

Grazing Tall Larkspur Ranges: A Livestock Producer's Decision-making Handbook

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INTRODUCTION

This handbook may help livestock producers reduce tall larkspur poisoning in cattle by providing information on: (1) identifying tall larkspurs, (2) treating poisoned animals, (3) collecting larkspur samples to determine toxicity, (4) understanding toxic alkaloid concentrations in tall larkspur, and (5) determining the relative risk of grazing tall larkspur rangelands. Armed with this information and working with extension agents and local veterinarians, livestock producers can make informed decisions about grazing tall larkspur-infested areas to reduce cattle losses. This information must be adapted for each ranching situation. Livestock producers must be aware of annual variations in growth and toxicity of tall larkspur and be flexible in

implementing any grazing management strategy.

This handbook focuses exclusively on two tall larkspur species: *Delphinium occidentale* and *D. barbeyi*. Less research has been conducted on other tall larkspur species in the western U.S. such as *D. glaucum* and *D. glaucescens*. In addition, the recommendations in this handbook do not apply to low (e.g., *D. nuttallianum*) or plains larkspur (*D. geyeri*).

The distribution of *D. occidentale* and *D. barbeyi* across the western U.S. is shown in Figures 1 and 2. These county-level maps show that in some areas the distributions of these two tall larkspurs overlap.



Figure 1. Distribution of *D. occidentale*.

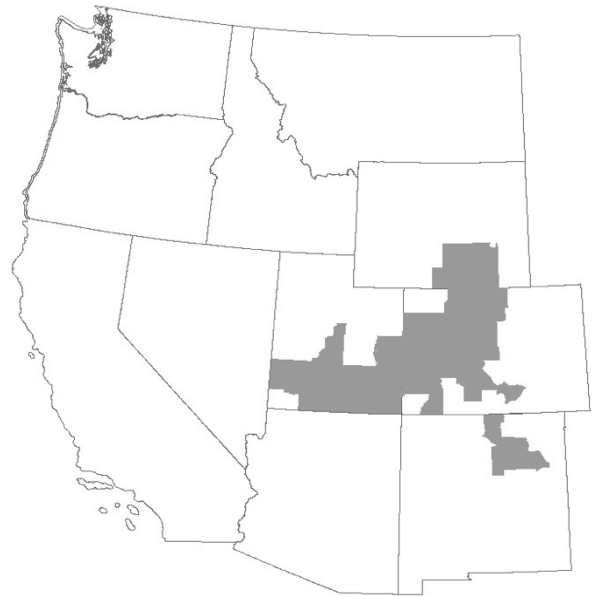


Figure 2. Distribution of *D. barbeyi*.

IDENTIFYING TALL LARKSPURS

Tall larkspurs have a characteristic spur behind the (usually) blue flower that can be up to 3/4 inches long (Figure 3). Tall larkspurs have multiple hollow stems, with wide-bladed leaves growing from slender leaf stalks (Figure 4). The leaves are typically deeply lobed with 3 to 7 toothed lobes in a palm shape. Plants are normally 36 to 72 inches tall when mature.



Figure 3. *Delphinium barbeyi* flowers showing the characteristic blue color and the prominent spur on the flowers.

Tall larkspur may be confused with monkshood (*Aconitum* spp.), but monkshood stems are not hollow. In addition, monkshood flowers have an irregular hood extending above the flower, whereas tall larkspur flowers have a spur projecting behind the flower. Larkspur is also confused with wild geranium, because the leaves of the two plants have similar shapes, but geranium is low growing with solid stems. Wild geranium flowers are very different from larkspur flowers.



Figure 4. Typical leaf from a *Delphinium* plant.

Tall larkspurs differ from low and plains larkspur. Low larkspurs grow on foothill and mountain ranges in spring and summer. They have fine (rather than broad) leaves, reaching a height of 4 to 30 in. Plains larkspur grows primarily on foothill and shortgrass prairie ranges in Wyoming, Colorado, and northern New Mexico, and may reach a height of 36 in.

RISK REDUCTION STRATEGIES

There are several strategies livestock producers may use to reduce cattle losses to tall larkspur. These strategies may require increased management for many producers. Each producer must evaluate the costs and benefits of implementing any of these recommendations.

Early and late season grazing

Cattle generally eat little tall larkspur before plants begin to produce flowering stalks (Figure 5). Thus, producers may gain four to six weeks of low-risk grazing early in the summer before larkspur flowers. The time of highest risk is from growth of flowering stems until pods begin to shatter. In high-risk situations, producers should consider removing cattle from tall larkspur-infested ranges during this toxic window. The toxicity of the plants is greatly reduced after pods shatter. Cattle may be returned to the pasture after pods shatter to graze until late in the season.

