Evaluation of Some Herbicide Treatments for Controlling Tall Larkspur

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Highlight: Esters or the amine formulation of silvex and 2,4,5-T were equally toxic to tall larkspur. Repeated annual treatments with 2,4,5-T, silvex, dicamba, and picloram proved equally effective for controlling tall larkspur. Applications of 2,4,5-T (or silvex) at 4 lb/acre for each of two summers were the most economical of the various effective treatments evaluated.

Tall larkspur (Delphinium barbeyi Huth.) causes severe and sometimes catastrophic losses of cattle grazing the subalpine ranges of Utah. The losses occur because tall larkspur grows on relatively small, localized areas in the subalpine zone where it receives an almost continuous water supply during the summer (Cronin, 1971). Tall larkspur is palatable to cattle (Kingsbury, 1964). Repeated or split applications of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] and silvex [(2,4,5-trichlorophenoxy) propionic acid] have effectively reduced densities of tall larkspur for periods of 5 or more years (Cronin and Nielsen, 1972).

Controlling tall larkspur with herbicides is the best established method that is effective and without serious adverse ecological effects to the plant community or soil (Cronin and Nielsen, 1972). Therefore, it is desirable to study the effectiveness of herbicides other than 2,4,5-T and silvex for controlling tall larkspur in event use of a particular herbicide is banned. This need was demonstrated by a temporary ban on the use of 2,4,5-T during the summer of 1970 by the Forest Service. Ecological justification for alternative herbicide treatments also exists. Too-frequent application of a single herbicide may selectively promote increases of other undesirable plants resistant to the herbicide.

Under some conditions, costs of application may represent the major expense of herbicide treatment. Also, each annual application can multiply the cost of the treatment. Therefore, a comprehensive study of the effectiveness of various annual treatments was undertaken in 1965, using the most promising herbicides evaluated to that date.

Methods and Materials

Study plots were located at the head of Manti Canyon on the Wasatch Plateau in central Utah. All plots were within tall-forb communities (Ellison, 1954) on snowdrift areas with high and relatively uniform densities of tall larkspur (Fig. 1).

All herbicide treatments were applied to 8- by 33-ft plots with a compressed-air knapsack sprayer. Each herbicide was applied, in 40 gpa of aqueous solution, when tall larkspur was 8 to 12 inches high and racemes were less than ½ inch long. The dogtooth violet (Erythronium grandiflorum)
florum Pursh) was past flowering, but
the leaves remained green and turgid.
Nuttall violet (Viola nuttallii Pursh) and
common rock-jaasmine (Androsace septen
trionalis L.) were in full bloom. Meadow
cinquefoil (Potentilla erecta Dougl.) and
Colorado columbine (Aquilegia caerulea
James) were starting to bloom.

An ocular point frame was used to
estimate changes in vegetation as a result of
herbicides applied (Cronin and Nielsen,
1972). Ten samples of 10 points each
to estimate changes in vegetation as a result of
herbicides applied (Cronin and Nielsen,
1972). Ten samples of 10 points each
(100 points/plot/year), spaced 3 ft apart
along the axis of the 8-by 33-ft plots,
were obtained on each plot before treat-
ment and annually for 4 or more years
after treatment. The first species or ob-
ject intercepted by the line of sight was
recorded for each point. The exception
was in the 1965 experiment, when 200
points (20 points for each of 10 samples)
were obtained annually for each plot.
Only changes in the density of tall lark-
spur are reported here, but detrimental
reductions of forage or potential erosion
hazards caused by any treatment were
also recorded.

Data from each experiment was sub-
ected to analysis of variance, and when
significant differences caused by treat-
ment were indicated, Duncan's new
multiple-range test was applied.

1963 Study

The purpose of this study was to
determine the relative effectiveness of
2,4,5-T and silvex, and whether the low-
volatile esters or the oil-soluble amines of
these herbicides were more toxic to tall
larkspur. A randomized-block design
was treated with the propylene glycol butyl-
ether ester or the diethylamine salt of
2,4,5-T and silvex. Each formula-

tion of each herbicide was applied to four
replications at rates of 4 or 8 lb/acre of
the active ingredient. One plot in each
block remained untreated as a check plot.
All plots were inside an enclosure at
9,800 ft near the head of Manti Canyon
in a completely randomized design. Plots
were on a level site at 8,500 ft in
Hougaard Fork of Manti Canyon.

