Herbicides, Nitrogen, and Control of Tall Larkspur under Aspen Trees

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Highlight: Tall larkspur (*Delphinium barbeyi* Huth.) dominates the herbaceous vegetation under quaking aspen (*Populus tremuloides* Michx.) on large areas of mountain summer ranges in southern Utah. These tall larkspur plants are more susceptible to single applications of 2,4,5-T and silvex than reported for the same species growing in the open subalpine meadows of central Utah. The herbicide treatments evaluated provide a means of manipulating the vegetation to produce various proportions of grasses and forbs that would be safe and desirable for cattle or for dual use by cattle and sheep. Nitrogen fertilization applied in addition to herbicide treatments did not enhance control of tall larkspur or stimulate forage production. High rates of nitrogen applied to otherwise untreated plots did not control tall larkspur, and increased forage production only the first year after application.

In central Utah, at its northern limits of distribution, tall larkspur (*Delphinium barbeyi* Huth.) is typically found at elevations above 9,500 ft. In southern Utah, it grows at elevations as low as 7,900 ft as the dominant understory plant on north-facing slopes in the extensive quaking aspen (*Populus tremuloides* Michx.) woodlands. Particularly in the mountains east of Cedar City, the abundant tall larkspur precludes safe grazing of cattle. Stockmen, except those fortunate few owning summer range free of larkspur, are restricted to grazing sheep. In the recent past this has been a serious economic handicap, forcing many livestockmen to sell their land to developers for summer homes—an irreversible act removing it from our range resource.

Sheep utilize tall larkspur extensively in late summer and fall without toxicity problems; however, some sheepmen in the Cedar City area have reported losses when herding sheep that have ingested large quantities of tall larkspur.

Control of tall larkspur could provide the operator with the option of grazing either sheep or cattle on these summer ranges and could prevent the loss of some sheep each year.

Herbicide treatments for controlling tall larkspur have been studied extensively. Data published by Hervey and Klinger (1961) indicate that tall larkspur growing in aspen "pockets" is somewhat less susceptible to herbicides than larkspur growing on aspen slopes. Binns, James, and Johnson (1971) reported good to excellent control after applications of ammonium sulfate, especially in combination with herbicides; however, their paper did not clearly indicate the rate of application. Cronin and Nielsen (1972) and Cronin (1974) found that control of tall larkspur in subalpine meadows required applications of herbicide treatments in two successive seasons.

The objectives of this study were: (1) to evaluate herbicide treatments and nitrogen fertilization alone and in combination for controlling tall larkspur growing under quaking aspen, (2) to

Fig. 1. *Tall larkspur (*Delphinium barbeyi *Huth.) dominates the understory vegetation of quaking aspen (*Populus tremuloides *Michx.) on a summer range on Cedar Mountain east of Cedar City, Utah. On such ranges the density of tall larkspur precludes grazing by cattle.*

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This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

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evaluate the response of the associated vegetation to the treatments, and (3) to determine the feasibility of manipulating the vegetation for safe grazing by cattle.[1]

Materials and Methods

This study was carried out on Cedar Mountain 11 miles east of Cedar City, Utah, on land owned by the Utah Agricultural Experiment Station, which has been described by Bowns (1971). The site, of which 50% or more was under the quaking aspen canopy, supported an understory of forbs and grasses (Fig. 1). The site at an elevation of 8,200 ft was on an east-facing slope. The dominant forb was tall larkspur, but ballhead waterleaf (*Hydrophyllum capitatum* Dougl. ex Benth.), American vetch (*Vicia americana* Muhl.), mountain bluebell [*Mertensia ciliata* (Torr.) G. Don], sweetnice [*Osmorhiza chilensis* (H. & A.) Torr.), and heartleaf arnica (*Arnica cordifolia* Hook.) were also abundant. Grasses, in order of abundance, were Kentucky bluegrass (*Poa pratensis* L.), slender wheatgrass [*Agropyron trachycaulum* (Link) Malte], and mountain brome (*Bromus carinatus* Hook & Arn.).

Herbicide treatments were applied as an aqueous solution with a knapsack sprayer at 20 gal/acre on June 9, 1971, and for split treatments also on June 6, 1972. Applications were made when the vegetative growth of tall larkspur was 10 inches tall. In 1971, silvex [2- (2,4,5-trichlorophenoxy)propionic acid] was applied at 8 lb/acre and 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] at the rates of 4 and 8 lb/acre. Silvex and 2,4,5-T were also applied as split treatments of 4 lb/acre in 1971 and 4 lb/acre in 1972. Paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) was applied at 1 lb/acre. Half of each herbicide plot (24 × 100 ft) received an application of 125 lb N/acre as ammonium sulfate applied with a hand-cranked broadcast spreader. For the last treatment in this experiment, ammonium sulfate was applied at 250 lb N/acre over the full plot (24 × 200 ft).

