A Close Look At Locoweed Poisoning On Shortgrass Prairies

Management recommendations to help reduce the risk of locoweed poisoning to livestock.

By Michael H. Ralphs, J. David Graham and Lynn F. James

Locoweed poisoning is a significant impediment to livestock production, particularly on shortgrass prairies. Early observations confused locoweed poisoning with starvation since the incidence of poisoning increased during seasons of feed shortage and on overgrazed rangelands (Marsh 1909).

Animals started eating locoweed in the late winter and early spring before new grass started growing. They seemed to thrive at first, then rapidly fell off in body condition as poisoning progressed. Marsh concluded that an abundance of good feed resulting from improved range conditions would greatly reduce and perhaps eliminate the problem.

Range conditions have improved greatly over the last 100 years, yet locoweed poisoning continues to be a significant problem. Many of the semiarid locoweed species experience extreme population cycles; increasing in wet years and dying out during drought (Ralphs and Bagley 1988, Ralphs et al. 2001a). The large seed bank in the soil (56 to 370 seeds/ft^2, Ralphs and Cronin 1987) allows it to exploit environmental conditions and maintain the "boom and bust" populations cycles. During the outbreak years, catastrophic livestock losses continue to occur.

This review of locoweed research presents several management recommendations to reduce the risk of poisoning.

The Effects Of Locoweed Poisoning

Table 1 lists the *Astragalus* and *Oxytropis* species that have caused locoism, or have been shown to contain the toxic alkaloid swainsonine. Swainsonine inhibits essential enzymes in glycoprotein metabolism, resulting in buildup of hybrid sugars which "constipate" the cells in all body systems, and disrupt hormone and enzyme synthesis and receptor binding (Stegelmeier et al. 1999).

Outward effects on animals include reduced fertility of both sexes, neurological disturbances ranging from extremes of depression to aggression, compromised immune system resulting in increased disease, and impaired ability to eat or drink leading to weight loss and eventual starvation.

Reproductive loss is the greatest economic cost associated with locoweed poisoning (Panter et al. 1999). Abortions are common. Offspring that are born are small and weak, death rates are high, and they are often retarded and lack the instinct to nurse. Young that survive, and even healthy offspring, receive swainsonine through their mothers milk and become lethargic, depressed and have lower weight gains.

Stocker cattle loose weight while grazing locoweed and do not gain again for several weeks after they stop eating the poisonious plant (Ralphs et al. 2000). Torell et al. (2000) estimated moderately poisoned steers lost $75 per head, and severely poisoned steers lost $282 per head.

Locoed steers going on to the feedlot were slower to start gaining weight, and finished approximately 66 lbs. lighter than healthy steers from the same lot (Duff, unpublished data) – thus increasing the time and expense of finishing to the desired market condition.

A secondary, but significant effect is the compromised immune system (Stegelmeier et al. 1998a), leading to other feedlot diseases and poor immunologic response to vaccines.

Although the signs and effects of poisoning linger, swainsonine is rapidly cleared from the body (Stegelmeier et al. 1998b). A conservative withdrawal period of 28 days from the time animals consume locoweed to slaughter will satisfy food safety requirements.

Livestock Find Locoweed Palatable

The early literature suggested locoweeds were distasteful and animals were forced to start eating them because of hunger (Kingsbury 1964). However, once started, animals seemed to become addicted to locoweeds. Recent research showed that locoweeds are not addicting, but are relatively more palatable than associated forages during various seasons of the year (Ralphs et al. 1989). Both sheep (Ralphs et al. 1991) and cattle (Ralphs et al. 1993) that were severely locoed, ceased grazing lo-

Table 1. Locoweed (*Astragalus* and *Oxytropis*) species, habitat and distribution

