Toxicity and Control of Kelsey Milkvetch

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Abstract

Kelsey milkvetch *(Astragalus atropubescens* Coult. and Fish.) contains miserotoxin (β-glucoside of 3-nitro-1-propanol). Chemical analyses and biological evaluations indicated moderately low concentrations of the toxin in this species. However, this plant has been implicated in cattle losses and a potential danger of both acute and chronic poisoning exists on grazing areas where kelsey milkvetch grows in abundance. It grows in mountainous areas in the Salmon River drainage in Idaho and the Big Hole River drainage in Montana. Kelsey milkvetch was controlled with an application of 2.24 kg/ha (2 lb/ac) of 2,4,5-T [2,4,5-tricholorophenoxy)acetic acid] and eradicated with an application of silvex [2-(2,4,5-tricholorophenoxy)propionic acid].

Kelsey milkvetch *(Astragalus atropubescens* Coult. and Fish.) grows in the mountainous areas of east-central Idaho, especially on the headwaters of the Salmon River. Its range extends northward to the Big Hole River and the headwaters of Clark's Fork in western Montana. The collection of some immature specimens suggests that the Missouri Valley near Helena, Montana, may also be part of its range (Barneby 1964).

Kelsey milkvetch plants consist of numerous erect, slender stems produced from a number of small caudexes on short branches from a woody taproot. The stems form a dense, narrow bundle that imparts a tall, slender appearance to the plants (1.5 to 30 cm or more). The showy racemes of white-to-creamy flowers emerge above the green herbage of the leaves which are composed of 19 to 20 leaflets. The flowers may tend to nod but the seed pods are held stiffly erect. Seed are smooth and vary from dull brown to dull black. The upper surface of the leaflets and the pods are glabrous but generally the rest of the plant is covered with stiff, appressed to sub-appressed hairs 0.3 to 0.6 mm long. These hairs are sometimes white but are frequently black as indicated by the specific name.

Although kelsey milkvetch has not been recognized previously as a potentially dangerous poisonous range plant, specimens of this plant were collected in 1975 because investigators thought that this species might have been responsible for the deaths of 28 cattle during June of 1974 near Challis, Idaho. The plant was growing on a ridge top reseeded to crested wheatgrass [*Agropyron cristatus* (L.) Gaertn.] on a Forest Service grazing unit. Specimens were

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collected on the Gooseberry Creek drainage, a part of the Morgan Creek and Salmon River system.

Duncecap larkspur *(Delphinium occidentale* S. Wats.) and water hemlock [*Cicuta douglasii* (DC.) Coult. and Rose] also grow along the banks of Gooseberry Creek within the grazing unit. However, the distribution of the dead cattle did not suggest that either of these poisonous plants was responsible for the observed mortality.

Previous analysis of the leaf samples from the herbarium specimens of kelsey milkvetch showed the presence of nitro compounds but not their form or concentration (Williams and Parker 1974; Williams and Barneby 1977). Therefore, the objectives of this study were: (1) to determine both the form and concentration of the nitro compounds to learn whether kelsey milkvetch was a potentially dangerous range plant that might cause chronic or acute toxicity in livestock; (2) to determine whether these plants were consumed; and (3) to find herbicide treatments to selectively control the species.

Materials and Methods

Specimens of kelsey milkvetch were collected and submitted to the Intermountain Herbarium of Utah State University at Logan, Utah, where voucher specimens are filed.

Plant materials were collected on the site where cattle died in June 1975 and in June 1976. Percentage of nitro, calculated as mg NO_2/g dry weight, was determined by the method of Cooke (1955) as modified by Williams and Norris (1969). Material from the 1975 collection was also sent to a commercial laboratory for identification of the form of the nitro-toxin contained in the samples.

Plant extracts for a standard chick bioassay were prepared (Williams and Binns 1967; Williams et al. 1979) and force-fed to 1-week-old chicks (avg wt = 70 g) at doses equivalent to 1, 2, 3, 4, and 5 g of plant material. After dosing, the birds were given food and water ad libitum and observed for signs of toxicity for a 24-hr period. Two chicks were used for each level.

To determine the effects of herbicide treatments on kelsey milkvetch and associated vegetation, a study site was established where the cattle had died. The plots were established on the edge of the site previously reseeded to crested wheatgrass. The plot area had been reinvaded by low sagebrush *(Artemisia arbuscula* Nutt.) and Idaho fescue (*Festuca idahoensis* Elmer), but kelsey milkvetch was the dominant species of the vegetation. Aerial cover on the plots consisted of approximately 15% grasses, 30% low sagebrush, 10% miscellaneous forbs, and 10% kelsey milkvetch; about 35% of the soil lacked plant cover.

