

Nitrates is a quick killer even on organic farms, so read it all

Nitrates killing grazing animals can be a major problem. Hundreds die from it annually. More occur in the mornings when cloudy, drizzly and animals are hungry.

Early winter, until there is mature pasture, is the worst time, so farmers need to be prepared.

Briefly, some species of algae produce nitrates. Nitrite in water is ten times more toxic to animals than when in feeds, due to the rapid absorption through the rumen wall into the bloodstream. Polluted water containing effluent can contain nitrites. The amount in water can aggravate that in grasses, creating a double whammy, so keep troughs clean.

If you have nitrate measuring equipment use it. If not, Google for Nitrate measuring equipment. There are lots. One will cost less than a dead animal.

Don't let your animals get so hungry that they eat fast, especially in the morning when nitrates are higher. Learn the high nitrate plants like ryegrass and weeds like Amaranthus shown below, Cape weed (Arctotheca calendula), etc.

Automatic milking machines have shown that cows don't like being milked in the early morning, so once a day milking can have another advantage during nitrate periods by milking in the afternoon when pastures and crops have much less nitrates, but on cloudy days there is not much difference.

Watch your animals. Can you imagine seeing 100 of your cows dead in a paddock.

Nitrates are not new. In 1888, 40 from a herd of 120 died.

Animals on any farm can be affected, i.e., organic or low nitrogen users.

There seems to be more deaths from nitrates now than decades ago which could be because less agricultural lime is applied now, so molybdenum levels are lower, also more urea is applied now than in the past. The sulphur in Sulphate of Ammonia (SoA) called Ammonium Sulfate in some countries, reduces the danger of nitrates and is generally a safer and better form of N than urea, and mostly works better over a wider range of conditions, and lasts longer. See Elements > Nitrogen.

Short yellow regrowth and weeds like Cape Weed and Amaranthus, an annual that grows in fertile patches, are the most dangerous. One Waikato cow in a herd of 300 died just inside the gateway which had a lot of Amaranthus. Her paunch contained 100% Amaranthus shown here.

Nitrates are indigestible proteins that increase in plants that have low energy (sugar) levels, more often when sunshine and moisture are lacking. Young fast growing plants as in new pastures have high nitrate levels from the cultivated soil and more so when sunshine, molybdenum and sulphur are lacking and if urea has been applied, especially on an already fertile soil.

Nitrate levels increase when conditions are hot and dry so growth slows, then after rain the rapid growth makes it harder for plants to convert the nitrates into protein fast enough.

In animals acute nitrate poisoning occurs when nitrate is released rapidly from plant material and converted to nitrite in the rumen and then moves too rapidly through the rumen wall into the bloodstream.

Ruminants use nitrates to produce protein. Microbes in the rumen convert nitrates to nitrites and then to ammonia for incorporation into amino acids. An excess of nitrates overloads and weakens the kidneys and liver, then excess ammonia increases in the blood which reduces the blood's ability to carry oxygen, resulting in a faster heart rate and animals gasping for air. Some of the excesses are excreted in the urine sometimes causing pasture burning.

Nitrate toxicity can be confused with Red Water which is also known as brassica poisoning where



urine becomes red, hence the name. Suddenly changing animals' diets to brassicas can bring it on, as can feeding too much without pasture or other safe feeds. Prussic acid and potassium toxicity cause some similar symptoms, but with nitrates the blood is brown.

Deaths are not just from the excessive use of artificial nitrogen. Both high organic soils containing natural nitrogen and an excess of animal manure can be causes.

International Problem

High nitrate levels killing animals is an international occurrence and is not new. In Kansas in November 1888, 40 cattle died from a herd of 120. They had been grazing buffalo grass and were then fed maize stalks that had grown rapidly and been harvested while immature so were bright green.

In Kansas in August 1894 seven died from a herd of twelve after coming off drought affected pasture and then fed drought affected dried maize stalks which were so short that they had no cobs. Note by the months that it is not a seasonal problem.

In both cases the maize was grown in highly fertile soils from animal manure and following dry conditions so there had been no leaching of the high potassium nitrate. In both cases the levels of potassium nitrates were extremely high.