Species	Common name	Habitat	Distribution
A. allochrous	Rattleweed	Desert grassland	AZ, NM
A. asymmertricus	Horse loco	Annual grasslands	CA
A. bisulcatus[1]	Two-grooved milkvetch	Limestone, shale, high in Se	MT, ND, WY, CO, NM, Ut
A. didymocarpus		Creosote deserts	CA, AZ, NV
A. drummondii[1]	Drummond milkvetch	Prairies, sage, oak, P/J	MT, WY, CO, NM, UT
A. emoryanus[2]	Red stem peavine	Creosote, Mesquite, P/J	NM, TX
A. humistratus	Ground cover milkvetch	P/J woodlands	AZ, NM
A. lentiginosus	Spotted locoweed	salt-desert shrub, sage, P/J	AZ, UT, NV, ID
A. lonchocarpus	Great rushy milkvetch	P/J woodlands	CO, UT, AZ, NV
A. missouriensis	Missouri milkvetch	Shortgrass prairies	Canada to TX
A. mollissimus	Woolly loco	Shortgrass prairies	CO, KA, OK, TX, NM
A. nothoxys	Beaked milkvetch	Oakbrush, P/J woodlands	AZ
A. oxyphysus	Diablo loco	Desert grasslands	CA
A. praelongus[1]	Stinking milkvetch	Sandstone, shale high in Se	UT, NM, AZ
A. pubentissimus	Green river milkvetch	Salt-desert shrub	CO, WY, UT
A. purshii	Pursh loco	Sagebrush, P/J woodlands	WY, MT, ID, NV
A. pycnostachyus	Brine milkvetch	Salt marshes and beaches	CA
A. tephrodes	Ashen milkvetch	Oakbrush, P/J woodlands	AZ, NM
A. thurberi	Thurber milkvetch	Creosote, Oak, P/J woodlands	AZ, NM
A. wootoni	Garbancillo	Creosote desert	AZ, NM, TX
O. besseyi	Red loco	Gravely hill tops	MT, WY
O. campestris	Yellow loco	Prairies, Mt. meadows	MT, Canada
O. lambertii	Lambert locoweed	Short and mid-grass prairies	MT, ND, SD, WY, CO, NM
O. sericea	White locoweed	rocky soils, foothills and Mt.	MT. SD, WY, CO, NM, UT

[1]Also contains selenium.
[2]Also contains nitro toxins.
There are many varieties, especially of *A. lentiginosus, A. mollissimus,* and *O. sericea,* that have been referred to as separate species in the past.
Species taken from Marsh 1909, Molyneaux et al. 1991, Smith et al. 1992, Fox et al. 1998.

coweed when green grass became plentiful.

Preference for locoweed is relative to what other forage is available. Many locoweeds are cool-season species that green-up and start growth early in the spring, then resume growth in fall. Livestock generally prefer the green-growing locoweeds to dormant grass. Sheep preferred the regrowth foliage of Green River milkvetch to dormant grasses during late fall and early winter on desert range in eastern Utah (James et al. 1968). Cattle readily grazed Wahweap milkvetch in proportion to its availability on desert winter range in southeastern Utah (Ralphs et al. 1988).

In a series of grazing studies in Northeast New Mexico, cattle readily grazed white locoweed in March, April and May, but stopped grazing it in June as warm-season grasses became abundant and white locoweed matured and became coarse and rank (Ralphs et al. 1993–2001c).

On mixed grass prairies on the eastern foothills of the Rocky Mountains in northern Colorado, cattle ceased grazing white locoweed when it matured following flowering in mid June, and became rank and unpalatable in 1998. However they continued to graze it throughout the summer in 1999 when abundant summer precipitation caused locoweed leaves to remain succulent (Ralphs et al. 2001b).

Management Strategies That Didn't Work

Supplements—Many minerals and feed additives have been investigated to prevent poisoning. Mineral supplements did not prevent poisoning, nor delay symptoms in sheep fed Garbancillo (James and VanKampen 1974), or prevent cattle from grazing white locoweed (Allison and Graham 1999).

Electrical charges on clay minerals may bind to swainsonine, but a variety of clays and minerals were not effective in preventing or reducing locoweed poisoning (Bachman et al. 1992, Pulsipher et al. 1994). Neither did vitamin E/selenium injections hasten recovery from locoweed poisoning (Richards et al. 1999).

On the other hand, there was concern that growth implants may enhance locoweed poisoning. An estradiol implant did not cause steers to select more locoweed in a grazing trial, and did not affect the degree of poisoning or rate of recovery in a locoweed feeding trial (Mikus et al. 2001).

Anecdotal evidence suggested cattle on a higher plane of nutrition, such as alfalfa hay or grazed on win-

ter wheat, may be more inclined to graze locoweed in the spring. However, these practices did not increase locoweed consumption (Ralphs et al. 2001c, Ralphs et al. 1997b).

Native Cattle and Breeds— Poisonous plant literature is filled with statements that native livestock are less likely to be poisoned than new, inexperienced livestock. Locoweed poisoning does not follow this general trend. Cattle that are familiar with locoweed will likely select it first (Ralphs et al. 1987).