A randomized block of 56 plots, each 2.44 m × 10.58 m (8× 33 ft), was established. Each of the four subblocks contained two untreated plots. Herbicides applied were: 2,4-D [2,4-dichlorophenoxy)acetic acid] mecoprop {2-[(4-chloro-*o*-tolyl)oxy]propionic acid}; 2,4,5-T[2,4,5-tricholorophenoxy) acetic acid]; and silvex [2-(2,4,5-tricholorophenoxy) propionic acid]. All herbicides were applied at rates of 1.1, 2.2, and 4.5 kg/ha (1, 2, and 4 lb/acre) in 187 liters/ha (20 gal/acre) aqueous spray solution. Herbicide treatments were applied the morning of June 3, 1976, when kelsey milkvetch was in full flower.

Vegetational changes resulting from the treatments were recorded on July 7, 1977. The number of living kelsey milkvetch plants in each plot was recorded. The percentage of dead, low sagebrush plants was estimated. The apparent relative abundance of the miscellaneous forbs was compared with forb abundance on the nearest untreated plot. Total grass production was also visually estimated and compared with production on the nearest untreated plot.

Consumption of kelsey milkvetch was estimated along four transects in a grazing unit used by cattle in June of 1977. On an adjacent grazing unit not used by cattle in 1977, the process was repeated. Transects were started 25 paces from the boundary fence, perpendicular to the fence and to the slope, and continued in a straight line until 25 plants had been intercepted. The number and the types of grazed plants were recorded on July 7, 1977.

Results and Discussion

Chemical analysis of kelsey milkvetch revealed that it contained miserotoxin (β-glucoside of 3-nitro-1-propanol) (analysis completed by Stermitz and Yost 1978). Analyses showed that the concentrations of the poisonous substance were 9.0 and 9.9 mg NO_2/g, respectively, for the 1975 and 1976 collections of kelsey milkvetch. The quantity of misrotoxin found in kelsey milkvetch is moderately low compared with the concentration of nitro compounds in some other species of *Astragalus* (Williams and Barneby 1977). However, the nitro concentration might have been slightly higher had the material been fresh-frozen prior to analysis (Majak and Bose 1974; Majak et al. 1974; Majak et al. 1977).

Chicks fed kelsey milkvetch extracts equivalent to 1 g of the plant stood with eyes closed and feathers ruffled, but exhibited no other signs of toxicity. Only one chick fed that dosage appeared to have recovered after 24 hr. Chicks fed extracts equivalent to 2 or 3 g of the plant lacked coordination and had difficulty maintaining their balance throughout the 24-hr observation period. Birds fed extracts equivalent to 4 or 5 g lost all semblance of coordination and lay with eyes closed and feathers ruffled. Except for the chicks dosed at 1-g equivalent, all chicks showed signs of nitro poisoning after 24 hr. Repetition of the 4- and 5-g equivalent doses resulted in death within 24 hr.

The relatively low concentration of miserotoxin is reflected in the response of the chicks. However, the level of miserotoxin would be lethal to ruminants, particularly cattle, if the plant constituted a significant portion of their diet (Williams et al. 1979). Approximately 3 g of the dried plant material per kg of body weight would be lethal to cattle (1.2 kg for a 400-kg cow). The plant could easily cause chronic poisoning if consumed over a week or 10 days in moderate amounts (about 0.6 kg of dried plant material).

Both acute and chronic poisoning are potential problems on the Morgan Creek Allotment because kelsey milkvetch is widely distributed on both Bureau of Land Management and Forest Service lands within the allotment. The abundance of kelsey milkvetch on this allotment can probably be compared with conditions in some parts of British Columbia where Columbia milkvetch [*Astragalus miser* var. *serotinus* (Gray) Barneby] has been the source of chronic poisoning. Kelsey milkvetch grows in plant communities dominated by low sagebrush or big sagebrush (*Artemisia tridentata* Nutt.), but appears to flourish in communities where grasses are important components of the vegetation. Cattle tend to concentrate on grassy areas where the milkvetch is most abundant. Growth of grasses intermixed with milkvetch herbage makes it difficult for cattle to avoid ingesting the milkvetch as they graze such grassy areas.

Highly significant reductions of kelsey milkvetch resulted with all applications of herbicide treatments (Table 1). However, only rates of 2 and 4.5 kg/ha (4 lb/acre) of silvex eradicated the milkvetch from treated plots.