1965 Study

This experiment was designed to evalu-
ate various split or annually repeated
applications of 2,4,5-T, silvex, dicamba,
2,4-D (2,4-dichlorophenoxo) acetic acid
picloram, and mixtures of 2,4-D and
2,4,5-T. Four replications of the treat-
ments and the untreated check plots were
in a randomized-block design. Most of the
for this experiment involved
applications repeated annually for 2 or 3
years. The names and total amounts of
erbicides applied are shown in Table 1.
Treatments were applied on July 14,
1965, July 8, 1966, and July 20, 1967, as
determined by the phenological develop-
ment of tall larkspur and selected species.
Plots were on a snowdrift area at 9,800 ft
and were grazed by cattle.

Results and Discussion

Although changes in the densities of
all plant species and the percent bare
ground were recorded on each sampling
date and will be reported in detail later,
only the changes in densities of tall
larkspur are reported here. However, it
may be assumed that herbicide treat-
ments increased forage production and
did not significantly increase the percent
bare ground unless noted in the following
discussion.

1963 Study

Significant differences between herbi-
cides and rates applied existed in 1964,
but these differences had disappeared by
1965 (Table 2). Densities of tall larkspur
remained significantly lower on all
herbicide-treated plots, except for plots
planted with the ester of 2,4,5-T at 4
lb/acre, than on the untreated check plots
until 1966. Single applications of these
herbicides seldom produce significant dif-
ferences beyond the season after applica-
tion. Protection afforded by the ex-

Table 1. Treatments applied to the 1965 study plots in 1965, 1966, and 1967.

<table>
<thead>
<tr>
<th>Herbicide applied</th>
<th>Rate applied in:</th>
<th>Number of applications made</th>
<th>Total amount of herbicide applied (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1965</td>
<td>1966</td>
<td>1967</td>
</tr>
<tr>
<td>Check—no treatment applied</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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<td>2,4,5-T</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>8</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Silvex</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Silvex</td>
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<td>8</td>
</tr>
<tr>
<td>Dicamba</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dicamba</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Picloram</td>
<td>½</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>Picloram</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2,4,5-T plus 2,4-D</td>
<td>2+2</td>
<td>2+2</td>
<td>2+2</td>
</tr>
<tr>
<td>2,4,5-T plus 2,4-D</td>
<td>4+2</td>
<td>4+2</td>
<td>4+2</td>
</tr>
</tbody>
</table>

1Rate of herbicide application indicate amount (lb/acre) of active ingredient applied.

Table 2. Percent cover of tall larkspur for each sampling year on plots treated July 11, 1963.

<table>
<thead>
<tr>
<th>Treatment applied</th>
<th>Rate (lb/acre)</th>
<th>Year sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td>0</td>
<td>1963-1968</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>4</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>Silvex</td>
<td>4</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>8</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>Silvex</td>
<td>8</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>10</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>Silvex</td>
<td>11</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>13</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>Silvex</td>
<td>13</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>15</td>
<td>2-1963, 3-1966, 4-1967</td>
</tr>
</tbody>
</table>

1Each value represents the average of four replications of each treatment.
2Means in the same column followed by the same letter are not significantly different at the 5% level.
3Propylene glycol butyl ether esters.
4Diethylamine.
Table 3. Percent of tall larkspur cover for each sampling year on plots receiving herbicide treatments on July 16, 1964.

<table>
<thead>
<tr>
<th>Herbicide applied</th>
<th>Rate applied (lb/acre)</th>
<th>Year sampled</th>
<th>1964</th>
<th>1965</th>
<th>1966</th>
<th>1967</th>
<th>1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2,4,5-T</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicamba</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicamba</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicamba</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picloram</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picloram</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picloram</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Each value represents the averages of four replications of each treatment.

2 Means in the same column followed by the same letter are not significantly different at the 1% level.

closure contributed to the duration of differences measured here.

Because applications of 2,4,5-T or silvex were equally effective for controlling tall larkspur, either herbicide could be substituted freely without significantly changing the results. Applications of 4 lb/acre of either herbicide produced results equal to applications of 8 lb/acre of active ingredient.

