CSU Veterinary Diagnostic Laboratory System

Fort Collins

Rocky Ford Laboratory

Western Slope Grand Junction
Plants Poisonous to Horses and Ruminants in Southern Colorado

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27847 CR 21
Rocky Ford, Colorado
Plants that cause Acute Death due to Asphyxiation

**Nitrate – blood can’t carry oxygen- muddy brown color**
- Species affected – Cattle > sheep >>> horses
- Toxic Principle – nitrite (rumen bacteria convert nitrate to nitrite)
- Drought stress plants - water
- Clinical signs
  - Dyspnea - shortness of breath
  - Muddy, cyanotic mucus membranes
  - Staggering gait
  - Bloat
  - Convulsions -Death
- Chocolate-brown blood
- Treatment – Methylene Blue – Not approved for use in food or dairy animals (18 month withholding)
- Prevention – adaptation; Proprionbacterium rumen inoculant

**Hydrogen Cyanide (Prussic Acid)-blood can’t release oxygen – cherry red color**
- Species Affected - Ruminants – equine?
- Toxic principle – cyanogenic glycosides – (dihurin)
- Regrowth (<24 in) especially important
- Clinical Signs -
  - Dyspnea
  - Cyanosis (blue discoloring of the lining of the mouth)
  - Bloat rumen contents may smell like almonds
  - Convulsions - Death
- Blood and tissues a bright cherry red
- Treatment - sodium thiosulfate, sodium nitrate
Blood Color Nitrate vs Cyanide
Nitrates

pigweed (hay)  
Amaranthus retroflexus  
(renal toxin)

kochia  
K. scoparia

Canadian thistle  
Cirsium arvense

sorghum sudan  
Sorghum sp
Nitrates

- oats
- corn/milo forages & stalks
Nitrate Variation 6 Acer Field

2/3 nitrate content in the lower 1/3 of the stock
Cyanide
toxin in the “green” leaves

**Arrowgrass** — *Triglochin maritima* - palatable
Early spring growth - marshes/wet hay meadows – retains toxicity in poorly cured hay; 0.5-2% bw

**Suckleya suckleyana** — Eastern front of Rocky Mountains – receding shallow ponds
Cyanide

- sorghum sudan
  - horses - ataxia/cystitis & fetal deformities
- johnsongrass
- Flax cultivated
  - rare in wild flax requires dense stands
Western Whorled (Horsetail) Milkweed

Asclepias subverticillata—one of the most toxic plants in North America

- Species affected – all except butterflies
- 0.2-0.4% bw is toxic
- Narrow verticillate-leaved – neurotoxic;
- Broad and narrowed-leaved – cardiotoxic (arrow poisons)
- Toxic Principal – unknown neurotoxin
- Unpalatable green but palatability increases when dry → hay
- Dense stands along ditches and irrigated hay fields

Clinical Signs
- Acute Death
- Depression, weakness, and staggered gait
- Difficulty in breathing with expiratory grunting sounds
- Rapid, weak pulse or other cardiac arrhythmias

- Loss of muscular control
- Elevated temperature
- Violent spasms - colic
- Bloating
- Respiratory paralysis
- Treatment – symptomatic
Western Whorled (Horsetail) Milkweed
Locoweed (Astragalus and Oxytropis spp.)
locoweed & milk vetches

• 2300-2500 species – Toxic Plants of North America lists 52 sp. as potentially toxic
• 1st USDA Poisonous Plant Laboratory est. at Hugo, CO – 1904 (CD Marsh)
• Colorado (late 1800’s) paid $50,000/year for Locoweed (dug below the crown)
• Stands generally short lived but seeds are viable >50 years
• Species affected – Horses > cattle, sheep, goats, and wildlife (elk, deer, antelope)
• 4 Clinical Syndromes occur in US:
  1. Locoism – swainsonine – highest concentration in seeds & pods, stems retains toxicity when dry
     • Neurologic disease
     • Emaciation
     • Poor reproductive performance, abortion, deformed fetuses
     • Right heart failure
     • Depressed immune function
  2. Selenosis – Selenium accumulation
  3. Photosensitization – Astragalus cicer (chickpea milkvetch) West and N Central US
  4. Nitrotoxicosis (cracker heels) – A miser (timber milk vetch) – Northwest US
Locoweed (Astragalus and Oxytropis spp.)