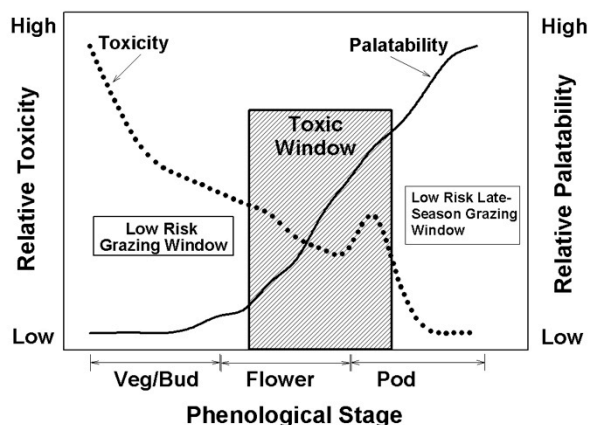


Figure 5. The relationship between stage of growth, palatability, and potential toxicity for cattle grazing tall larkspur during a typical summer grazing season: Tall larkspur toxicity declines as plants mature, however palatability increases as plants flower and mature into pods. Most cattle deaths (i.e., toxic window) occur after tall larkspur has elongated flowering shoots, flowers, and moves into the pod stage. Toxicity often increases in the pod stage as the pods accumulate toxic alkaloids. Once pods shatter, and leaves turn brown, toxicity is typically low.

Herding

Many rangelands have patches of larkspur, whereas other areas on the same range may have little or no larkspur. In these cases, a rider can move cattle to areas with lower densities of larkspur, particularly during times when toxicity is a problem and cattle are likely to eat larkspur.

Alternatively, moving cattle into larkspur-dominated areas when cattle are not likely to eat tall larkspur (early summer before flowering) or when larkspur is much less toxic (late summer or fall after seed shatter) may provide weeks of low-risk grazing, and allowing previously grazed areas to rest. Herding to reduce larkspur losses may also improve health of riparian areas because livestock are managed more intensively.

Herbicides

Control with herbicides is most economical if larkspur grows in dense patches that can be largely eliminated. Picloram at 2 lb/acre will kill tall larkspur (>80% kill) when applied in the vegetative, bud, and flower stages. Picloram applied at the above rate reduces forb cover, but

has little effect on grass cover when compared to several other herbicides.

Studies by Dr. Ron Carlstrom at Montana State University (MSU) show that control with Escort (1 oz./acre) or Cimarron X-tra (1 oz./acre) is excellent (100%) for larkspur in the vegetative stage, but effectiveness decreases rapidly as plants begin to flower. However, MSU research also shows that Cimarron X-tra (or generic equivalent; 1 oz./acre) combined with 2,4-D ester 6 lb. formulation (1 pint/acre) produced 80% kill when applied during the flower stage.

Identifying stage of growth prior to spraying is very important because it is often difficult to access the level of infestation of tall larkspur ranges before the early flower stage due to snow and mud.

Herbicidal applications have been shown to last at least five years. In some cases treatments may last up to 20 years. *Caution:* Sprayed plants are often more palatable to cattle than unsprayed plants even after plants dry up. Unfortunately, sprayed plants retain their toxicity for some time after spraying and may increase the risk of poisoning if cattle are allowed to graze sprayed areas.

Common table salt will kill about 75% of tall larkspur when applied at a rate of 2/3 cup per plant at the base of the plant. Two years after application of salt, bare spots remained at the location of the plants. These spots were 13% to 46% of the original plant depending on soil type. The cost for this treatment, though labor intensive, was \$0.02/plant.

Grazing sheep before cattle

In Wyoming, the Upper Ruby Grazing Association grazed 2,700 cows and yearlings on their allotment from June to October. Cattle deaths from larkspur occurred intermittently on several pastures. In 1981, 50 cattle died due to larkspur poisoning prompting a change in management. In subsequent seasons, sheep grazed these pastures 2 to 4 weeks before cattle were turned out. Cattle losses to larkspur were eliminated.

Normally, sheep do not eat larkspur early in the growing season. Studies on sheep grazing to reduce the amount of larkspur on rangelands are variable. Sheep grazing reduced the number of bites cattle took of waxy larkspur by 50% compared to cattle grazing a pasture not grazed by sheep. In Nevada, sheep grazed tall larkspur early in the growing season and eliminated the threat to cattle. In another study, sheep did not eat tall larkspur but trampled it through close herding, making it unacceptable for cattle to eat. Several other studies reported that sheep ate little tall larkspur early in the growing season unless herded.

Herding encourages sheep to eat more tall larkspur by trailing or bedding them in larkspur patches. Just trailing sheep through larkspur increases the number of broken stems because the hollow stems break easily. Broken stems tend to dry out quicker than unbroken stems. Bedding sheep in larkspur patches increases both the number of stems trampled and grazing larkspur heads and leaves. Cattle typically do not eat trampled larkspur plants. Herding also confines sheep to high-density areas of tall larkspur reducing their impact on the quantity and quality of other desirable forages in the pasture.

TREATING POISONED ANIMALS

A variety of remedies have been proposed to treat larkspur poisoning. Treating larkspur-poisoned animals by cutting their tails and bleeding them is not effective. Neither is treating them with atropine, strychnine, potassium permanganate, aluminum sulfate, tobacco, or whiskey.

Alkaloids in larkspur are toxic to cattle by interfering with the junction between the nerves and muscles. This inhibits transmission of nerve impulses resulting in muscle paralysis. Larkspur poisoning results in a progression of symptoms including muscle weakness, staggering gait, inability to stand, bloat, respiratory paralysis and finally death.

