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Grass tetany in cattle – predicting its likelihood

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Introduction

This is one of three Primefacts about grass tetany. This Primefact examines some ways to predict the likelihood of the disorder occurring. Primefact 420 describes the causes and symptoms of the disorder. Primefact 421 focuses on treatment and prevention.

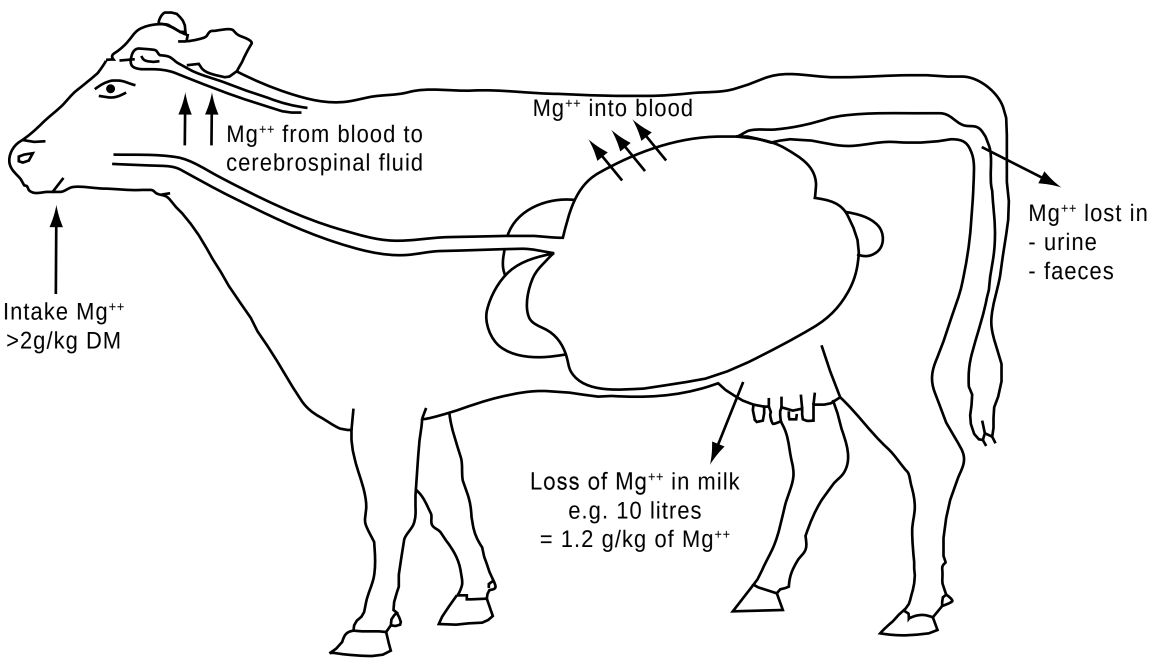
The disease

The complex form of grass tetany occurs where the animal is affected by a lack of magnesium (Mg^{++}) due to the interference of magnesium (Mg^{++}) absorption in the rumen by potassium (K^{+}) excess in the diet. Mg is an important component of cerebrospinal fluid, the fluid that surrounds the brain and spinal cord and is necessary for the transmission of signals throughout the animal's body. Milking cows are most susceptible to the disease.

Figures 1 and 2 show how an excess of K in the diet can interfere with Mg absorption from the rumen.

Figure 1 shows a cow in a normal state where magnesium intake is adequate for her to absorb enough magnesium (Mg^{++}) into her bloodstream to supply the nerve tissues that transmit signals throughout her body. Magnesium (Mg^{++}) cannot be stored in the body therefore the animal needs a constant supply to maintain normal functions.

Figure 1. Cow receiving an adequate supply of Mg in her diet.