- Swainsonine effects are cumulative – 0.03% in plant can produce effects in as little as 3 weeks
  - Threshold dose of 0.3 mg swainsonine/kg of body weight (0.14 mg/lb bw)
- Toxic at all stages of growth, dry and in hay
- Learned process that can lead to habituation
- Excreted in milk – offspring can become ill before their dams
- Signs and Lesions of Poisoning
  - Depression
  - Dull dry hair coat
  - Eyes dull and staring
  - Irregular gait or some loss of muscular control
  - Weakness
  - Some animals show extreme nervousness
  - Loss of sense of direction
  - Withdrawal from other animals
Locoweed and Oxytropis spp

• Clinical Signs cont.
  Some animals develop inability to eat or drink
  Abortions are common; hydrops may occur in some cattle
  Skeletal malformations may occur
  Animal may become violent if stressed
  Reduced libido in males and altered estrous behavior in females
  Cessation of spermatogenesis and oogenesis
  Recumbency and death may follow prolonged consumption of locoweed
  Vacuolation of neurons, renal tubular epithelium, hepatocytes, etc.
  Congestive heart failure when grazed at high elevations

• Diagnosis
  serum swainsonine – half live <20 hrs - animal must be eating locoweed at the time of testing
  serum mannosidase – cattle; no commercial place to test samples

• Treatment
  Remove from source
  Symptomatic
    Horse reserpine (temporary/transport)

• Prevention
  Flash graze during early pod stage
  Rotational graze – 1 week on 2 weeks off (2 on - 3 off)
  Aversion therapy - lithium chloride
Locoweeds

A. mollissimus
wooly Loco

Oxytropis sericea
white loco
Locoweed

A. lambertii – purple loco

A. lentiginosus - spotted loco
Artemisia filolia - fringed sage; A. frigida - sand sage

Species affected – Equine
sage sickness
Toxic principle – lactones
abrupt ingestion of large amounts 0.75% bw
Target Organ – nervous system
Clinical signs
  incoordination – front legs
  excitable & unpredictable
  stumble & fall
Diagnosis – sage smell to breath
Treatment – none
Recovery general complete 2-3 days
Selenium Toxicosis

**Acute**
- Lethargy
- Dyspnea with abnormal posture
- Ataxia
- Diarrhea
- Abdominal pain (teeth grinding)
- Death (Sheep may not show signs and are found dead)
- Treatment none - remove source

**Chronic**
- Dullness
- Rough hair coat loss of mane/tail
- Emaciation
- Lack of vitality, anemia
- Lameness, joint stiffness
- Hooves may become overgrown or deformed circular bumps or breaks below coronary band
- Cardiomyopathy and liver cirrhosis
- Reproductive losses in cattle
Selenium Indicator Plants

**Primary - several thousand ppm Se**
- milkvetch (Astragalus)
  - TPNA list 19 species of Astragalus
- aster (Machaeranthera section Xylorrhiza),
- goldenweed (Haplopappus section Oonopsis)
- princes plume (Stanleya pinnata).
- stickleaf (Mentzelia)

**Secondary - several hundred ppm Se**
- asters (Aster)
- milkvetch (Astragalus)
- saltbush (Atriplex)
- Indian paintbrush (Castilleja)
- toadflax (Comandra)
- gumweed (Grindelia)
- snakeweeds (Gutierrezia)
- woody aster (Machaeranthera)
- narrowleaf marsh elder (Iva)
- beardtongue (Penstemon)
- goldenrod (Solidago)
Primary Selenium Accumulator Plants

Princes plume

A. bisulcatus two-grooved milkvetch
Primary – up to 3000 ppm Se
Primary Selenium Accumulator Plants

**Pyrrocoma sp.** - goldenweed

**Mentzelia sp** - stickleaf
Secondary Selenium Accumulator Plants

**Atriplex sp** – fourwing saltbrush

**Castilleja** – Indian paintbrush
Secondary Selenium Accumulator Plants

Comandra - toadflax

Grindelia - gumweed
Secondary Selenium Accumulator Plants

Gutierrezia - snakeweed

Iva – narrow leaf marsh elder
Secondary Selenium Accumulator Plants

Penstemon - beardstongue

Soldiago - goldenrod
Selenium toxicosis
Selenium toxicosis
Selenium toxicosis
Selenium toxicosis