Cattle can be treated intramuscularly with the drug neostigmine (0.04 mg/kg body weight, IM) to reverse neuromuscular paralysis. Treatment should only be considered for animals that have been down (sternal or lateral recumbency) for at least 30 minutes. Cattle down for less than 20-30 minutes are likely to survive if left alone as long as they are resting on their sternum, their heads are facing uphill, and they don't bloat. We have noted that poisoned cattle may be unable to stand up for 12-18 hours in some cases, but still survive the poisoning episode. There is no reliable way to determine if an animal has eaten a fatal dose of larkspur alkaloids. Cattle paralyzed for many hours will be weak when the effect of larkspur toxicity wears off. Typically their vigor and forage intake is reduced for another 48 hours.

Neostigmine relieves the symptoms of larkspur poisoning for about 2 hours, and animals are usually up and walking within 15 minutes of treatment. Depending on the amount of larkspur eaten, animals may need an additional injection of neostigmine to remain upright. If poisoned animals are treated and relapse without further treatment, they may die from muscular fatigue and respiratory failure from toxic alkaloids still circulating through their system. The risk of dying from larkspur intoxication remains for over 24 hours after eating the plant.

Bloating occurs in larkspur poisoning because the belching mechanism is paralyzed. Early remedies for treating larkspur poisoning such as oral dosing of bacon fat and turpentine may have been successful because they reduce bloat. Since bloating is a significant component of poisoning, the animal must be kept resting on its sternum (upright; ideally with the head uphill). Dosing with anti-bloating medication may be beneficial. Above all, do not stress the animal, even if it means not treating it. Stressing (e.g., moving them by horseback) affected animals will likely hasten their death.

TOXICITY OF TALL LARKSPURS

The toxic alkaloid concentration of *D. barbeyi* typically declines well below 3 mg/g during the pod stage. Therefore, we recommend grazing early in the season when it is not palatable, removing cattle during the toxic window (see Figure 5) from bud elongation (early flowering) through mid pod stage, then grazing late in the season.

D. occidentale occurs as two sub-types. Some populations of *D. occidentale* do not contain

highly toxic alkaloids and are much less toxic. It is critical to know which tall larkspur is growing on infested rangelands as the two sub-types grow in distinct geographical regions. In some parts of Colorado and Utah, the less-toxic type of *D. occidentale* may grow alone or in pastures mingled with toxic *D. barbeyi*. A map has been developed to show the distribution of the less-toxic type of *D. occidentale* (Figure 6). Keep in mind that there is a potentially highly toxic type of *D. occidentale*, and further that all *D. barbeyi* populations should be considered toxic.