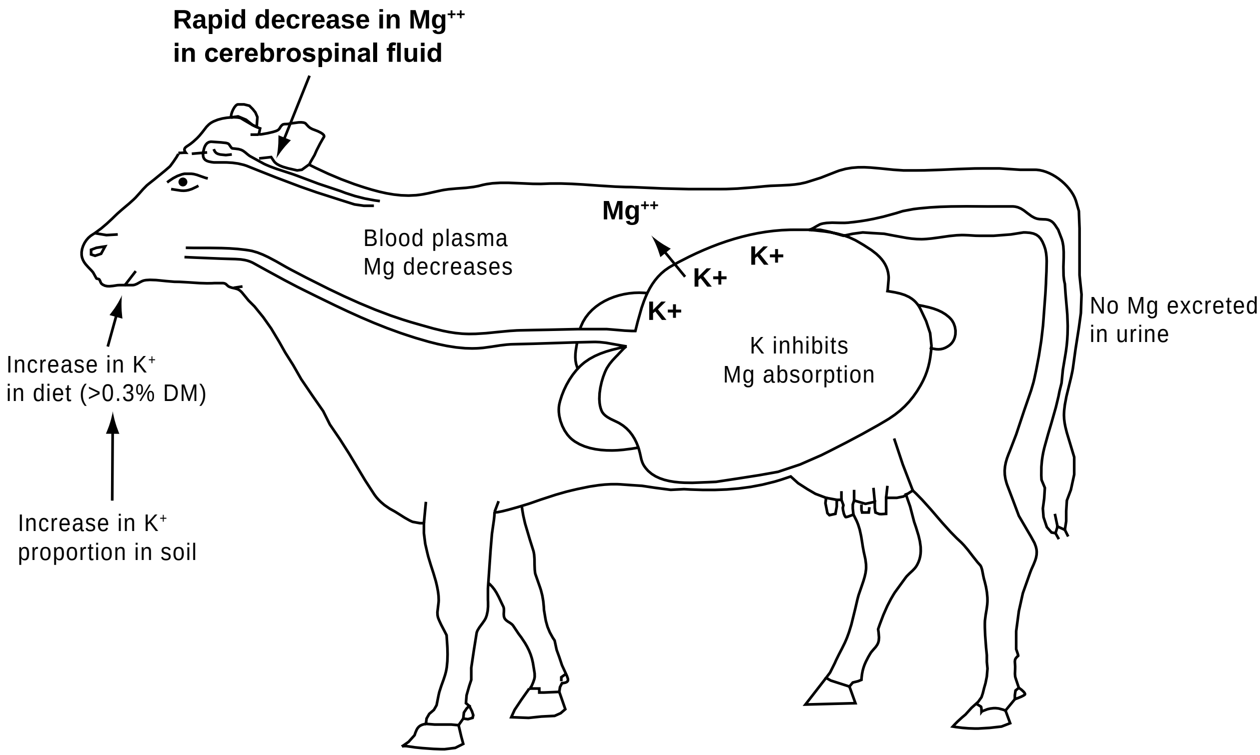


Figure 2. Cow with a temporary magnesium deficiency as a result of a high intake of K in her diet.

Figure 2 shows a cow with a high intake of potassium (K^+) in her diet. Potassium levels can increase in the diet for various reasons to levels >0.3% DM (dry matter) which floods the rumen with potassium (K^+) and blocks absorption of magnesium (Mg^{++}). This gives the animal a temporary lack of magnesium (hypomagnesemia), and blood levels of Mg^{++} decrease. This may lead to mild signs through to fatal grass tetany.

The concentration of magnesium in cerebrospinal fluid (CSF) decreases when blood magnesium and blood calcium levels decrease. If the cow can maintain her blood Ca the CSF Mg does not decrease even in cows that have hypomagnesemia.

The first indication of grass tetany is hyperexcitability (or just ‘plain stirry’) which can last for as long as 20 to 40 minutes. Ear twitching is characteristic. Death sometimes in large numbers can soon follow with the animals showing a characteristic paddling of the legs before death.