<table>
<thead>
<tr>
<th>Se Concentrations</th>
<th>Selenium (ppm) – Hoof</th>
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<tbody>
<tr>
<td>Blood, ppm</td>
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<tr>
<td>0.45</td>
<td>Adequate 0.60 – 1.20</td>
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<tr>
<td>0.39</td>
<td>High 0.8 – 2.8</td>
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<td>0.35</td>
<td>Toxic chronic 5.0 – 20.0</td>
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<td>Toxic Acute – 2.8</td>
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<td>Liver, ppm, DW</td>
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<td>2.16</td>
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<td>5.33</td>
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<td>Case 2</td>
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<td>Hoof 7.43</td>
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<td>Hair 8.63</td>
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Locoweed, Selenium and General Custer

• Custer, selenium and swainsonine.
• Hintz HF1, Thompson LJ.
• Abstract

• The Battle of Little Bighorn was fought over 100 y ago but many controversies remain. Some feel the defeat of Custer could have been avoided if Benteen and Reno had united with Custer. A slow-moving pack train may have hindered the troops of Benteen and Reno from joining up with Custer. One report indicated the horses and mules in the pack train were lame and behaved crazily. It has been previously suggested that the animals had selenium toxicosis. We propose the lameness could have been caused by selenium, but that the behavioral problems may have been caused by the ingestion of plants containing swainsonine.
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<thead>
<tr>
<th>Animal</th>
<th>CREA</th>
<th>PHOS</th>
<th>Ref Range Serum</th>
<th>Ref Range Urine</th>
<th>Zn</th>
<th>Ref Range Serum</th>
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<td>310</td>
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**Case Comments**

- Adequate serum vitamin A concentrations in adult cattle range between 2.0 and 5.0 μg/ml; values less than 1.0 μg/ml are considered deficient.
Death Camas – *Zigadenus nuttallii*

All species are considered toxic.

Western US - <8000 ft

Early season growth
Death camas – several species - all toxic

Early spring growth – leaves and stalks toxic
Ingestion of 0.5-1% bw for sheep; same for cattle (less likely to eat Zigadenus)
Species affected - all (toxic pollen –bees) <24 hrs
Toxic principle – neurotoxic alkaloids (nitrogen compounds) - repetitive firing of nerves to muscles
Clinical Signs
  found dead or die within 48 hours
  ropey salivation and frothing
  retching, vomiting and colic
  posterior incoordination and staggering
  sheep hyperexcitable - pulse fast, weak and possibly irregular
  prostration, labored breathing, gasping
  convulsions, collapse or coma

Treatment – sheep (atropine 2 mg, picrotoxin 8 mg), activated charcoal
Larkspur - Delphinium sp

• 3 types - Tall, Low and Plains

• Toxic principle – alkaloids; all parts of all larkspur species are poisonous, but new growth and the seeds contain the highest concentrations of toxic substances.
  • Effects are cumulative
    • 5 – 20 # of low larkspur lethal for 1000# cow; less for tall larkspur
    • Early grazing season (April-May-plains larkspur)

• Species affected cattle>sheep (management tool)> horses

•
Western US – plains larkspur

Clinical Signs

Occur within 3 - 8 hours

6 stages

- tremors, wide stance, staggering
- lies down often
- can lift body but not stand
- sternal recumbency
- lateral recumbency
- death

Treatment - prevent bloat - position animal on sternum facing uphill

- atropine, physostigmine, neostigmine

Prevention aversion training – lithium chloride; vaccination; genetic modification, insect control
Larkspur Delphinium sp.

Plains larkspur – high plains of CO, WY, NM – early growth
Delphinium

Tall Larkspur - >7000 ft – late growth

Short larkspur, low elevation early growth
Equine Chewing Disease

Yellow Star Thistle  Russian Knapweed

Centaurea solatitialis  Acrptilon repens

Nigropallidal Encephalomalacia
Signs and Lesions of Poisoning
• Clinical signs occur after the horse has eaten large quantities of either plant for 30-60 days
• Chewing disease (dysfunction of facial, mouth, and throat muscles)
• Facial paralysis
• Depression
• Dehydration and malnutrition
• Incoordination
• Muscle tremors
• Irreversible necrosis of the brain
Equine Chewing Disease
Plants that cause Liver Disease

equine walking disease, hard liver disease

Plants Containing Pyrrolizidine Alkaloids

- Species affected – equine and cattle
- Disease occurs from a few days up to months depending on the quantity of toxins
- Cynoglossum – throughout NA - pastures & hayfields – remains toxic
  houndstongue
- Senecio >1000 species-gravely plains/foothills primary horse & cattle groundsels ragworts lambstongue ragwort
- Amsinckia-SW US disturbed ground/roadside
  horse
- Packera – numerous ragworts Midwest & E US
- Crotalaria – Easter US- Missouri Bottom Disease