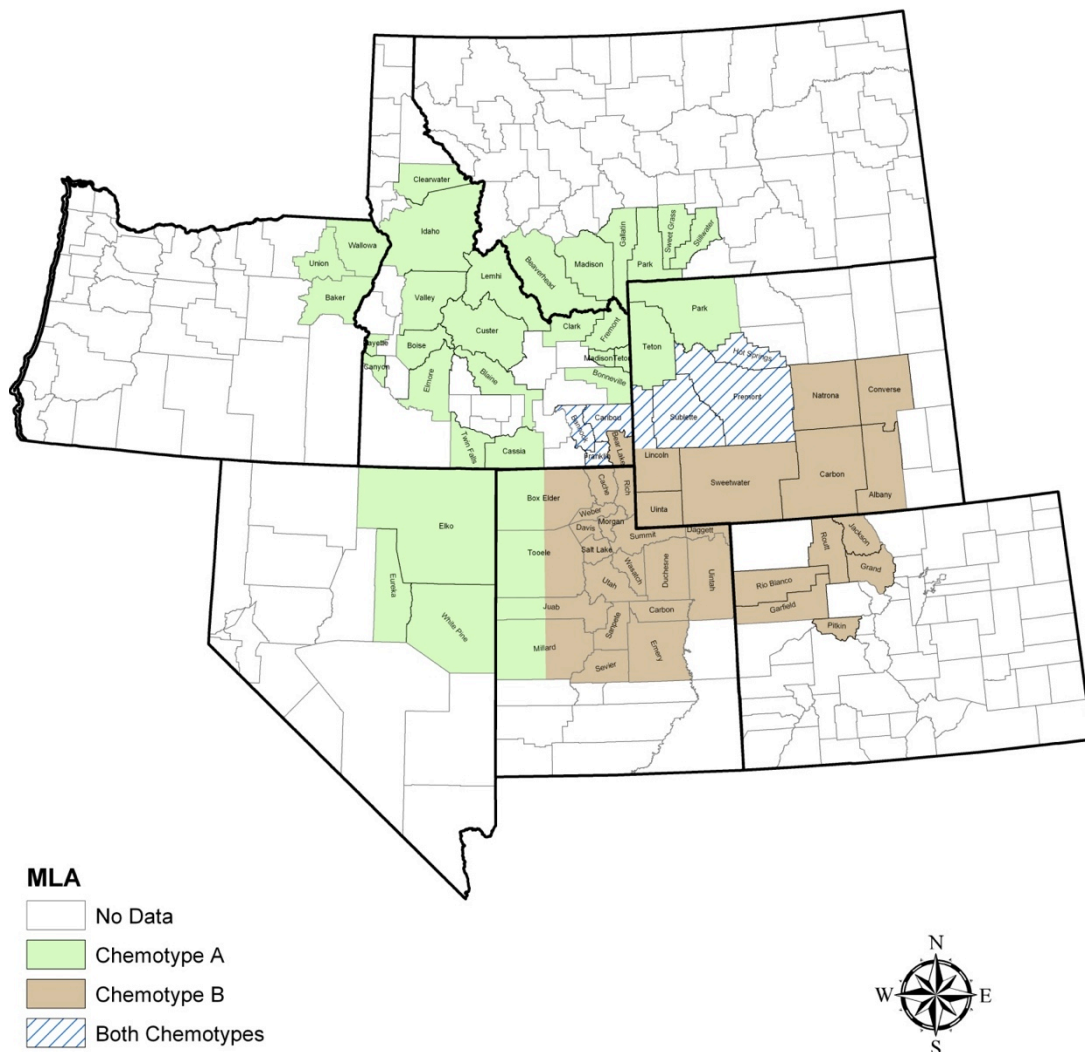


Figure 6. Distribution of two sub-types (i.e., “chemotypes A and B) of *D. occidentale* in the western U.S. Some populations of *D. occidentale* (type B) do not contain the highly toxic alkaloids and thus are much less toxic than Type A plants. It is critical to know which tall larkspur is growing on infested rangelands as the two sub-types generally grow in distinct geographical regions. In some instances, the less-toxic sub-type B of *D. occidentale* may grow alone or in pastures mingled with toxic *D. barbeyi* or toxic *D. occidentale*. Refer to Figure 2 for the distribution of *D. barbeyi*.

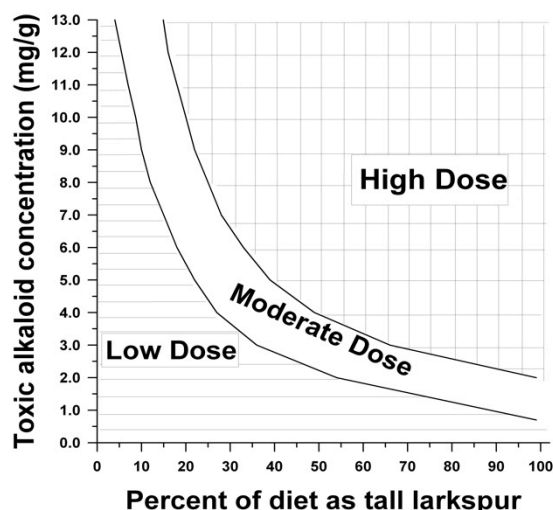


Figure 7. Relationship between the toxic alkaloid concentration in tall larkspur plants (Y axis; mg/g in plants), and the amount of tall larkspur eaten by cattle (X axis; tall larkspur as a percent of an animal's diet), and the relative risk of poisoning in cattle.

In general, when larkspur plants contain less than 3 mg/g of toxic alkaloids, the risk of poisoning is low because cattle must eat large amounts of the plant to be poisoned. As the alkaloid concentration increases, so does the risk of animals dying from eating the plant. Other factors also influence the risk, including how quickly animals eat tall larkspur, how many consecutive days they eat tall larkspur, and the individual animal's susceptibility to larkspur toxins.

A rapid and accurate assay is now available to measure toxic alkaloids in larkspurs. Plants should be tested during the flowering and pod stages of growth. Larkspurs with concentrations of toxic alkaloids in leaves, flowers, and pods under 3 mg/g should be safe to graze during the growing season because usually cattle don't eat enough of the plant to cause death (Figure 7). If the toxic alkaloid concentration exceeds 3 mg/g during the flowering stage and cattle begin eating the plant, cattle should be removed until pods shatter in August or September. If the toxic alkaloid concentration in pods exceeds 3 mg/g, risk will be moderate or greater if cattle are eating mainly pods (often the entire top of a plant).

HOW DOES TALL LARKSPUR GROW?

Tall larkspurs are long-lived perennial plants that grow rapidly in early summer as snow recedes. Initially, flowering stalks grow 18 to 24 inches then form bud clusters on each stalk. As tall larkspur continues to grow, the bud clusters enlarge on the top of the flowering stalk. After the bud clusters are fully formed, tall larkspurs begin rapid elongation of flowering stems (early flower stage). Elongation takes one to several weeks, depending on temperature and moisture. If sufficient soil moisture is available, higher temperatures increase speed of elongation.

Tall larkspurs reach their maximum height in about 50 days. Plants begin to flower when they reach 80% of their maximum height. In general, at 9500 feet elevation, tall larkspurs begin flowering mid- to late July, and finish flowering within three weeks. As stalks elongate from the bud to flower stage, it may take one or two weeks for flowers to open fully (flower stage). Drought or insect damage may cause flowers to abort and stalks to become stunted.

Seed pods form later in the summer from mature flowers. On high-elevation ranges, pods develop gradually over several weeks, and usually mature in August or September. Mature pods dry, shatter and disperse seed when pods split open. As pods dry so does the plant, and the leaves and stems gradually turn brown. At times pods will still be partially green while the remaining plant has turned mostly brown. At the end of the growing season, the brown larkspur leaves fall off, and stems die back completely to the root crown.

SAMPLING TALL LARKSPUR

Why sample tall larkspur?

The purpose of sampling tall larkspur is to estimate the toxicity of the plant population in a specific area or pasture. Typically, tall larkspur toxicity decreases (except for pods) as the plant matures. Alkaloid concentrations may vary

widely from plant-to-plant, site-to-site, and year-to-year. For that reason, it is very important to carefully sample an area that represents a pasture or larkspur patch. Because of the variability in alkaloid concentrations from plant to plant, livestock producers need to determine the average alkaloid concentration in a patch or pasture.