Predicting grass tetany

There are three types of complex form grass tetany:

1. Grass/crop tetany
2. Post drought grass tetany
3. Penned feeding grass tetany

All types affect the animal in the way described above but the potassium excess for each type occurs under a different set of environmental conditions. Knowledge of these environmental conditions can help producers predict the likelihood of grass tetany occurring.

1. Grass/crop tetany

Under normal conditions in advanced grassy pastures or cereal crops (notably winter wheat and oats), the three critical minerals magnesium (Mg^{++}), calcium (Ca^{++}) and potassium (K^+) are in ‘balance’ (Figure 3). This means that the ratio of K^+ to Ca^{++} and Mg^{++} is less than 2.2.

Changes occur in the plant roots when cold conditions of <7ºC maximum temperatures occur for four or more consecutive days. Plant roots temporarily hibernate and cease to absorb nutrients. This hibernation is termed ‘passive absorption’. As mineralisation of nutrients in the soil is relatively constant, even under these colder conditions and as potassium (K^+) is more chemically reactive than Ca and Mg, a build up of potassium (K^+) occurs around the roots of the plant, as represented in Figure 4.

Typically, temperatures may temporarily warm up in cold areas with air temperatures above 8ºC and more critically night temperatures above 8ºC. The literature quotes climatic temperature variations of 16ºC day and 8ºC night temperatures causing the

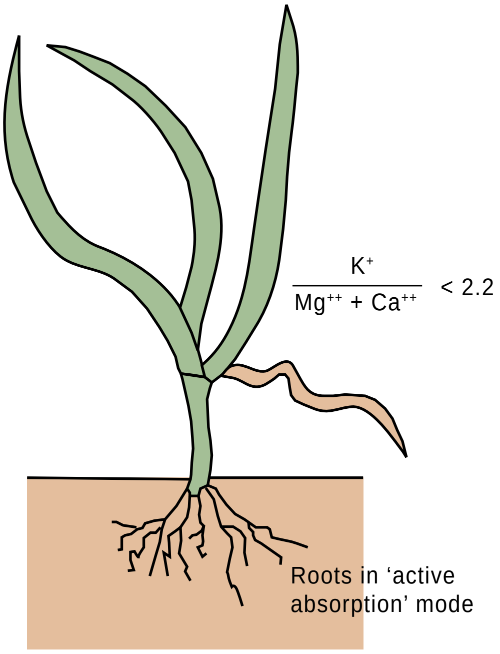


Figure 3. A grass in its normal state with magnesium (Mg^{++}), calcium (Ca^{++}) and potassium (K^+) in balanced ratio less than 2.2 and the plant roots in 'active' uptake mode for nutrients.

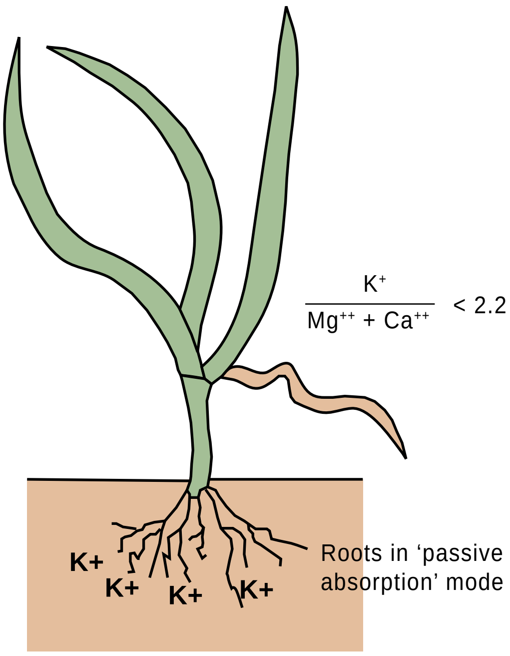


Figure 4: A grass in 'passive absorption' mode as a result of several days of cold weather. At the same time K^+ is accumulating around its roots.

soil to warm up after approximately four days of these conditions.