Nitrates has been a concern for years even in the vast ranching areas of Alberta, Canada. A dairy farmer in Australia in June 2007 had 140 cows die and 40 abort because they were allowed to graze a pasture with Capeweed, a high nitrate plant, for too long in the morning. Had the manager grazed it in the afternoon when nitrate levels are two or three times lower, the cows might have been safe. Capeweed is also known as Cape Dandelion (*Actothea*) and grows up to 25 cm high with rosette shaped leaves with a woolly top. Its daisy-type flowers are yellow. Where it is a majority of the pasture, prolonged grazing can cause high nitrates buildup and death.

A farmer in New Zealand had 30 cows die in the 1980s because he allowed them to back graze short yellow regrowth of a grass type forage crop on soil he had not limed so molybdenum was low. I have not mentioned the name of the crop because it was not its fault. No short yellow regrowth of any crop or pasture should be grazed.

Between May and July 2007 at least a hundred died in the Waikato, so how many died around New Zealand and the world, unnecessarily.

An example of a combination several items causing nitrate poisoning was a farmer who planned to take a seed company to court for 10% of his animals dying after grazing their comparatively safe grass type forage crop, when it was all his fault. I acted for the company and visited the farmer 'out of interest' (I was consulting for his brother in the area) and after checking everything explained to him that he would not succeed at court because of a number of things he had or had not done, some of which was in the information he had been given, but admitted he hadn't read.

- The cows went to the crop at 9.30 am hungry after a late milking caused by a power failure and he was interrupted after breakfast so didn't take the cows off the break until 12 noon.

- There was no back fence so they back grazed the short yellow regrowth.

- Cultivation releases N so from pasture there was plenty.

- There was a lot of *Amaranthus* that measured 10,500 ppm (1%) or about ten times the amount present in the crop's leaves which were under 1,000 ppm (0.1%).

- It had been very dry so N in the soil increased because there was no leaching and being dry, not much had been used by the crop. Rain had fallen a few days before causing rapid growth.

- He had rightly cultivated deeply, but had not applied enough lime so molybdenum was very low.

I explained that under cross-examination by a knowledgeable lawyer (who make it their business to become familiar with the topic) he would lose the case, and I made a friend for whom I then consulted.

Symptoms

- Blue mucous membranes and chocolate brown blood - check the veins in the uterus.

- Noisy, rapid and difficult breathing.

- Rapid pulse (150+/min).

- Salivation, bloat, tremors, staggering.

- Below normal body temperature.

- Weakness, coma, death.

- Dead ones show almost no signs of having struggled or moved their legs.

Calves can be born prematurely and die shortly after birth without the dam showing severe signs. Grazing calves can have convulsions and brown blood. Sheep tolerate higher levels better than cattle, but affected lambs have reduced birth weights and difficulty sucking. Pregnant females that survive nitrate poisoning may abort up to two weeks later due to lack of oxygen to the foetus.

Respiratory Fog fever can also occur after an abrupt change of diet from dry pasture to lush green growing pasture. A combination of both high nitrates and Fog is extremely dangerous. If magnesium is low, mild grass tetany can occur, which makes things worse. 25% white clover with the fescue or any grass reduces these problems because it has less K, 50% more Mg (30% in tissue) and 50% more B (30 ppm in tissue), than most grasses.

Nitrate Levels

Animals can consume lethal amounts of high nitrate feed in half an hour, or, if levels are not as high, over several days and gradually suffocate through lack of oxygen. Foetuses can die for the same reason, and abort some time later.

Be careful with the figures read and recommended. I've seen translations from ppm to percent that were incorrect.

Some say that 2,000 ppm (0.2%) nitrates in pasture are safe, but it depends on -

- The height at which the sample was taken (tops have half or less than bases, partly because of the top getting the sunshine) and height to which the animals graze. Some animals will eat leaves only and some will eat more stems.

- The pasture tissue molybdenum level. This should be at least 1.6 with copper 13 for cattle and 9 for sheep. The copper level has no effect on nitrate toxicity, but enough is needed to avoid molybdenum scours.

