Forage-Related Animal Disorders

Types of disorders:
- Poisonous plant disorders
- Seasonal or conditional disorders due interactions with environment, management and animal conditions
- Forage species-related disorders (sometimes referred to as “antiquality” factors)

Mineral disorders
- Toxicity
- Deficiency

Naturally derived toxins
- Plant derived
- Non-plant derived (fungi, bacteria, insects)

Stored forage problems
- Hay
- Silage

Nitrate Toxicity
- Nitrate toxicity is not common but can be acute (as in the picture below) or chronic.

In the rumen, nitrate converts to nitrite ($NO_2^-$) which causes methemoglobinemia (ties up oxygen in the blood)

Can occur from excessive N in the soil that is taken up by the plant but can also occur with normal N fertilization

Plants accumulate nitrate during conditions when plant metabolism slows but does not entirely stop
- Drought
- Cool, cloudy periods
- Early, mild frosts
**Fate of Soil Nitrate**

Soil NO$_3^-$ → Denitrification → Plant NO$_3^-$ → Peptides, Amino acids → Plant sugars → Leaching → Erosion and Runoff

**In a Drought Year**

Soil NO$_3^-$ → Denitrification → Plant NO$_3^-$ → Peptides, Amino acids → Plant sugars → Leaching → Erosion and Runoff

**Nitrate Toxicity**

- Most susceptible crops
  - Corn, sorghum, small grains
  - Less risk with cool season grasses and pasture but can occur
  - Not a problem with legumes
- Some weeds are nitrate accumulators:
  - Pigweed
  - Lambsquarters
  - Wild mustard

**Managing for Nitrate Toxicity**

- Don't chop or bale immediately after the relief of drought stress - wait a week
- Chop high if possible
- Do not feed green chopped forage - wait until it fully ferments
- Test for nitrates
  - < 0.44% NO$_3^-$ - Should be safe to feed
  - 0.44% to 1.5% NO$_3^-$ - Need to be careful and dilute
  - > 1.5% NO$_3^-$ - Very toxic - Do not feed

**Animal Metabolic Disorders**

- Hypocalcaemia
  - Hypomagnesaemia

- Hypocalcaemia Or “Milk Fever”

- Forage-Related Animal Disorders

http://www.cvmbs.colostate.edu/ilm/proinfo/calving/notes/damcare.htm
Hypocalcaemia (Milk Fever)

Ca absorbed in the gut

During onset of lactation

Influenced by the Dietary Cation-Anion Difference (DCAD)

\[((\text{Na} + \text{K}) - (\text{Cl} + \text{S}))\]

Ca from bone

High Demand for Blood Ca

\(\text{Milk Ca}\)

Hypocalcaemia and Potassium

Dietary Cation-Anion Difference (DCAD)

\[((\text{Na} + \text{K}) - (\text{Cl} + \text{S}))\]

Very low

Relatively low

Quite variable but often relatively high

To calculate:

\[\text{DCAD (meq/100g DM)} = (\%\text{Na} \times 43.48) + (\%\text{K} \times 25.64) - (\%\text{Cl} \times 28.17) - (\%\text{S} \times 62.5)\]

Hypocalcaemia and Potassium

With high K forage in diets of “close up” dry cows

Increase in the Dietary Cation-Anion Difference (DCAD)

\[((\text{Na} + \text{K}) - (\text{Cl} + \text{S}))\]

Increases risk of milk fever

Hypocalcaemia and Potassium

So, what influences K levels in forage?

What Affects Potassium Content

- Forage Species

- Orchardgrass
- Tall fescue
- Reed canary
- Smooth Brone
- Timothy

Increasing forage K content

Source: Cherney, Cornell University

K Content Can Vary Widely

Source: UVM Forage Testing Lab
What Affects Potassium Content

- Stage of Maturity
- Time of year

Source: Cherney, Cornell University

Luxury K content required for optimum growth (2.0 to 2.2% of dm)

Very Low
Low
Optimum
High
Very High

Soil Test Potassium Levels

Hypocalcaemia and Potassium

Should farms maintain low soil K levels in order to reduce the risk of milk fever?

NO!

Potassium and Alfalfa Management

Alfalfa removes and requires a lot of K (45 to 70 lbs. K2O per ton d.m.)

Potassium is important for reducing the risk of diseases and winter injury in alfalfa.

Potassium and Grass Management

Grasses are capable of removing a lot of potassium but are also very competitive for K when soil test is low.