Highly significant reductions of low sagebrush also resulted from applications of the herbicide treatments (Table 1). Reductions in the number of low sagebrush plants are not only acceptable, but usually desirable for increased forage production and enhancement of the quality of the watershed. All herbicide treatments reduced the low sagebrush to the extent that would be desirable on sites where sagebrush is limiting forage production.

Reductions in the relative number of miscellaneous forbs were also highly significant after applications of the herbicide treatments (Table 1). However, it is doubtful that the response of the miscellaneous forbs should influence the selection of any of the herbicide treatments for controlling kelsey milkvetch. The forbs were a diverse group of species highly variable in palatability and nutritional value. No individual species contributed significant herbage to the total production of the community.

Significant increases in grass production resulted from the appli-

Table 1. Vegetation responses as evaluated in July 1977 on plots treated in June 1976 with various herbicides for the control of kelsey milkvetch.[1]

Herbicide applied	Rate of application (kg/ha)	(lb/ac)	Kelsey milkvetches per per plot[2] (No.)	Dead low sagebrush per plot[2] (%)	Rating of forb numbers per plot[2,3]	Production ratings for grasses on plots[4,5]
	1.1	1	27 b	69 b	3.0 a	6.25 bc
2,4-D	2.2	2	2 c	100 a	1.8 abc	6.75 abc
	4.5	4	3 c	100 a	0.8 c	7.25 ab
	1.1	1	12 c	96 ab	2.0 abc	7.25 ab
Mecoprop	2.2	2	20 c	88 ab	2.5 ab	7.75 a
	4.5	4	2 c	99 a	1.2 bc	7.25 ab
	1.1	1	6 c	25 c	2.8 a	6.50 abc
2,4,5-T	2.2	2	2 c	71 ab	2.5 ab	7.00 abc
	4.5	4	2 c	98 a	2.2 abc	7.50 ab
	1.1	1	2 c	99 a	1.5 abc	6.75 abc
Silvex	2.2	2	0 c	100 a	1.2 bc	7.25 ab
	4.5	4	0 c	100 a	1.5 abc	6.75 abc
Control 1	No treatment		48 a	2 c	3.0 a	4.75 d
Control 2	No treatment		61 a	5 c	3.0 a	5.75 d

[1]Data are averages of four replications.
[2]Data in this column followed by the same letter are not significantly different at the 1% level of probability.
[3]Ratings are: 1 = forb numbers substantially below those on untreated areas; 2 = forb numbers approximately half those on untreated areas; 3 = forb numbers approximately the same as those on untreated areas; and 4 = forb numbers higher than those on untreated areas.
[4]Ratings are: 0 = no grass production; 5 = grass production about the same as that on untreated areas; and 10 = grass production about 3 to 4 times greater than that on untreated areas.
[5]Data in this column followed by the same letter are not significantly different at the 5% level of probability.

cations of all herbicide treatments (Table 1). However, the precision of the estimates of grass production militates against conclusions regarding differences in production on plots treated with herbicides.

Sampling indicated that approximately 30% of the kelsey milkvetch plants had been consumed in the grazing unit used by cattle. All or most of the flowering racemes had been removed from these plants. Only 11% of the grazed plants had leaf tissue removed and removal of the leaf tissue appeared to have been coincidental to ingestion of the flowering racemes.

In the grazing unit not used by cattle in 1977, only four of the sampled plants exhibited evidence of consumption. Seven racemes or parts of racemes had been removed. Observations suggested that the racemes had been cut from the plants by rodents because four of the racemes were found at the base of the plant from which they had been removed.

Conclusions

Kelsey milkvetch contains moderately low concentrations of miserotoxin but is a potential danger to ruminants. When it constitutes a significant portion of the diet the plant could be lethal; if small amounts are consumed daily, it could cause chronic toxicity.

The plant is grazed by cattle that appear to select the raceme while it is in flower and as the young pods begin to develop.

The existence of miserotoxin in the plant and the apparent palatability of the plant to cattle support our assumption that cattle deaths in 1974 near Challis, Idaho, were probably the result of ingesting kelsey milkvetch. These factors also suggest that cattle grazing areas supporting large populations of kelsey milkvetch should be carefully observed for signs of chronic poisoning.

Herbicide treatments can effectively control the milkvetch on sites where it causes death or losses resulting from chronic poisoning. Selection of a herbicide treatment will depend on the effectiveness of the treatment for controlling the vetch and the cost of the herbicide. The other vegetation responses appear to be quite similar, regardless of the particular herbicide applied.

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