If these conditions are likely to occur, it is a good idea to treat cattle with magnesium (Mg^{++}) supplements such as Causmag (MgO) and or other magnesium supply such as magnesium (Mg^{++}) pellets. Treatment at the sign of animal symptoms is not recommended as the additional stress can result in more deaths.

Under the warmer temperatures the plants switch from passive to active root absorption and a rapid uptake of potassium (K^+) relative to magnesium (Mg^{++}) and calcium (Ca^+) occurs. (Helyar. K - pers. com. 1996). The greater proportion of K^+ is due to the uptake of the additional K^+ formed around the roots during the cold conditions described above.

The nett result as shown in Figure 5 is a crop or grass with a K^+/ (Mg^{++} + Ca^{++}) ratio greater than 2.2 which when eaten can cause K^+ replacing Mg^{++} absorption in the rumen of susceptible animals which are already excreting large quantities of Mg^{++}. This temporary replacement mechanism in its mild form is known as hypomagnesemia or in its severe or fatal form as grass tetany.

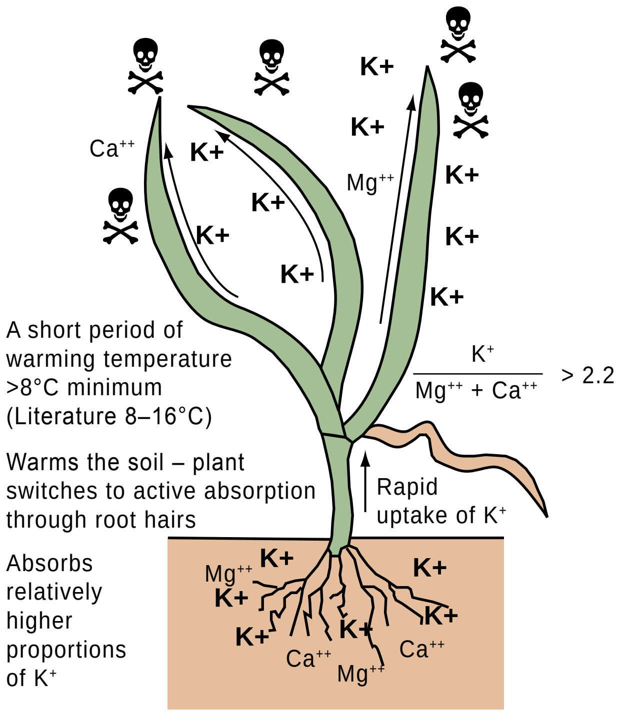


Figure 5. A plant with high potassium (K^+) in the leaves and a K^+ to Ca^{++} and Mg^{++} ratio greater than 2.2, which if eaten can cause grass tetany.

The plant mineral balance will stabilise over a period of about five days and return to its normal state as shown in Figure 3 where the plant ratio K^+/ (Mg^{++} + Ca^+) is less than 2.2.

2. Post drought grass tetany

The three important minerals for grass tetany are potassium (K^+), magnesium (Mg^{++}) and calcium (Ca^{++}) and while they remain in 'balanced' proportions in the soil they present no problem. However, potential exists for grass tetany to occur when potassium (K^+) is in greater supply than calcium (Ca^{++}) and magnesium (Mg^{++}). These imbalances occur in a number of ways.

Plant nutrients are made available to plants through a process called mineralisation which proceeds in the soil at a relatively constant rate. However, potassium (K^+) is more chemically reactive than calcium (Ca^{++}) and magnesium (Mg^{++}) and builds up more rapidly in the soil thus creating an imbalance.

Some soils such as granite soils are more acidic and tend to have high potassium (K^+). Other soils may be naturally less acid but become 'imbalanced' with excess additions of potash (a potassium K^+ fertiliser) or ash type fertilisers containing high amounts of potassium (K^+).