K management is very critical when managing mixtures if legumes are to be maintained.
Milk Production and Potassium
Relationship between DCAD and 4% FCM in a meta-analysis

Once in lactation, cows actually need a higher DCAD – about 30 to 50 meq/100g DM

Hypomagnesaemia Or “Grass Tetany”
• Low blood Mg levels
• Usually associated with older lactating animals grazing cool season grasses in the spring
• Can affect cows or ewes
• Reduced appetite, dull appearance, staggering gait, increase nervousness, tremors, collapse, paddling of feet, coma, death

http://www.teara.govt.nz

Hypomagnesaemia and K
• Mg concentrations in the forage reduced by:
  – High levels of K
  – Low soil oxygen levels
• Mg absorption in the gut is reduced by:
  – Low Ca and P
  – Low energy
  – High levels of N

Reducing Risk of Hypomagnesaemia
• Increase legume content of pasture, but not too much
• Split applications of N and K (avoid K applications in the spring)
• Lime with dolomitic limestone (contains Mg)
• Supplement with Mg salt
• NZ – dust with MgO powder

http://www.teara.govt.nz

Forage-Related Animal Disorders
Selenium Deficiency
• White muscle disease of newly born calves or lambs
• A problem in the eastern U.S. where plant growth exceeds Se uptake; thus, diluting Se to below critical levels
• Se must be supplemented either by injection or oral

Forage - Related Disorders
Naturally derived toxins
  – Alkaloids
  – Glycosides
  – Proteins and amino acids
  – Phenolics
  – Oxalates
Forage - Related Disorders

Alkaloids
- Bitter substances containing N in a heterocyclic ring structure
- There are thousands of alkaloid compounds with toxicity varying from none to extreme
- Most mind altering drugs and stimulants are alkaloids

Reed Canarygrass
- Past problems with palatability and intake due to high indole alkaloid content (tryptamin, gramine, carboline)
- "Low alkaloid" varieties released on the market starting in the 1980's greatly reduced this problem.
  - Bellevue, Palaton, Rival, Venture, Vantage

Endophyte and Tall Fescue
- Tall fescue has long been associated with animal toxicity problems (primarily poor animal performance and sometimes reproductive problems).
- In the 1980's researchers discovered that animal problems were caused by a fungal endophyte living inside the plant.
- The endophyte produces an alkaloid, ergovaline, which causes vasoconstriction of the blood vessels.

Endophyte Infected Tall Fescue
- Neotyphodium coenophialum
- Fungal hyphae grow between plant cells, with the highest concentrations in the stem and seedheads.

Tall Fescue Alkaloids
- Ergovaline
  - One of the Ergot Alkaloids
- Loline

Animal Problems With Tall Fescue
- "Summer syndrome"
  - Unthrifty
  - Poor hair coat
  - Elevated body temperature
  - Higher respiration rate
  - Less time grazing
  - More time in shade and water
  - Decreased weight gain
  - Lower milk production
Animal Problems With Tall Fescue

- **Fescue Foot**
  - Dry, gangrenous condition of the body extremities
  - Lameness or loss of tips of tails or ears
  - Sloughing of hooves or feet
  - Caused by vasoconstriction of the blood vessels
  - Generally a cool weather condition

- **Fat Necrosis**
  - Masses of hard fat in the abdominal cavity
  - Causes digestive and calving problems
  - Associated with tall fescue pasture that has been heavily fertilized with poultry manure or N fertilizer

“Low Endophyte” Tall Fescue

- “Low endophyte” or “endophyte free” varieties are available that eliminate the animal problems; however, they are much less persistent than the high endophyte varieties.

“Non-Toxic Endophyte” Tall Fescue

- New Zealand researchers discovered endophytes that do not produce ergovaline in the top growth, but still produce other alkaloids that help plant survival (eg. lolines in the roots).
- Refered to as “Novel Endophytes”

One of the NZ non-toxic endophytes has been patented under the name MaxQ

Endophyte infected Tall Fescue provides many benefits

- Improved establishment of seedlings
- More vigorous plant growth
- Resistance to insect pests and nematodes
- Tolerance to abuse and overgrazing
- Tolerance to drought
- Persistence of the stand

Entophyte Dilution With Legumes

<table>
<thead>
<tr>
<th>Forage</th>
<th>Toxic Endophyte-infected</th>
<th>Endophyte-Free</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tall Fescue</td>
<td>Tall Fescue</td>
</tr>
<tr>
<td>Grass alone</td>
<td>0.7%</td>
<td>2.03%</td>
</tr>
<tr>
<td>Grass + Regal white clover</td>
<td>1.4%</td>
<td>0 to 2</td>
</tr>
<tr>
<td>Grass + Barlow white clover</td>
<td>3.0%</td>
<td>5 to 10</td>
</tr>
</tbody>
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Testing for endophyte
- ELISA test
- Randomly collect 60 to 100 fresh tillers
- Cut out and save the lower portion (crown and lower three inches of the tiller)
- Keep cool and fresh

Stem cross sections are placed in ELISA cells for detection

Fescue Identification
Tall Fescue
Meadow Fescue

Ergot in Grass Seedhead
- Caused by *Claviceps purpurea*
- Symptoms include behavioral changes, lameness, abortions, convulsions, gangrene, death
- Animals may be affected by ergot from eating small amounts over a long period of time, or eating greater quantities in a short period of time