- The length of time and the quantity animals are fed at the nitrates level concerned.

- The plant. Animals will gorge on some plants and eat others more slowly. Rapid filling of the rumen with high nitrate feed doesn't give the rumen time to cope. Tetraploids (Winter or Annual ryegrasses) are more palatable (cattle prefer them) and grow faster in winter so cause more nitrate problems than Diploids (perennial ryegrasses). New pastures can have up to 7,000 (0.7%) nitrates, but they have to be grazed to prevent clovers from being smothered so measure the nitrate level and if necessary let it get longer then measure it again and graze it on sunny afternoons after the animals have been well fed. Limit the time and feed to 25% of the total and remain with them to move them slowly to safe pasture immediately any nitrate signs are seen.

- If you have nitrate measuring equipment use it. If not, Google for Nitrate measuring equipment. There are lots. One will be cheaper than a dead animal.

- The time on high nitrate pasture and the type of other feed being fed, preferably before grazing the high nitrate pasture.

- The time of day. On sunny days 7 am levels of pastures, crops and weeds are two to three times higher than 4 pm ones.

- The amount of cloud, rain or sun on the three days prior. Animals on a high level of nitrates (in cloud or rain) for a few days will be adversely affected more than ones that have previously had sun. Remember that nitrates poisoning is an accumulating problem.

If animals are changed to high nitrates gradually there are usually fewer problems, but leaving hungry animals in a paddock high in nitrates for too long can be fatal. Too long can be hours or days depending on the levels.

Dangerous Plants

All grasses and grass type forages and brassicas are a risk, as are weeds such as Amaranthus, Canada (Californian) thistle, Johnson grass, Nightshade and Capeweed. If Kikuyu is irrigated high nitrates can occur.

Weeds such as Amaranthus (Redroot) or Pigweed, has toxic nitrate levels of 12,000 ppm (1.2%) at almost all times and can cause severe kidney damage. Sometimes a crop such as Shirohie millet is blamed for adversely affecting animals when it is not the crop, but Amaranthus that kills some within a few hours. Its levels can be 2,000 ppm (0.2%) when 1,000 is too much. If an animal likes Amaranthus and selects it when grazing a crop, it can die within hours while no others are affected (the paunch

contents can reveal this).

Some crops, especially in the flowering stage especially in cloudy conditions are dangerous. Never allow the brassica Pasja to flower before grazing because its nitrate levels increase to dangerous levels when in the reproductive stage. If grazed correctly flowering will not occur, however early spring sown Pasja can shoot to flower and seed quickly if a cold spell makes it think that winter has arrived. Graze it immediately, even if the feed is not required. Pasja, being a brassica is a milk-tainting crop, so graze it after the afternoon milking, and not before any milkings.

The July 1973 issue of the New Zealand Journal of Agriculture Grasslands the new Tama (tetraploid westerwolds) ryegrass was promoted without mention of the increased possibility of nitrate poisoning so deaths occurred.

Drought stressed crops such as maize, if grazed before maturity can kill, especially if rain falls on drought affected plants which then take up nitrates quickly.

Perennial ryegrass, cocksfoot, fescue and white clover are less likely to, but with the increased use of artificial N on high fertility soils, they can be affected to a smaller degree.

Ensiling is method of handling forages high in nitrate because fermentation can reduce the nitrates, but one herd would not eat pasture silage made after poultry manure was applied five weeks prior to harvest.

With oats for hay, harvest it at a more mature stage and cut it a bit higher to harvest less stem.

Almost all feeds can be fed safely if done correctly.

Feeding High Nitrate Feeds

Low nitrate levels of under 0.1% dry matter are generally safe if other conditions mentioned above are adhered to and if adequate nitrate-free water is available.

Levels of 0.1 to 0.15% are safe for non-pregnant animals, however, some animals may go off feed, have a drop in production.

Levels of 0.15 to 0.20% can be fed but the feed should be restricted to 50% of the total ration. Abortions may occur.

Levels of 0.25 to 0.35% in feeds can be fed, but only with feeds to reduce levels in the total ration and fed carefully.