1964 Study

Typically, single applications of either 4 or 8 lb/acre of active ingredient of 2,4,5-T had significantly reduced the density of tall larkspur for 1 or at most 2 years, as recorded in the 1963 study. However, treatments of 2,4,5-T in 1964 produced significant reductions that persisted through 1968, when these plots were last sampled (Table 3). Environmental conditions and phenological development of the plants were similar when treatments were applied throughout this period. No explanation for the variation in response of tall larkspur was evident. It was evident, however, that such long-term reductions could not be achieved consistently with one application of either 2,4,5-T or silvex, and a single application of one of these herbicides should not be relied on for controlling tall larkspur.

Applications of 16 lb/acre of 2,4,5-T did not reduce the density of tall larkspur significantly more than did 4 or 8 lb/acre. Applications of 2 and 4 lb/acre of active ingredient of dicamba produced results similar to those from treatments with 2,4,5-T. Densities of tall larkspur remained lower on treated than on the untreated check plots until the third and fourth season after the treatments were applied. Even as late as 1968, the density of tall larkspur on plots treated with 8 lb/acre of active ingredient of dicamba was not significantly different from densities on plots treated with 2,4,5-T.

The three rates of applications of picloram reduced the density of tall larkspur to zero, but, as expected, picloram sterilized the soil. Tansymustard [Descurainia pinnata (Walt.) Britton] and letterman needlegrass (Sīnora lettermanii Vasey) were the first plants to appear on these plots, but by 1968 many good forage species were growing on these plots. By 1968 bare ground had been reduced to 53%, 58%, and 69% for the 2, 4, and 8 lb/acre of active ingredient treatments respectively. This compared with 18% bare ground on the untreated check plots and 35% on the plots treated with 8 lb/acre of active ingredient of 2,4,5-T.

1965 Study

Most split treatments effectively reduced the density of tall larkspur. One lb/acre of dicamba applied each summer, both split treatments with picloram, and all split treatments with 2,4,5-T were equally effective as late as 1970 (Table 4). Picloram has not yet been registered for use on grazing lands, and, therefore, cannot be recommended at this time. Only one split treatment was evaluated, but results from other experiments (Cronin and Nielsen, 1972) and the 1963 study reported here indicate silvex could be substituted for 2,4,5-T in any of these split treatments without significantly changing the results.

Conclusions

The options provided by the many effective treatments for controlling tall larkspur should be considered before choosing a particular herbicide treatment. The treatment should increase the production of the associated forage species. Higher rates of chemicals such as picloram should be avoided on sloping snowdrift sites, because of the high erosion potential (Ellison, 1954). The cost of the various herbicide treatments should be an important factor in selecting a particular treatment. The cost of the herbicides applied was small compared to the anticipated costs of applying them to relative small patches of tall larkspur scattered over tough terrain. Therefore, methods of treatment involving the smallest number of applications offered substantial financial reward.

These criteria indicated that two annual applications of 4 lb/acre of active ingredient of 2,4,5-T or silvex should be selected for controlling tall larkspur on subalpine grazing land (Fig. 2). The re-

Table 4. Percent cover of tall larkspur on plots before treatment in 1965 and for each sampling year following.

<table>
<thead>
<tr>
<th>Applied herbicide</th>
<th>Rate (lb/acre) applied</th>
<th>Year sampled</th>
<th>1965</th>
<th>1966</th>
<th>1967</th>
<th>1968</th>
<th>1970</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-D</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicamba</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picloram</td>
<td>1/4</td>
<td></td>
<td></td>
<td></td>
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<td>2,4,5-T</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Dicamba</td>
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<tr>
<td>Picloram</td>
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<td></td>
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<tr>
<td>2,4-D</td>
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<td>2,4,5-T</td>
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<td></td>
</tr>
<tr>
<td>2,4,5-T plus 2,4-D</td>
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</tr>
<tr>
<td>2,4,5-T plus 2,4-D</td>
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<td></td>
</tr>
</tbody>
</table>

1 Each value represents the averages of four replications of each treatment.

2 Means in the same column followed by the same letter are not significantly different at the 1% level.
sponse of the associated vegetation has been favorable, and no other treatment has resulted in significantly higher grass production. Control of tall larkspur should permit proper management of these subalpine pastures for improved quality and production of forage.

Literature Cited