For the 1971 experiment where applications of both herbicides and nitrogen were evaluated, a block of completely randomized paired plots was used. Each of these plots measured 24 × 200 ft. In a second experiment initiated in 1972, applications of nitrogen at rates of 75, 150, 300, 600, and 1,200 lb N/acre constituted the only treatments. Plots were 12 × 50 ft, and treated plots alternated with untreated plots. Nitrogen was applied as ammonium sulfate with a hand-cranked broadcast spreader in the fall of 1972.

In both studies sampling was conducted along the common border between the treated and untreated plots. Estimates of the total herbage production of tall larkspur, of forbs other than tall larkspur, and of the grasses for both experiments were made in August of 1974. An electronic capacitance meter (Neal Electronic Company model 18-1000[2]) was used to estimate herbage production on the plots (Morris et al. 1976 and Neal et al. 1976). Meter readings were obtained and one of every four samples was clipped at a stubble height of ½ inch using a 3-dimensional technique described by Currie et al. (1973). Clipped samples were separated into the three groups of vegetation listed, bagged, oven-dried, and weighed. A coefficient of linear determination (r^2) was calculated between the meter reading and the total oven-dry weight of the herbage and between the estimated percent of the total vegetation of each subgroup and the percent of the oven-dry weight of each subgroup on the clipped samples. Meter readings were converted to oven-dry weight using a linear regression equation. The weight of each subgroup was calculated from the estimated percent in each sample.

For the 1971 experiment 40 paired samples on treated and untreated plots were used to measure the effects of the treatments on the vegetation. These paired samples, between 10 and 20 ft apart were spaced along the common border of the paired plots (Klingman et al. 1943). All samples were at least 4 ft from the border of the plot.

On the smaller fertilization plots of the 1972 experiments, 32 paired samples were used.

Data were subjected to analysis of variance, and differences in treatment means were evaluated with Duncan's multiple range test. Because not all the plots were treated with additional nitrogen, a *t*-test was used to determine significant differences between a herbicide treatment and the same herbicide treatment plus nitrogen.

Results

Coefficient of determination (r^2) between the meter readings and the oven-dry weight of the total herbage was 0.76. The r^2 for estimated percent of total production in samples of tall larkspur, other forbs, and grasses and their percent weight in the oven-dry herbage was 0.83, 0.54, and 0.48, respectively.

All herbicide treatments significantly reduced herbage production of tall larkspur (Table 1). All applications of silvex and 2,4,5-T reduced tall larkspur production to a level that should be safe for grazing cattle; however, the larkspur would have to be reduced to this level all over the grazing area accessible to them (Cronin et al. 1976). Areas treated with 1 lb/acre of paraquat (where production of tall larkspur was reduced by 85%) would be safer for cattle than an untreated area but it is questionable whether production would be reduced enough to prevent all losses. Hyder (1972) reported that applications of ½ lb/acre of paraquat killed 90–95% of Geyer larkspur (*D. geyeri* Greene) but his data indicate timing of applications was critical.

Table 1. Herbage production (lb of air-dry herbage/acre) measured in 1974, where various treatments were applied to one of two paired plots.[1]

Treatment applied			Pounds of air-dried herbage produced per acre[2]			
Chemical	Rate (lb/acre)	Year	Tall larkspur	All grasses	Forbs other than tall larkspur	Total herbage
Silvex	8	1971	0.0 f	55.5 a	28.6 ef	84.1 ef
Paired untreated area			28.9 d	20.3 e	47.2 bc	96.4 de
Silvex	4 4	1971 1972	0.6 f	58.3 a	2.5 f	61.4 g
Paired untreated area			45.7 bc	32.2 cd	45.7 bc	123.6 b
2,4,5-T	4	1971	0.0 f	39.1 b	20.1 f	59.2 g
Paired untreated area			28.7 d	38.6 bc	31.6 def	98.9 cde
2,4,5-T	8	1971	1.5 f	40.4 b	33.0 def	74.9 fg
Paired untreated area			29.5 d	31.5 cd	44.2 bcd	105.2 cd
2,4,5-T	4 4	1971 1972	0.0 f	51.8 ab	55.5 a	110.2 bcd
Paired untreated area			52.0 bc	33.6 cd	67.3 a	152.9 a
Paraquat	1	1971	9.3 e	27.7 de	29.1 ef	66.1 fg
Paired untreated area			62.6 a	22.8 de	28.4 ef	113.8 bc
Nitrogen	250	1971	42.6 c	20.8 e	40.5 cde	103.9 cd
Paired untreated area			53.5 b	21.3 e	44.0 bcd	118.8 b

[1] Each value represents the average for 40 samples of vegetation growing ina 12 × 24 × 18 inch cube.