Drought conditions, where plants are not absorbing minerals from the soil, can also lead to high amounts of available potassium in the soil.

The danger period for grass tetany is when a drought breaks. After germinating rains, new plant growth rapidly absorbs these excesses of available potassium in the soil, causing the first new plant shoots to contain high levels of potassium (K^+) that can trigger grass tetany (Figure 8). A typical situation where grass tetany is possible is shown in Figure 9 where drought fed animals are able to graze short grass with inordinately high levels of potassium (K^+).

As the grasses grow, the high potassium (K^+) levels are effectively diluted, so hungry stock should be kept off this pasture until it grows to at least 12 cm

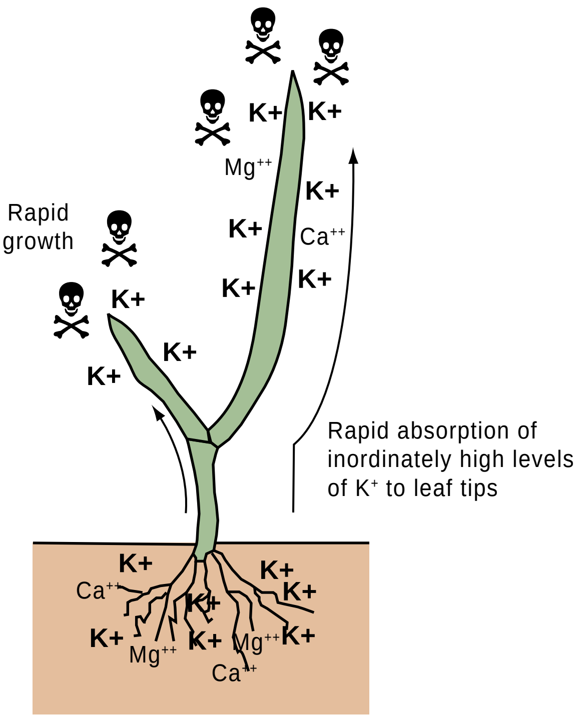


Figure 8. The culprit – first shoots of green grasses or cereal crop after germinating rain that contain high levels of potassium.

Figure 9. High risk short pasture.

in length. This is often easier said than done as hungry stock will eat anything. Hand feeding hay is advised until the pasture attains this length on soils with a high potassium level.

3. Penned feeding grass tetany

A comparatively rare but nonetheless real situation can exist for grass tetany where numbers of animals are kept in yards for extended periods for handfeeding or other hay/grain feeding.

Grain and or hay intensive feeding tends to enrich the manure of the animals with minerals such as potassium. In certain circumstances where rain has germinated short pick grass, a danger exists that animals can consume the short grass as it appears in the pen – a situation that often goes unnoticed by stock managers.

The plant and stock mechanism for this type of grass tetany to occur will be similar to post drought grass tetany.

Figure 10. Penned cattle that are intensively fed can produce manure that is high in potassium thus creating an imbalance in the soil.

Prediction – can we measure the potential danger of grass tetany?

1. Plant/leaf analysis – not recommended because of its complexity

Measuring the mineral components of plant leaves would seem to be the best way to measure imminent danger periods. However, this creates two challenges.

Challenge 1 – The change from safe to potential hazard occurs rapidly over a number of days. Sampling and analysis usually takes about a week so by the time the results of the analysis are received often the danger period is past.

Challenge 2 – Results from plant analysis must be converted to a form that can be used in the $K^+/(Ca^{++} + Mg^{++})$ grass tetany hazard ratio.

Example calculation:

Say a plant has 3% K^+, 0.2% Ca^{++} and 0.2% Mg^{++}, which would represent a typical young grass in post drought conditions.