Clinical signs

- Lethargy; loss of interest in food and abdominal pain
- Crustiness around eyes and nose; eyes may also be red and watery, especially in bright sunlight (secondary photosensitivity)
- There may be diarrhea or constipation
- Weakness as manifest by wobbling and dragging rear feet
- Secondary neurologic disorder - animals may wander aimlessly and appear to be blind, and may become belligerent
- Cattle may develop a pig-like odor that has a somewhat sweetish quality
- Ascites - the abdominal cavity may fill with fluid
- Death may occur within a few days after symptoms appear
- Icterus and hyperbilirubinemia
- Liver cirrhosis, fibrosis, enlarged liver cells (megalocytosis) and bile duct proliferation
Plants that cause Liver Disease

houndstongue - Cynoglossum

tarweed fiddleneck - Amsinckia
Plants that cause Liver Disease

Riddell’s (sand) groundsel – *S. riddellii*

Threadleaf ragwort (wooly) - *S. flaccidus*
Plants that cause Liver Disease

lambstongue ragwort (butterweed)  Crotalaria – Missouri bottom disease
S. integerrimus
Cocklebur - Xanthium strumarium

- Location – throughout NA
- Species affected – all calves > sheep > horses
- Toxic principle – glycoside carboxyatractylocide
  - spring / early summer
  - Sprouts - 1% bw calves; 2-2.5% sheep bw
    - 4 leaf stage – toxicity greatly decreased
  - Burrs (ground) – 02 -5% bw; whole 20-30% grain or hay
    - mechanical damage
- Clinical signs - acute liver failure
Cocklebur - Xanthium strumarium

**Clinical signs**
- Within 12 hrs (pre-ruminant) up to 1-2 days
- Salivation
- Tremors
- Ataxia
- Seizures
- Death

**Diagnosis – blood tests**
- ↑ liver enzymes (10X)
- ↓ blood glucose (approach 0)

**Massive liver failure (necrosis)**

**Treatment**
- symptomatic
Plants that Accumulate Sulfur
Ruminant Neurologic disease - PEM/Polio

Sulfur Accumulating Plants

• Canada thistle - Cirsium arvense
• Kochia - K. scoparia
• Lambsquarter - Chenopodium album
• Fourwing saltbrush - Atriplex
• Tansy mustard - Descuraina pinnata

Polioencephalomalacia – PEM/Polio

• Sulfur intake is accumulative
  • Feed- grain, molasses & dairy byproducts
  • Hay
  • Water
  • Weeds
• Clinical Signs
  • Blind
  • Circling
  • Depressed or Nervous
  • Salivation
  • Teeth grinding
  • Head pressing
  • Dead or down unable to rise
• Treatment – Thiamine (vitamin B1)
Plants that Accumulate Sulfur

Kochia – Kochia scoparia

Canada thistle - Cirsium arvense
Plants that Accumulate Sulfur

Lambsquarter – C. album

Fourwing saltbrush - Atriplex
Plants that Accumulate Sulfur

tansy mustard - Descuraina pinnata

Water
Sulfur calculator

- http://csu-cvmbs.colostate.edu/vdl/sulfur-calculator/Pages/default.aspx
Oak Poisoning – Quercus sp.
Oak Poisoning – *Quercus sp*

- Oak buds/leaves - spring
- Large amounts for 2-10 DAYS
- Acorns – fall
- Toxic agent – tannins
- Destroys kidneys
- Species – cattle>sheep/goats>horses

### Clinical signs

- Cattle
  - anorexia, listless, rumen stasis, constipation
  - diarrhea (bloody), increased urination (decreased urine specific gravity)f, ventral edema
  - weakness, recumbency
- Sheep – less edema
- Horse – diarrhea (bloody), colic, straining to defecate (severe)
- Postmortem findings
  - Subcutaneous edema
  - GI irritation
  - Renal failure – ascites
- Treatment – remove from source
- Prevention – 5-10% calcium hydroxide supplement
Oak Poisoning – Quercus sp

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• Toxic Plants of North America 2nd ed, Burrows and Tyrl; Wiley-Blackwell 2013

• Plants Poisonous to Horses, A. P. Knight BVSc, MS, DACVIM; Colorado State University, February 2005

• USDA - Plants Poisonous to Livestock in the Western States
  http://www.ars.usda.gov/is/np/PoisonousPlants/PoisonousPlants.pdf

• USDA Agricultural Research Service
  http://www.ars.usda.gov/Services/docs.htm?docid=9951

• Colorado’s Poison Menace - BCHA www.boulderhorse.org.
kochia
Clinical Signs cont.