Feeds with levels above 0.35% should not be fed without extreme care and a high percentage of safe feed.

Feeding diets containing moderate levels of nitrate to dairy cows does not change milk protein or fat content. Feed consumption may reduce with a drop in milk production. In one feeding trial done by Farra, (1971) cows placed on a 2% nitrate diet for 16 weeks produced 4 kg/day less milk and lost 20 kg of weight compared to the control animals. The control animals fed a nitrate free diet over the same stage of lactation gained 13 kg of weight.

The bad effects of forages that contain high nitrate levels can be helped with grain and/or safe barley straw or safe forages.

Hay may not help if it has high nitrate levels at the time of harvesting. This can happen if artificial N, animal or poultry manure was applied and/or it was cut in the morning after days of rain and/or cloud. Feeding high nitrate hay on its own has killed animals.

Causes

Usually more than one of the following is required to cause severe problems.

High rates of artificial N, low or high molybdenum, low sulphur, low boron, drought and rain after dry conditions are the most important factors contributing to nitrate increases in plants. Also anything that upsets normal plant growth such as frosts can increase nitrate levels in plants. New pastures are the exception - the faster they grow the more toxic they become, especially hybrid ryegrasses which are very dangerous and kill animals every autumn and winter, and they don't have much if any edible clover. Clovers don't normally have high nitrate levels so when with grasses they lower the nitrate levels.

There seem to be more deaths now than decades ago which could be because less agricultural lime is applied now so molybdenum levels are lower, and more urea is applied now than in the past. The sulphur in Sulphate of Ammonia reduces the danger of nitrates and is generally a safer and better form of N than urea and mostly works better over a wider range of conditions. See Elements > Nitrogen.

The incidence of nitrate toxicity is aggravated by-

- Excess artificial N application especially in autumn after a dry period of no growth when soil N increases, and Ca and S are low.
- Rain and/or warmth after a no-growth period, which always increases N levels.
- Rain because it always adds N, especially if with lightning.
- Fast plant growth.
- Fast growing tetraploids (Winter or Annual ryegrasses) cause more nitrate problems than Diploids (perennial ryegrasses).
- Stressed plants from drought (even maize), hot winds, hail or frost can have higher levels.
- Fast eating by hungry animals is more dangerous.
- A lack of sunshine.
- Low pasture molybdenum - below 0.5 ppm. 1.6 is optimum.
- Molybdenum pasture levels above 4 ppm, especially if pasture sulphur is low.
- Low pasture sulphur levels - below 0.25 ppm.
- Low pasture calcium and phosphorus levels could increase the incidence, because blood levels decrease over time when on nitrate feed.
- Young very fast growing new pastures have the highest nitrates, especially when sunshine, Ca, molybdenum and sulphur are lacking.
- Spraying any hormone or toxin stresses plants. Even spray drift can cause problems.
- Animals eating N fertiliser spills can die fairly quickly.
- Sudden changes to even moderate nitrate plants.
- Morning grazing when nitrates levels are higher, especially when sunshine is lacking.
- Grazing stems.
- Grazing of regrowth stubble, especially if yellow.
- Cold nights or frosts during droughts.
- Extreme heat and dryness causing plant growth to slow so plants can't convert the nitrates taken up from the soil into protein in the plant.
- Harvested plants allowed to heat in the vehicle, because heat converts nitrates to nitrites, which are ten times more toxic.

High nitrate hay and/or silage

If in doubt let the pasture grow longer and harvest it in the afternoon after a few days sunshine. Exclude air quickly and aim for 70% moisture, low pH (<4.4) silage, and test it. If toxic, feed small amounts with safe feed.

Nitrates remain in the plant material so cereal hays can have high levels because they are usually grown in well fertilised cultivated (cultivation releases N) land and harvested when they contain a high level.

Improving Pastures

When diets are fully controlled, as in confinement feeding, the aim is for protein levels of about 18% for dairy cows, which is much lower than that in fast growing pasture, which is about 25% crude protein (N figure times 6.25) in spring and after autumn rains, and can rise to 30%.