Where should I sample?

Select an area within a pasture where cattle deaths have occurred (so-called 'hot spots'), or an entire pasture that contains high densities of tall larkspur and cattle deaths have occurred nearby. Careful selection of a site that is representative of a broader area will make the alkaloid analysis more meaningful. If tall larkspurs grow in different plant communities (e.g. open slopes, under aspen trees, within spruce-fir groves), collecting samples from each community may be important and necessary.

How do I select plants to sample?

The objective is to randomly select 10 tall larkspur plants from each representative area where it grows. The size of the area to be sampled depends on the distribution of tall larkspur across the pasture or range in question. On the Wasatch Plateau in Utah, tall larkspurs often grow in patches or clusters that rarely exceed 5 acres. In this situation, samples should be taken across a patch.

Collect the samples by walking through a patch or pasture, and randomly harvest several leaves and the top 6-inch portion of one flower or pod stalk from 10 different plants. Put all the material together loosely into a paper bag.

Samples of larkspur need to be taken throughout the summer to determine alkaloid concentrations over time. Sample plants at least 3 times during the tall larkspur growing season (every 10 to 14 days), when tall larkspur is growing rapidly, and/or when information on alkaloid concentrations would help you decide about grazing a pasture.

What should I do with the samples?

Write the following information legibly on the paper bag using a permanent marker:

1. **Ranch name or contact person and telephone number**
2. **Date of collection**
3. **Location of collection (e.g. Poverty Gulch; poison patch on Roxanne's Rim) or GPS reading**
4. **Estimate elevation and stage of growth of the majority of tall larkspur plants**
5. **Brief note on any special circumstances, (e.g. lost 10 head here last year on 7/25/2010; collected after 4" snowstorm)**

The larkspur sample should be at least partially dry before mailing to the Poisonous Plant Research Laboratory to prevent molding. Place the paper bag(s) on the dashboard of a pickup out in the sun for a day (if summer temperatures are warm), or dry it in a conventional oven at 150°F for 12 hours. Be certain that the plant material is placed loosely into the bag; if packed tight, the interior material will not dry quickly. **Do not microwave** the sample as this will alter alkaloid concentrations.

Mail the sample to the following address:

**USDA-ARS Poisonous Plant Research Lab
Larkspur analysis
1150 E 1400 N
Logan, UT 84341**

UNDERSTANDING ALKALOID CONCENTRATION DATA

Normally alkaloid analysis will be finished within five working days after receiving the sample. Alkaloid concentrations are reported in metric units (mg/g). To change concentration from mg/g to percentage dry weight multiply by 0.1 (e.g. 5 mg/g = 0.5% dry weight).

The higher the concentration of toxic alkaloids the less tall larkspur cattle need to eat to cause poisoning. Most samples will fall between 2 and 20 mg/g. Samples below 3 mg/g are low and unlikely to poison cattle unless large amounts are eaten. Alkaloid concentrations above 3 mg/g indicate greater toxicity, and consequently

greater risk of poisoning cattle, if consumption is high enough.

Keep in mind that this alkaloid value is an **average** of the samples that were taken, and without a doubt plants that are more and less toxic can be found in a pasture. Nonetheless, the alkaloid concentration should provide a benchmark or a reference to compare results from other locations and/or times.

Toxicity information should be integrated with information on stage of growth and how much tall larkspur cattle are currently eating or are likely to eat. Understanding toxicity and the likelihood of consumption by cattle will provide important information on relative risk and help you make grazing management decisions, particularly if samples are taken before cattle enter a pasture. Furthermore, over years a pattern of larkspur toxicity will emerge that will be useful to plan grazing management in the future.

In conjunction with alkaloid measurements of plants, we recommend that the livestock producer or herder make visual observations of the cattle herd and larkspur plants in order to assess if animals are eating larkspur. Typically, if a few animals are eating larkspur, then it can be assumed that most of the herd is eating some larkspur. Close observation of plants will also show if tall larkspur is being grazed to some extent or not. If many tall larkspur plants show evidence of grazing, then the risk is probably high if the toxicity is also moderate or high.

WHEN DO CATTLE USUALLY EAT TALL LARKSPUR?

Studies have shown that cattle eat larkspur in a somewhat predictable fashion, depending upon the growth stage. Cattle generally eat little tall larkspur before tall larkspur elongates flowering stems. Consumption usually begins when the flowers are partially or fully open, and may increase as larkspur moves into the pod stage (Figure 5). Cattle usually eat leaves and flowers or pods. Eating flowers during the early or full

flower stages often means potentially high consumption later in the summer. In drought years, cattle may eat little tall larkspur during the summer.

Cattle increase larkspur consumption during stormy weather. Cattle consumed larkspur almost exclusively for 20-30 minute periods during storms, as opposed to usual intermittent grazing of larkspur flowers, pods, and leaves. Larkspur consumption was negatively correlated with decreasing temperature and barometric pressure and positively correlated with increasing relative humidity, leaf wetness, and precipitation. Weather during storms may reduce the level of total alkaloids in larkspur, increase the sugar levels in the leaves, rain may wash off the bitter wax that builds up on the leaves or some other factor may increase intake.