Mycotoxins in Silage
- Many mycotoxins caused by different fungi species
- Animal response can vary from reduced milk production to damaged organs
- Fungi found in silage includes Fusarium, Penicillium, and Aspergillus
- Oxygen contamination into the silo is a major factor contributing to mycotoxin

Forage - Related Disorders
Glycosides

Sugar molecule  Aglycone

Non-toxic when two molecules are attached

Forage - Related Disorders
Glycosides

Sugar molecule  Toxic Aglycone

When exposed to beta-glucosidase the bond can get broken
Sorghum, Sudangrass or Sorghum-Sudangrass Hybrids

- Prussic acid poisoning (hydrogen cyanide - HCN)
- Free cyanide is released from glycoside (dhurrin) due to enzymatic action
- The glycoside and the enzyme are in different parts of the plant, but mix during damage such as wilting, trampling, frost, drought, or in rumen
- Symptoms include labored breathing, excitement, convulsions, paralysis, death

Sorghum, Sudangrass or Sorghum-Sudangrass Hybrids

Risk factors include:

- Plant age
  - Younger forage has higher concentration
- Type of utilization
  - Hay is highest risk
  - Grazing is moderate to high risk
  - Silage is least risk
- Fertilization
  - High N enhances risk
- Environmental conditions
  - Frost, drought, wilting
- Species/varieties
  - Species/varieties vary
  - ‘Piper’ Sudangrass has low content

Sweetclover Poisoning

- Contains coumarin glycosides
- Mold growth converts it to dicoumarol, a toxin that reduces blood clotting, thus causing prolonged bleeding and hemorrhaging.
- Risk is highest when hay is cured during wet, humid weather with favors mold growth.
- Cattle are main livestock affected
- Low-coumarin varieties are available

Brown Mid-Rib Non Brown Mid-Rib

There is no relationship between BMR gene and HCN potential.

Forage - Related Disorders

Bloat

Pasture bloat is mainly a problem when ruminants graze legumes or very lush

Pasture Induced Bloat

- Caused by rapid release of cell contents of succulent, immature legume during rumen fermentation
- Succulent material rapidly releases soluble proteins and fermentable carbohydrates
- Soluble proteins act as foaming agents which prevents belching
- High sugar content promotes abundant microbial growth, thus, increasing gas production.
- Esophagus becomes blocked, rumen distends and animal succumbs to respiratory paralysis
Pasture Induced Bloat

- Reduce risk of bloat by slowly introducing animals to lush pasture
- Avoid pasture with high clover (over 40%) especially when first exposing animals to pasture
- Avoid extended cool, cloudy periods when pasture has high legume content or lush vegetative grasses
- Encourage high grazing pressure by strip or rotational grazing

Forage - Related Disorders Associated with Legumes

Phytoestrogens
Mainly a problem with sheep causing reduced fertility of ewes.

Clover “Slobbers”

- Associated with black patch disease caused by Rhizoctonia leguminicola
- Toxin is Slaframine an indolizidine alkaloid
- Rainy conditions and high humidity promote the disease
- Can infect red clover, white clover, alsike clover and alfalfa

Clover “Slobbers”

- The fungus persists on infected fields from year to year.
- Slaframine can be active in stored hay for 10 months or more but biological activity does decrease.
- Regular cutting decreases problem

Alsike Clover Phototoxins

- Light colored animals most sensitive
- Photosensitization and big liver syndrome
- The actual toxin is unknown
- “reddening of the skin ... followed by either superficial or deep dry necrosis of the skin or by edematous swelling and serous discharge”

Toxic Plants

- Isolated cases
- Local
- Diverse (many plants and many symptoms)
- Similar to symptoms of many other diseases and maladies
- Most likely to occur when animals are hungry and lack forage
Toxic Plants

Black Nightshade

Pokeweed

False Hellebore

Bracken Fern

Cherry (Prunus species)

Red Maple

- The toxin that affects ruminants depresses bone marrow production causing weight loss, bruising and bleeding
- Requires 1 to 2 months of consumption
- Generally not palatable, but some animals acquire a taste for it.

- Contains prussic acid glycosides
- Found mainly in damaged leaves but also found in fruit and bark

- Highly toxic to horses
- Most toxic when wilted
- 3 lbs. is lethal
- Causes destruction of red blood cells
White Snakeroot

- Found in woods and damp, shady pastures
- Mainly a problem when forage supplies are low
- Very toxic (toxin can pass into milk)
- Depression, stiff gait, tremors, jaundice, prostration, death
- Toxin is cumulative

Minimizing Forage-Related Animal Disorders

- Be mindful of potential problems
- Provide adequate forage and minerals
- Provide legume/grass mixtures when possible
- Be able to identify, eliminate and/or separate animals from potential poisonous plants