• Some animals develop inability to eat or drink
• Abortions are common; hydrops may occur in some cattle
• Skeletal malformations may occur
• Animal may become violent if stressed
• Reduced libido in males and altered estrous behavior in females
• Cessation of spermatogenesis and oogenesis
• Recumbency and death may follow prolonged consumption of locoweed
• Vacuolation of neurons, renal tubular epithelium, hepatocytes, etc.
• Congestive heart failure when grazed at high elevations

Prevention

• Flash graze during early pod stage
• Rotational graze – 1 week on 2 weeks off
• Aversion therapy - lithium chloride
Oak Poisoning – Quercus sp

- Oak buds/ leaves -spring
  - LARGE AMOUNTS FOR 2-10 DAYS
- Acorns – fall
- Toxic agent – tannins
  - Destroy kidneys
- Species – cattle>sheep/goats>horses

- Clinical signs
- Cattle
  - 1. anorexia, listless, rumen stasis, constipation
  - 2. diarrhea (bloody), increased urination (decreased urine specific gravity), ventral edema
  - 3. weakness, recumbency
- Sheep – less edema
- Horse – diarrhea (bloody), colic, straining to defecate (severe)
  - Postmortem findings
  - Subcutaneous edema
  - GI irritation
  - Renal failure – ascites
  - Treatment – remove from surce
  - Prevention – 5-10% calcium hydroxide supplement .3
Oak Poisoning – Quercus sp
Plants that cause Liver Disease

Amsinckia hard liver disease  Crotalaria – Missouri bottom disease
Houndstongue and groundsel (Senecio) thread leaf & ridell bottom.
Ridell grounseal  crotilaria  amsinkia
Chewing Disease - Equine

- Signs and Lesions of Poisoning
- Clinical signs occur after the horse has eaten large quantities of either plant for 30-60 days
- Chewing disease (dysfunction of facial, mouth, and throat muscles)
- Facial paralysis
- Depression
- Dehydration and malnutrition
- Incoordination
- Muscle tremors
- Irreversible necrosis of the Brain
- Treatment None
Equine Chewing Disease
Western US

**Yellow Star Thistle**  *Centaurea solstitialis*

**Russian Knapweed**  *Acroptilon repens*
Brakenfern \textit{pteridium aquilinum} wide dist, thiamine def, wasting, depression incoordination, cumulative hay, crouch, arched back legs apart. WUS large amt 2-4 wks tremble
Brakenfern – clinical signs

**Ruminants**  acute disease

- In cattle and sheep: destroys bone marrow – bladder cancer
- • High fever
- • Loss of appetite
- • Depression
- • Difficulty in breathing
- • Excessive salivation
- • Nasal and rectal bleeding; bloody urine and feces
- • Anemia, leukopenia, thrombocytopenia, and hemorrhagic syndrome
- • Hemorrhages on mucous membranes
- • Aplastic bone marrow
- • Bladder tumors in cattle
- Hemmorhage
- • Treatment none

**Equine**  chronic disease

- In horses: disrupts thiamine vit b1 metabolism
- • Loss of weight and condition; emaciation
- • Progressive incoordination
- • Marked depression
- • Crouching stance, back arched with legs apart
- • Twitching muscles
- • General body weakness
- • Weak, fast pulse
- • Inability to stand
- • Convulsions or spasms
- • Pericardial and epicardial hemorrh
- Treatment - Thiamine
PAs
Senecios - threadleaf roundsel ragworts houndstongue cynoglossum md
Milk vetch nitro compounds acute (death n hrs) and chronic palatable toxicity decrease as mature wasatch milkvetch (2# kill 1000# cow)
Milk vetch wasatch

