5a
" "	8	1961	46	–30bc	–19abc	–22abc	–14abc
" "	4	1961[3]	49	–19ab	–44cd	–44cde	–46def
" "	8	1962[3]					
" "	2	1961[4]					
" "	4	1962[4]	54	–16ab	–38bc	–38bcd	–46def
" "	4	1963[4]					
Check (no treatment)			46	+ 3a	–11a	– 8a	– 8ab

[1] Each datum represents an average for 3 replications.
[2] Means in the same column followed by the same letter are not significantly different at the 5% probability level as determined by Duncan's New Multiple Range Test.
[3] Treatments were applied to the same plots in 1961 and 1962.
[4] Treatments were applied to the same plots in 1961, 1962, and 1963.

population of mirid bug (*Hoplomachus affiguratus* Uhler). This insect usually has a wide host range but it appears to feed exclusively on tall larkspur in the subalpine region of the Wasatch Plateau.

The percent bare ground increased the first season after applications of herbicides. Generally, herbicide applications resulted in more bare ground on the grazed plots than on ungrazed plots. Increased bare ground was largely the result of reduced cover of tall larkspur and other broadleaf plants. Significant differences resulting from herbicide treatments tended to persist longer on the grazed plots. Following completion of the multiple herbicide applications in 1963, and as grasses began to fill in spaces, differences due to herbicide applications started to disappear. All significant differences due to herbicide treatments and to grazing except on plots grazed and treated 3 times with ester of 2,4,5-T had disappeared by 1967.

Grasses and sedges were generally more dense on the grazed plots than on plots in the exclosure before any herbicide treatments were applied. Herbicide treatments resulted in highly significant increases in the percent aerial cover of the grasses and sedges on most grazed and ungrazed plots. Increases in grasses and sedges are related to and in general a direct response to reduced stands of tall larkspur resulting from treatments. In many cases the decreased stands of tall larkspur and other broadleaved plants, in the first and second years after treatment, allowed the filling in of some of the space by grasses. These stands of grasses persisted even where tall larkspur had partially reinfested the plots by 1967. There was not a close response to rates and the herbicides applied. Large increases in grass were all related to plots treated with herbicides, with a tendency of the larger increases to occur on plots receiving repeated treatments.

Letterman needlegrass (*Stipa lettermanii* Vasey) was responsible for most of the increased grass cover on the grazed plots. It was not a significant increaser on plots in the exclosure. Slender wheatgrass (*Agropyron trachycaulum* (Link) Malte) usually increased also on the ungrazed plots. The more productive and palatable mountain brome (*Bromus carinatus* Hook. & Arn.) was the major increaser on the ungrazed plots.

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