Early observations by Marsh (1909) suggested that black cattle and black-faced sheep were more inclined to be poisoned by locoweed than white-faced cattle and sheep. In a recent grazing study comparing breeds, Brangus steers consumed more locoweed than Hereford and Charolais steers (Duff et al. 2001). The gregarious nature of Brangus cattle may have facilitated the social acceptance of locoweed among the steers.

Grazing Management Recommendations

1) Restrict Access. Livestock should be denied access to locoweeds during critical periods when they are relatively more palatable than associated forages. On short-grass prairies of northeastern New Mexico, stocker cattle should not be turned onto locoweed-infested rangelands until warm season grasses start growth in late May or early June. Cattle on rangeland year-round should be removed from locoweed-infested areas in the spring when it is green and growing, and warm season grasses remain dormant. They can be returned to locoweed-infested pastures in summer when warm season grasses are abundant.

Most locoweed species are endemic, growing only in certain habitats or on specific soils. Fences could be constructed on soil or vegetation boundaries to provide seasonal control of grazing. Reserving locoweed-free pastures for grazing during critical periods in spring and fall can prevent locoweed poisoning.

2) Consider herbicide controls. Locoweed-free areas can be created by strategic herbicide use (McDaniel 1999, Ralphs and Ueckert 1988). However, natural population cycles should be considered to determine the practicality of spraying large areas and the potential lifetime of control. With the abundant seed bank in the soil, locoweeds are sure to germinate and reestablish when environmental conditions are favorable.

3) Sort out animals that graze locoweeds. Animals that start eating locoweed may influence others to start. Social facilitation or peer pressure is a very strong influence inducing others to start eating locoweed (Ralphs et al. 1994b). Graham developed the "eat and pull" management strategy, whereby livestock should be watched closely and removed if they start eating locoweed to prevent poisoning and prevent them from influencing others to start (Torrell et al. 2000).

4) Don't overstock locoweed-infested areas. Grazing pressure can also force cattle to begin grazing locoweed when they run short of desirable forage (Ralphs 1987, Ralphs et al. 1994a). Ranchers should not overstock locoweed-infested ranges, but rather should ensure adequate forage is always available.

Improper use of some grazing systems can cause livestock to graze locoweed. Rest-rotation grazing systems are designed to force livestock to uniformly graze all forage in a pasture. This caused cattle and horses to start grazing spotted locoweed in western Utah (James et al. 1969). Changing to a 3-herd, 4-pasture deferred rotation grazing system stopped locoweed poisoning by reducing the grazing pressure and allowing the cattle to select alternative forages in preference to white locoweed (Ralphs et al. 1984). The heavy grazing pressure associated with short-duration grazing systems may also induce poisoning problems.

5) Train animals to avoid locoweed. Conditioned food aversion can be used as a management tool to train animals to avoid grazing locoweed (Ralphs et al. 1997a). In the conditioning protocol, animals are brought into a pen and fed fresh-picked locoweed, then lithium chloride (an emetic that causes gastrointestinal distress) is administered by stomach tube. The animals associate the induced illness with the taste of the plant and subsequently avoid eating it. Naive animals that are unfamiliar with the target plant form strong and lasting (> 3 years) aversions following a single dose.

Averted animals must be kept separate from non-averted animals on locoweed areas to prevent social facilitation from extinguishing the aversions. Aversion conditioning may be feasible where losses are heavy and persist year after year.

Conclusions

Locoweed is the most widespread poisonous plant problem in the western U.S. Knowledge of sites where locoweeds grow and environmental conditions when they cause problems is necessary to manage livestock and prevent poisoning.

Since locoweeds are relatively palatable and many locoweeds are the first plants to start growing in the spring and may also regrow in the fall, livestock generally prefer the green-growing locoweeds to other forage that is dormant in the fall, winter, and spring.

The most effective management strategy is to deny livestock access to locoweeds during critical periods when they are more palatable than associated forage. Reserving locoweed-free pastures or controlling existing locoweed populations with

herbicides can provide "safe" pastures for critical periods. Watching animals closely and removing those that begin eating locoweed can prevent further intoxication and prevent them from influencing others to start. Condition food aversion is another effective practice and may be economical where losses are large and persistent.

Bottomline, good range management and wise grazing strategies can provide adequate forage for livestock and avoid critical periods of the year when locoweed is relatively more palatable than associated forages.