[2] Means followed by the same letter within a column do not differ significantly at the 5% level.

Grass production increased significantly as a result of treatments, except where 250 lb N/acre, 1 lb/acre of paraquat, and the single application of 4 lb/acre of 2,4,5-T were applied (Table 1). Only the silvex treatments reduced the production of forbs other than tall larkspur (Table 1). Total herbage decreased on all treated areas except where 8 lb/acre of silvex was applied, thus the increase in grass production did not replace the production lost by the depletion of larkspur and other forbs.

[1] Cattle should not be permitted to graze treated areas after applications of herbicides until frost has dried the plants. Treated plants can increase in toxicity and palatability immediately after application of the herbicides; this could result in heavier consumption of the poisonous plant.

[2] The use of trade names in this paper is for identification only and does not constitute endorsement of the product.

Differences in production of grasses, tall larkspur, and other forbs were not statistically significant between any herbicide treatment alone and the same herbicide treatment plus 125 lb N/acre (data not shown), and no visible differences were observed in the year of nitrogen application or the season after. Treatment with various rates of nitrogen did not affect the vegetation on plots treated in 1972, but during the following summer, the grasses treated with 300 lb N/acre appeared larger and darker green than those on the untreated plots. The leaf margins of tall larkspur plants became necrotic during the summer after application of 600 and 1,200 lb N/acre, and the latter rate burned the tips of grasses the summer after application. After the 1973 growing season, no visible differences were evident between plants on the treated and untreated plots.

No attempts were made to measure production of the quaking aspen trees on any of the plots. However, trees were observed for signs of herbicide injury and for nitrogen injury. None was observed.

Discussion and Conclusions

Single applications of 8 lb/acre of silvex and 2,4,5-T produced excellent control of tall larkspur growing under quaking aspen trees in this study. Both treatments have consistently failed to produce satisfactory control of tall larkspur growing in the open meadows of the subalpine zone (Cronin and Nielsen 1972; Cronin 1974). Hervey and Klinger (1961) reported similar results from Colorado. Since application costs are a substantial part of the costs of treatments, a single application of 8 lb/acre of silvex or 2,4,5-T would be more advantageous than two treatments of 4 lb/acre in each of two successive years. The success of the single treatment appears to be restricted to sites where the trees provide some protection from the sun and wind. Where these conditions exist, the single treatment might be considered,

Results also suggest that the composition of the plant community can be manipulated by herbicide treatments. Applications of 1 lb/acre of paraquat left less than 15% of the larkspur without statistically significant changes in the amount of grasses or other forbs. It might be the best treatment for a sheep range. Applications of 2,4,5-T or silvex removed most tall larkspur and substantially increased grass production and might be selected for cattle range. Silvex removed both tall larkspur and other forbs, leaving an understory community composed almost exclusively of grasses. Treatments with 2,4,5-T resulted in a mixture of grasses and forbs.

Applications of nitrogen have been reported to have controlled or enhanced the effectiveness of herbicide treatments (Binns et al. 1971), but results from our study do not support these findings. In our study the response of the vegetation to nitrogen, even amounts we considered excessive, was negligible. Perhaps the quaking aspen utilized the nitrogen before it was available to the understory vegetation. This speculation is based on the dominance of the trees on the plots and the observation that growth of the aspen commenced before the snow melted from over the herbaceous plants in the spring. Denitrification could have been a factor; conditions were optimum. During the winter the unfrozen soil was saturated, and during the spring the soil was supersaturated with water from the melting snow. Leaching was also a factor under these conditions.

Results of this study indicate that vegetation such as that found on Cedar Mountain can be manipulated with herbicide treatments so that cattle can graze safely. Production of the understory herbaceous vegetation can probably be increased by harvesting the aspen to open up the canopy and to reduce competition with forage species. Effects of aspen growth and competition were not included in this study but should be investigated on land used primarily for grazing as it is on Cedar Mountain.

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