3% K^+ = 30 g K^+/kg dry matter

divided by its atomic weight (39.0983 g/mole)

= 0.767 moles K^+/kg dry matter

K^+ has a valence of 1 so

= 0.767 eq K/kg dry matter

Similarly 0.2% Ca^{++} = 2 g Ca^{++}/kg dry matter

divided by its atomic weight (40.078 g/mole)

= 0.05 moles Ca^{++}/kg dry matter

multiply by valence of 2

= 0.1 eq Ca^{++}/kg dry matter

Similarly Mg 0.2% Mg^{++} = 2 g Mg^{++}/kg dry matter

divided by its atomic weight (24.305 g/mole)

= 0.082 moles Mg^{++}/kg dry matter

multiply by valence of 2

= 0.165 eq/kg dry matter

Now to our grass tetany hazard ratio:

$$\frac{K}{Mg + Ca} = \frac{0.767}{0.1 + 0.165} = 2.89$$

which is a worry as it is >2.2. This method must be used for accurate plant leaf hazard determination for grass tetany.

2. Soil ratios – a quick and easy method

Advantages over leaf analysis

a) The soil tests are usually in milliequivalents per 100 g which need no complex conversions (Conyers. M - pers. com. 2002).

Simply, the soil tests in milliequivalents can be put straight into the K/(Mg + Ca) ratio and then compared to Table 1. K/(Mg + Ca) soil risk.

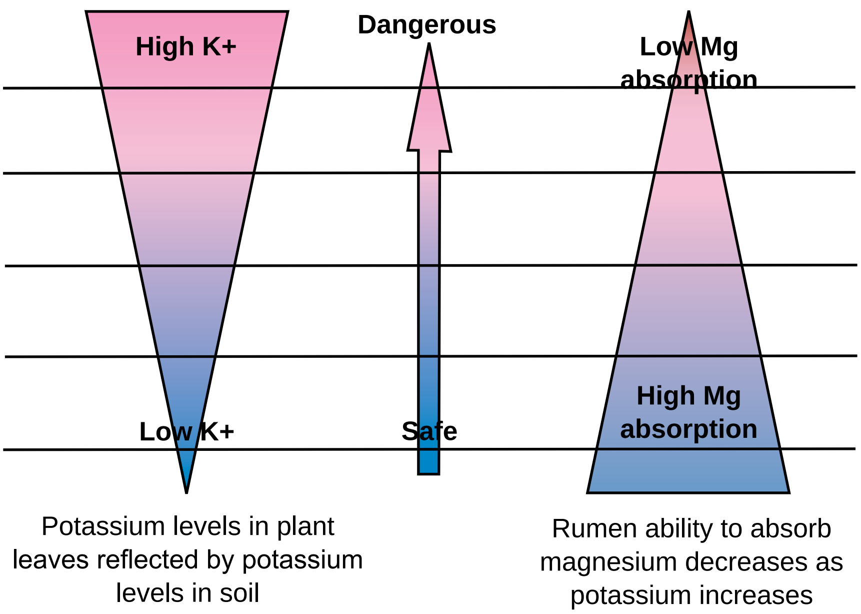
b) Soil tests can be carried out prior to crops/ grasses being grazed and the danger evaluated prior to animals grazing that area.

Your agronomist or farm advisor can assist you with this process or if you are confident that your soil test accurately reflects your current situation you can do this yourself.

Recent tests must always be used as old soil tests may not reflect the current mineral balance.

Table 1. Soil ratio and risk of grass tetany.

*K/Mg + Ca Ratio	Soil Risk
> 0.09	Dangerous
0.08 – 0.09	Hazardous
0.07 – 0.08	Critical
0.06 – 0.07	Marginal
< 0.08	Safe



* Determined by normal soil test

Acknowledgments

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Further information

For further information on grass tetany, see Primefact 420 *Grass tetany in cattle* and Primefact 421 *Grass tetany in cattle – treatment and prevention*

Hypomagnesemic tetany in adult cattle and sheep
http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/80402.htm

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