Authors are Rangeland Scientist, USDA/ARS Poisonous Plant Lab, 1150 E. 1400 N., Logan UT 84341; County Extension Agent, Clayton NM, 88415, and Research Leader, USDA/ARS Poisonous Plant Lab. Much of this research was conducted under a cooperative research agreement between USDA/ARS Poisonous Plant Lab and New Mexico State Univ.

References

Allison, C. and J.D. Graham. 1999. Reducing locoism with management decisions. pp. 64–66 in: T.M. Sterling and D.C. Thompson (eds), Locoweed Research Updates and Highlights, New Mexico Agr. Exp. Sta. Res. Rep. 730.

Bachman, S.E., M.L. Galyean, G.S. Smith, D.M. Hallford, and J.D. Graham. 1992. Early aspects of locoweed toxicosis and evaluation of a mineral supplement or clinoptilolite as dietary treatments. J. Anim. Sci. 70:3125_3132.

Duff, G.C., M.H. Ralphs, D. Walker, D. Graham, J.D. Rivera, and L.F. James. 2001. Influence of beef breeds (Hereford, Charolais, Brangus) on locoweed consumption. J. Anim. Sci. (in review).

Fox, W.E., K.W. Allred, and E.H. Roalson. 1998. A guide to the common locoweeds and milkvetches of New Mexico. New Mexico Agr. Exp. Sta. Cir. 557.

James, L.F., K.L. Bennett, K.G. Parker, R.F. Keeler, W. Binns, and B. Lindsay. 1968. Loco plant poisoning in sheep. J. Range Manage. 21:360–365.

James, L.F., K.R. Van Kampen, and G.R. Stacker. 1969. Locoweed (*Astragalus lentiginosus*) poisoning in cattle and horses. J. Am. Vet. Med. Assoc. 155:525–530.

James, L.F. and K.R. VanKampen. 1974. Effect of protein and mineral supplementation on potential locoweed (*Astragalus* spp.) poisoning in sheep. J. am. Vet. Med. Assoc. 164:1042–1043.

Kingsbury, J.M. 1964. Poisonous Plants of the United States and Canada. Prentice-Hall, Englewood Cliffs, NJ.

Marsh, C.D. 1909. The loco-weed disease of the plains. USDA Bur. Anim. Ind. Bull. 112.

McDaniel, K.C. 1999. Controlling locoweed with herbicides. pp. 52-53 in: T.M. Sterling and D.C. Thompson (eds), Locoweed Research Updates and Highlights, New Mexico Agr. Exp. Sta. Res. Rep. 730

Mikus, J.H., G.C. Duff, C.R. Krehbiel, D.M. Hallford, D.A. Walker, J.D. Graham, and M.H. Ralphs. 2001. Effects of an estradiol implant on locoweed consumption, toxicity, and recovery in growing beef steers. Prof. Anim. Sci. 17:109–114.

Molyneux, R.J., L.F. James, K.E. Panter and M.H. Ralphs. 1991. Analysis and distribution os swainsonine and related polyhydroxyindolizidine alkaloids by thin layer chromatography. Phytochem. Analys. 2:125-129.

Panter, K.E., L.F. James, B.L. Stegelmeier, M.H. Ralphs and J.A. Pfister. 1999. Locoweeds: effects on reproduction in livestock. J. Nat. Toxin. 8:53–62.

Pulsipher, G.D., M.L. Galyean, D.M. Hallford, G.S. Smith, and D.E. Kiehl. 1994. Effects of graded levels of bentonite on serum clinical profiles, metabolic hormones, and serum swainsonine concentrations in lambs fed locoweed (*Oxytropis sericea*). J. Anim. Sci. 72:1561–1569.

Ralphs, M.H. 1987. Cattle grazing white locoweed: influence of grazing pressure and palatability associated with phenological growth stage. J. Range Manage. 40:330–332.

Ralphs, M.H. and V.L. Bagley. 1988. Population cycles of Wahweap milkvetch on the Henry Mountains and seed reserve in the soil. Great Basin Nat. 48:541–547.

Ralphs, M.H. and Cronin, E.H. 1987. Locoweed seed in soil: density, longevity, germination, and viability. Weed Sci. 35:792–795.

Ralphs, M.H. and D.N. Ueckert. 1988. Herbicide control of locoweeds: a review. Weed Tech. 2:460–465.

Ralphs, M.H., L.F. James, D.B. Nielsen, and K.E. Panter. 1984. Management practices reduce cattle loss to locoweed on high mountain range. Rangelands. 6:175–177.