We assume cattle have adequate feed, and are not forced to graze larkspurs due to lack of forage. Many catastrophic losses have occurred when cattle were forced into an area dominated by tall larkspur with a shortage of other forage.

ASSESSING THE RISK OF DEATH LOSS

The ultimate objective of determining cattle preference for larkspur and its toxicity is to determine the risk of grazing an allotment or pasture. The risk of losing cattle to tall larkspur is influenced by both plant and animal factors. The major animal factor is individual animal consumption of larkspur and their susceptibility to toxic alkaloids. Major plant factors include the concentration of toxic alkaloids in tall larkspur and its palatability (i.e., do cattle prefer to eat larkspur over other forages?), which determines the dosage and rate of consumption of toxic alkaloids. Toxicity and preference can both be estimated, and used to make judgments about the relative risk of grazing a tall larkspur patch or pasture.

For example, if consumption of tall larkspur is very low, then the risk of losing cattle will also be low regardless of the toxic alkaloid concentration. If cattle begin to increase intake

of tall larkspur, the concentration of toxic alkaloid becomes critical in making grazing management decisions. Figure 7 provides a visual aid to help producers determine relative risk based on (1) the toxic alkaloid concentration of the plant, and (2) the amount of larkspur that must be eaten to poison cattle. Figure 8 provides a flow chart that can be useful to determine relative risk by answering several questions about tall larkspurs on the ranges. Figure 8, along with the other figures in this publication, should compliment, but should not replace a rancher's observations about the specific circumstances of the livestock operation.

EXAMPLES OF RISK ASSESSMENT

Some examples follow to demonstrate these relationships.

Example 1:

Phenological stage: bud

Observations of cattle and plants: none available

Toxicity: leaves - 9 mg/g; buds - 12 mg/g

Assessment: Relative risk is probably low.

Even though no information is available on the amount of tall larkspur in cattle diets, cattle usually don't eat larkspur during the bud stage. Larkspur is highly toxic, but if cattle aren't eating larkspur, poisoning is unlikely. Reassess the situation when larkspur begins to elongate

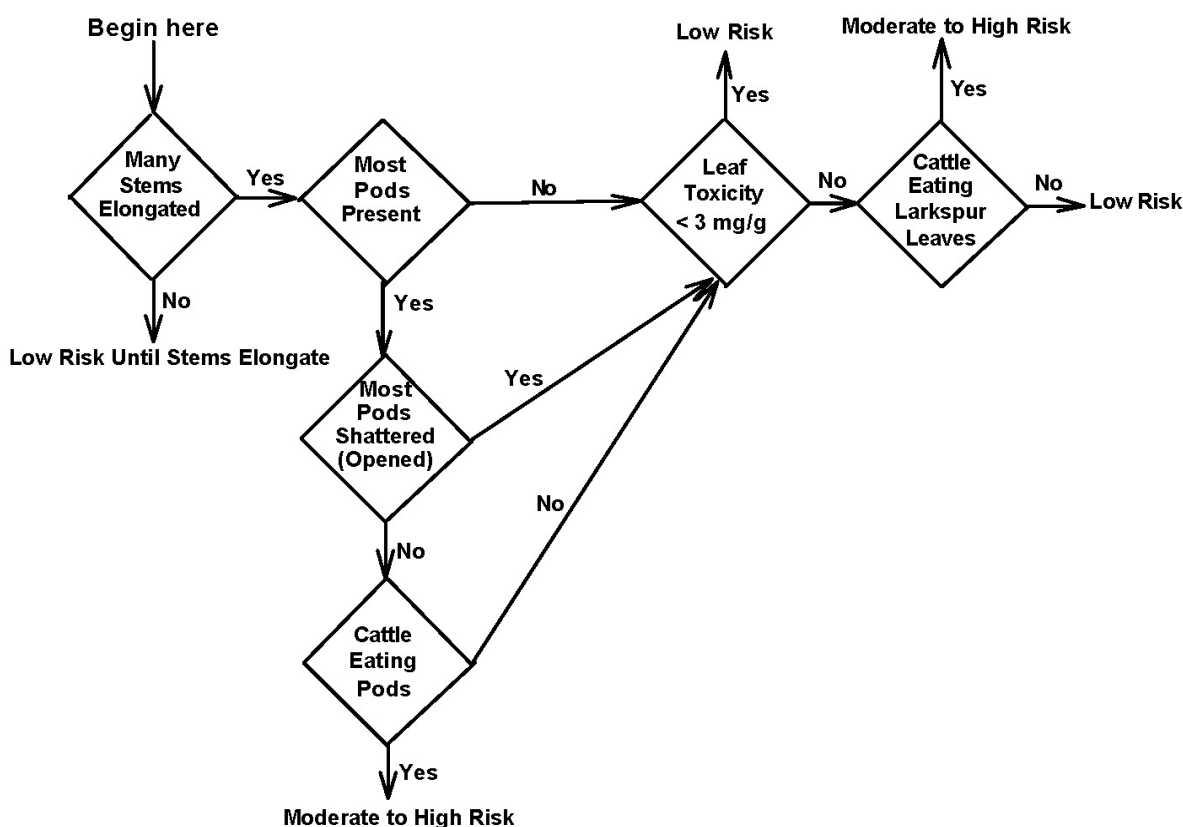


Figure 8. Decision-making flow chart: Enter the flow chart at the top where it says, "Begin here." Each diamond-shaped box is a decision point; if the answer to the statement in the box is yes then follow the 'yes' arrow; if the answer is no then follow the 'no' arrow to the next decision point. Answering the questions requires 1) an on-the-ground assessment of the larkspur stage of growth, 2) an estimate of the alkaloid content of the leaves, and 3) a determination by the rancher or herder if cattle are eating either leaves or pods of tall larkspur.

flowering stalks, and as the probability that cattle will begin eating larkspur increases.