A miser - timber milkvetch
• Acute Poisoning:
  • Respiratory distress
  • Muscular weakness primarily in pelvic limbs; prostration
  • Death usually occurs in 3 to 4 hours
  • Lobular alveolar emphysema; collapsed lungs and constricted bronchioles with interlobular edema
  • Forced movement may cause these animals to collapse and die

• Chronic Poisoning:
  • Nervousness
  • Labored, rapid respiration
  • As intoxication progresses, respiration develops a wheezing or roaring sound
  • Knuckling of fetlocks
  • Goose stepping, knocking of hocks and/or feet when walking
Drooping of pelvic limbs and loss of control of hind limbs, which may be dragged when animal moves. Indications of temporary blindness. Drooling; rough hair coat; constipation or diarrhea may occur. When forced to move rapidly, animal may collapse and die. All signs of poisoning increase with forced movement. Lactating cows are more commonly affected than nonlactating.

Animals with advanced poisoning seldom recover but waste and die after several months. Sheep show more respiratory and less neuromuscular involvement. Horses can be intoxicated; cannot get them to back up. Focal hemorrhages in brain. Wallerian degeneration in spinal cord in pelvic region. Alveolar emphysema, interlobular edema. Death.
chokecherry moist fertile fields .25% bw
Co rubberweed hymenoxys 6000*80000ft foothills cumulative 1/4-1/2/100# 1-2 wks
Sucklyea sucklyeana – Poison Sucklyea
Poison Sucklyea
Selenium
<table>
<thead>
<tr>
<th></th>
<th>Se Concentrations</th>
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<tbody>
<tr>
<td>Blood, ppm</td>
<td>Hoof, ppm</td>
</tr>
<tr>
<td>0.45</td>
<td>6.82</td>
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<tr>
<td>0.39</td>
<td>4.78</td>
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<td>0.47</td>
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<tr>
<td>Liver, ppm, DW</td>
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<tr>
<td>2.16</td>
<td>5.33</td>
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</table>
Veratrum skunk cabbage 14 -35 days1
Greasewood sarcobatus oxalates sheep acute 4-6 hrs, depression, drool palatable OK in moderate amts

Halogeton disturbed soils overgrazed 12-18 oz kills
Halogeton
Hemp dogbane gravel up to 7000
horsebrush
Horsebrush + black sagebrush artesemia = sheep
big head photosent early growth = $\frac{1}{2}-\frac{3}{4}$ # pohotsen
Apocynum hemp dogbane cardiac glycoside $\frac{1}{2} - 1$ oz/100 death 6-12 hrs <7000 ft, gavel sandy fields
Tansey ragwort
Lupine
crooked calf cleft palate 40-100 days decease after
seed shatter
nightshades
Larkspur delphinium palatable toxic declines with maturity place up hill (bloat) only growth early spring
Poison hemlock
Water hemlock
Rayless goldenrod
Suckleya
Snakeweed
sneezeweed
Spring parsley - cymopterus
St Johns wort
Sweet clover
yew
horsetail
Tansey mustard
Hydrogen Cyanide (HCN) – Prussic Acid

Cardiac glycosides in foliage

- **Species Affected** - Ruminants
- **Regrowth especially important**
- **Clinical Signs** -
  - Dyspnea; rapid breathing and gasping
  - Cyanosis (blue discoloring of the lining of the mouth)
  - Increased salivation
  - Muscular twitching, staggering, and convulsions
  - Bloat may occur; rumen contents may smell like almonds
  - Convulsions
  - Coma
  - Death (animals consuming large amounts of the plant may die in 1 to 60 minutes and show only convulsions and death as signs of poisoning)
- Blood and tissues a bright cherry red (hyperoxygenation)
- Tracheal and pulmonary congestion
- Cattle and sheep may be severely affected if they eat large amounts of arrowgrass leaves or stalks in a short time. The leaves contain substances that produce the poison hydrogen cyanide on ingestion.
- **Treatment** - sodium thiosulfate, sodium nitrate
milkweed
Loco
wooly    spotted
nitrate
cyanide
Selenium toxicosis

<table>
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<tr>
<td>Adequate 0.60 – 1.20</td>
<td>Blood, ppm</td>
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<tr>
<td>High 0.8 – 2.8</td>
<td>0.45</td>
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<td>Toxic chronic 5.0 – 20.0</td>
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<td>Toxic Acute – 2.8</td>
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Locoweed

*A mollissimus* - wooly loco

*O sericea*