Ralphs, M.H., L.V. Mickelsen, and D.L. Turner. 1987. Cattle grazing white locoweed: diet selection patterns of native and introduced cattle. J. Range Manage. 40:333–335.

Ralphs, M.H., L.F. James, D.B. Nielsen, D.C. Baker, and R.J. Molyneux. 1988. Cattle grazing Wahweap milkvetch in southeastern Utah. J. Anim. Sci. 66:3124–3130.

Ralphs, M.H., K.E. Panter, and L.F. James. 1989. Feed preferences and habituation of sheep poisoned by locoweed. J. Anim. Sci. 68:1354–1362.

Ralphs, M.H., K.E. Panter, and L.F. James. 1991. Grazing behavior and forage preference of sheep with chronic locoweed toxicosis suggest no addiction. J. Range Manage. 44:208–209.

Ralphs, M.H., D. Graham, R.J. Molyneux, and L.F. James. 1993. Seasonal grazing of locoweeds by cattle in northeastern New Mexico. J. Range Manage. 46:416–420.

Ralphs, M.H., D. Graham, and L.F. James. 1994a. Cattle grazing white locoweed in New Mexico: influence of grazing pressure and phenological growth stage. J. Range Manage. 47:270–274.

Ralphs, M.H., D. Graham, and L.F. James. 1994b. Social facilitation influences cattle to graze locoweed. J. Range Manage. 47:123–126.

Ralphs, M.H., D. Graham, M.L. Galyean, and L.F. James. 1997a. Creating aversions to locoweed in naive and familiar cattle. J. Range Manage. 50:361–366.

Ralphs, M.H., D. Graham, M.L. Galyean, and L.F. James. 1997b. Influence of over-wintering feed regimen on consumption of locoweed by steers. J. Range Manage. 50:250–252.

Ralphs, M.H., D. Graham, G. Duff, B.L. Stegelmeier and L.F. James. 2000. Impact of locoweed poisoning on grazing steer weight gains. J. Range Manage 53:86–90.

Ralphs, M.H., D.R. Gardner, J.D Graham, G. Greathouse and A.P. Knight. 2001a. Influence of defoliation on locoweed vigor, longevity and toxicity. J. Range Manage. (in press).

Ralphs, M.H., G. Greathouse, A.P. Knight and L.F. James. 2001b. Cattle preference for Lambert locoweed over white locoweed throughout their phenological stages. J. Range Manage. (in press).

Ralphs, M.H., G. Greathouse, A.P. Knight, D. Doherty, J.D. Graham, B.L. Stegelmeier and L.F. James. 2001c. Prior feeding practices do not influence locoweed consumption. J. Range Manage. (in press).

Richards, J.B., D.M. Hallford and G.C. Duff. 1999. Serum luteinizing hormone, testosterone, and thyroxine and growth responses of ram lambs fed locoweed (Oxytropis sericea) and treated with vitamin E/selenium. Theriogenology 52:1055-1066.

Smith, G.S., K.W. Allred, and D.E. Kiehl. 1992. Swainsonine content of New Mexican locoweeds. Proc. West. Sec. Amer. Soc. Anim. Sci. 43:405–407.

Stegelmeier, B.L., P.D. Snyder, L.F. James, K.E. Panter, R.J. Molyneux, D.R. Gardner, M.H. Ralphs, and J.A. Pfister. 1998a. The immunologic and toxic effects of locoweed (*Astragalus lentiginosus*) intoxication in cattle. pp. 285-290 in: T. Garland and A.C. Barr (Eds), Toxic Plants and Other Natural Toxicants. CAB International, Wallingford, Oxon, GB.

Stegelmeier, B.L., L.F. James, K.E. Panter, D.R. Gardner, M.H. Ralphs and J.A. Pfister. 1998b. Tissue swainsonine clearance in sheep chronically poisoned with locoweed. J. Anim. Sci. 76:1140–1144.

Stegelmeier, B.L., L.F. James, K.E. Panter, M.H. Ralphs, D.R. Gardner, R.J. Molyneuc, and J.A. Pfister. 1999. The pathogenesis and toxicokinetics of locoweed (*Astragalus* and *Oxytropis*) poisoning in livestock. J. Nat. Toxin. 8:35–45.

Torrell, L.A., L.P. Owen, K.C. McDaniel, and D. Graham. 2000. Perceptions and economic losses from locoweed in northeastern New Mexico. J. Range Manage. 53:376–383.

Photo taken south of Buffalo, South Dakota. Photo by Aaren L. Nellon.