Example 2:

Phenological stage: early flower

Observations of cattle and plants: some larkspur plants show evidence of being grazed by cattle

Toxicity: leaves - 3 mg/g; flowers - 10 mg/g

Assessment: Relative risk is currently low to moderate depending on consumption; risk is likely to increase into the high category. Cattle will likely increase consumption in the next week or two as larkspur matures. Even though leaf toxicity is low to moderate, and likely to decrease, cattle may soon begin eating enough flowers (i.e., entire top portion of the plants) to be poisoned (10 to 20% of diet with an alkaloid concentration near 11 mg/g). The producer should consider finding a safer pasture soon.

Example 3:

Phenological stage: late bud or early flower

Observations of cattle and plants: Cattle have not yet entered the pasture

Toxicity: leaves 9 mg/g; flowers 10 mg/g

Assessment: Risk for cattle entering this pasture will be moderate for the first 10 days or so.

Cattle will probably eat small amounts of tall larkspur initially, but the larkspur they eat will be very toxic. Risk could change rapidly and may be very high when larkspur is in full flower, unless toxicity decreases substantially or larkspur consumption stays low. If cattle graze this pasture, observe what they eat and reevaluate after 2 weeks. If a lower risk pasture is available, consider grazing it first.

Example 4:

Phenological stage: full flower

Observations of cattle and plants: Cattle are eating many larkspur plants, mostly flowering tops with some leaves

Toxicity: flowers - 2 mg/g; leaves - 5 mg/g

Assessment: Relative risk is moderate, but could increase greatly when flowers change to pods. Cattle may be able to safely graze this pasture for several weeks as long as they eat mainly low-toxicity flowers with few leaves in the diet.

Reevaluate as flowers change to pods. Pods are likely to be more toxic than flowers, and cattle are likely to eat many pods, as the pods are highly palatable. Leaf toxicity may remain stable for several weeks or decline as the summer progresses.

Example 5:

Phenological stage: full flower

Observations of cattle and plants: About 30% of larkspur plants showing evidence of grazing; additionally some cattle observed eating larkspur.

Toxicity: leaves - 6 mg/g; flowers - 8 mg/g

Assessment: Relative risk is high. Cattle are in grave danger, especially since consumption is likely to increase as larkspur matures. If the herd averages 30% larkspur in the diet, then some cows are probably eating much more at times, and may die. Move cattle to a safer area.

Example 6:

Phenological stage: late flower or early pod

Observations of cattle and plants: Larkspur plants show evidence grazing; mostly leaves appear to be eaten

Toxicity: leaves - 4 mg/g; flowers - 3 mg/g

Assessment: Relative risk is moderate, but may become high, as consumption is likely to increase at times when storms occur and as larkspur enters the pod stage. Cattle are in danger from tall larkspur poisoning. A decision must be made now about moving the cattle to a safer area.

Example 7:

Phenological stage: late flower or early pod

Observations of cattle and plants: Many larkspur plants show evidence grazing; some cattle observed eating larkspur leaves and flowering tops.

Toxicity: none available

Assessment: Risk is probably moderate to high. Even though toxicity data are not available, one should assume a toxicity level of at least 3 to 4 mg/g; toxicity of immature pods may be over 6 mg/g. In this situation, if consumption is high for the herd, some animals will probably

consume even greater amounts (e.g. > 50% of diet in a day) and are likely to be poisoned. Average consumption may increase as larkspur enters the pod stage, thus increasing risk even more. Move cattle to a safer pasture.

Example 8:

Phenological stage: Full flower for most plants; some pods beginning to appear

Observations of cattle and plants: Some larkspur plants show evidence of grazing. Cattle are scheduled to move soon into a different larkspur-infested pasture

Toxicity: leaves in the new pasture contain 6 mg/g; flowers contain 5 mg/g

Assessment: Risk is high and likely to remain high for several weeks until toxicity decreases as the plants mature. Cattle will likely increase the amount of tall larkspur they are eating. Delay grazing in the new pasture until most of the larkspur pods have shattered.

Example 9:

Phenological stage: full pod

Observations of cattle and plants: Many pods have been grazed from larkspur tops.

Toxicity: Leaves - 3 mg/g; pods - 8 mg/g

Assessment: Cattle are in the moderate to high risk category. Risk may be high at times for animals eating more than the herd average. Grazing this pasture will continue to be risky for 2 or 3 weeks, until pods dry, begin to shatter and toxicity decreases substantially. Leaves are not a major factor because cattle are eating few leaves, and leaf toxicity during the late season is typically low.

Example 10:

Phenological stage: Mid to late pod; some pods are beginning to dry and shatter

Observations of cattle and plants: Cattle were removed from this allotment during the flower stage, and are scheduled to return to graze the pasture in the fall

Toxicity: Leaves - 3 mg/g and pods - 5 mg/g

Assessment: Risk is currently moderate, because cattle may eat substantial quantities of pods. Risk will soon be low as pods continue to

mature and shatter; both pod and leaf toxicity will likely decrease in the next week or two. Continue to monitor toxicity. Late summer moisture may cause leaves to green up and increase in toxicity.

Example 11:

Phenological stage: Mid to late pod; most plants have shriveled or have no pods

Observations of cattle and plants: Many larkspur plants show evidence of grazing; cattle observed eating some larkspur.

Toxicity: Leaves: 2 mg/g; pods mostly absent due to insect damage

Assessment: Risk is low, but still present.

Leaves are not very toxic and will likely decrease even more in the next week or two. Without pods, cattle can graze this pasture for the remainder of the grazing season (assuming sufficient forage) with very little risk because toxicity is low.

CONCLUSIONS

The examples above are intended to provide a framework to show ranchers how to use information on cattle diets, larkspur toxicity, and stage of plant growth to make decisions about cattle management on tall larkspur ranges. It is important to remember that we don't understand all the factors influencing cattle consumption of tall larkspur, and there are exceptions to every rule. For example, current research suggests that within a herd of cattle there are both susceptible and resistant animals and that the level of susceptibility can vary widely. What may be a "safe" alkaloid level for most cattle may be lethal to others. The grazing studies that form the basis for this handbook were conducted with adequate amounts of available forage; hungry cattle on larkspur pastures are no doubt at great risk.

Comments from livestock producers regarding this handbook are encouraged. Call 435-752-2941 or email:

<http://www.ars.usda.gov/npa/logan/pprl>, or go through your local veterinarian or extension

agent to tell USDA scientists of successes or failures in dealing with tall larkspur.

Glossary

Some terms used in the handbook refer to different parts of tall larkspur plants and to poisoning in cattle. Thus some brief definitions are provided:

Bud—undeveloped flower shoot; in tall larkspurs a cluster or clump of buds forms and enlarges on the end of the stem as plants mature. These bud clusters may sometimes droop to one side as stems elongate and flowering begins. The term bud or pre-flower stage also describes tall larkspur that has not elongated flowering stems.

Early flower stage—the stage of larkspur growth after flowering stems have elongated, but before flowers have opened into full bloom.

Full flower stage—the stage of larkspur growth after flowering stems are fully elongated and flowers have opened completely.

Late flower or early pod stage—the stage of growth when flowers begin to mature into pods on the lower portion of the flowering stem. Plants may exhibit a mixture of flowers and pods because the transition to pod stage is gradual.

Low and plains larkspur—Low larkspurs are low-growing plants (4 to 30") with narrow leaves. They are found on foothill and mountain ranges throughout the western U.S. Plains larkspur (mature height 36") occurs primarily on the high plains of Wyoming and Colorado.

Pod stage—the stage of larkspur growth when most flowers have developed into seedpods. Seedpods ripen slowly then dry out before shattering.

Preflower stage—the stage of larkspur growth before larkspur elongates flowering stems. Encompasses the vegetative and bud stages of growth.

Sample—a fraction of a larger set of possible observations (e.g. one leaf harvested from an entire larkspur plant). A random sample is an

unbiased set of observations taken such that chance has played a major part in the outcome.

Tall larkspur plant—tall larkspur stems grow from a relatively large root crown. Individual tall larkspur plants arise from a single root crown and usually have many (3 to 100) stems arising from the root crown. They typically grow 3 to 6 feet tall.

Toxic alkaloid(s)—mostly refers to the major toxic alkaloid in tall larkspur: MLA. MLA is highly toxic. Tall larkspurs also produce other alkaloids. The amounts of MLA and other alkaloids determine the toxicity of larkspurs.

Toxin concentration—amount of toxic alkaloid in tall larkspur is usually expressed as mg/g. The percentage dry weight can be calculated as mg/g multiplied by 0.1 (e.g., 10 mg/g = 1.0% dry weight)

Vegetative—Tall larkspur plants having no visible buds or flowers.

HIGHLIGHTS: HOW TO ASSESS RISK FROM TALL LARKSPUR POISONING

Sampling tall larkspur for toxic alkaloid concentration

- Select representative pasture or patch
- Sample 10 individual plants by harvesting a few leaves and the top 6 inches of one flower or pod stalk from each plant
- Place all the material loosely into a paper bag;
- Label the bag then partially dry in oven or on truck dashboard in the sun
- Mail to PPRL in Logan

Understanding the alkaloid concentration

- Less than 3 mg/g indicates low toxicity
- 3 to 6 mg/g indicates moderate toxicity
- More than 6 mg/g indicates high toxicity
- Most sample values will fall between 2 and 20 mg/g

Determining if cattle are eating tall larkspur

- Observe larkspur plants for evidence of consumption by cattle
- Have herder observe cattle during peak grazing periods (early morning/early evening) when in larkspur-infested areas to see if some cattle are eating larkspur

Determining relative risk of grazing

- What is tall larkspur's stage of growth?
- Are cattle eating the plant or are they likely to eat larkspur?
- What is the concentration of toxic alkaloids in tall larkspur plants?
- Considering samples taken over time, is the concentration stable, increasing, or decreasing?
- Use Fig. 5 and 7 with the Decision Flow Chart (Figure 8) to estimate risk based on toxicity and actual or expected larkspur consumption

Further reading:

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