Confinement feeding total mixed rations (TMR's) usually include enough soluble carbohydrates (sugars) to digest the protein, pastures sometimes don't. However, balancing grazed feeds by having legumes and mixed grass species, correct length and correct element levels without excessive N, becomes the grazer's TMR.

New Zealand dairy cows have been developed over generations on high protein pastures and can cope with them to a degree.

When soil N levels become too high, pasture becomes less palatable and plant uptake of sugars decreases, which is bad for animal health, resulting in scouring, metabolic problems and low production. On top of this, because the energy level of the pasture decreases, animals don't get sufficient energy to digest the high nitrate (crude protein) content of pasture. In trying to do so the animal uses its fat reserves, causing it to lose inside and outside body condition, produce less, and, if prolonged, become thin and unhealthy.

Effluent paddocks can aggravate this so spread effluent over a larger area and increase lime and apply only the trace elements needed on the effluent areas. Spread animal and poultry manures sparingly over a wide area of poor pastures rather than on fertile pastures.

With the concern about leaching and water pollution, the following should be remembered. Measurements in Britain comparing nitrate leaching from soils showed that clover based pastures not using artificial N, leached only one seventh as much as did soils under pastures getting artificial N. Clovers can aggravate bloat, but New Zealand research has shown that pastures with a high percentage of high N perennial ryegrass can give as much bloat as clover. Some clover pastures hardly blow at all. See Animal Health > Bloat.

Applying too much N from any source (animal and poultry manure included) even six weeks before harvesting for silage or hay can produce a high nitrate feeds that can kill.

It is not safe to recommend an absolutely safe nitrate figure because nitrates are cumulative, so grazing cows fed low nitrate hay first then 0.5% (5,000 ppm) nitrate pasture for half an hour may have no problems, while empty hungry cattle on a pasture with only 0.25% (2,500 ppm) for a longer period may have problems.

Problems can occur after changing from dry summer pasture to fescues that can have high nitrates, also fescue is extremely low in boron (4 ppm - good pasture should have about 20 ppm). Calcium and boron help the uptake of sugars, which as energy help change nitrates to digestible protein. Energy is inversely proportionate to nitrates, i.e., the higher nitrates the lower the energy.

Perennial ryegrass breeders are currently selling and some are developing high sugar varieties. The higher the sugars, the lower the nitrates, but feed them too much N or stress them and nitrate toxicity can still occur.

Prevention

Sunshine (photosynthesis) raises the sugar (energy) content of pasture, so cut hay and silage after a few sunny days and after four or five hours of sunshine. This is not always easy, but could be worth it.

High N pasture, sorghums, cereals and brassicas, need sulphur to reduce the chances of nitrate toxicity. This is another reason why SoA is better for grazed forages than urea, and because sulphur and N work together. If either is low, the other is not as effective. Also in winter SoA is more effective than urea in achieving grass growth.

Molybdenum also helps reduce nitrate toxicity, so should be monitored by pasture mineral analysis and kept at about 1.5 ppm, usually by applying lime. In 1952 it was found that when molybdenum was deficient, nitrate (undigestible toxic protein) levels were higher. Molybdenum is necessary for the conversion of nitrates into amino acids. Molybdenum (Mo) helps counter NT, so if Mo pasture levels are below 0.3 ppm in winter or 0.2 in summer, levels should be increased. Correct liming and/or the use of ground reactive phosphate (RP) containing Mo can maintain Mo levels. It can become too high and once applied can't be removed, so don't apply any before getting a pasture analysis and experienced advice, and apply Sodium Molybdate at 0.15 kg/ha only if liming is unnecessary based on pasture Ca levels, not pH, and/or doesn't increase Mo sufficiently.

Graze just the leaves, not the base.

I repeat, don't apply N to new pastures at sowing or until they show signs of needing it, and still be careful because there can be fertile areas which can kill in less than an hour without artificial N. An animal can selectively graze these.

Watching and removing animals grazing newly sown pastures is important, but the symptoms come on suddenly and the cure is slow, so losses can still occur.

Hay and silage cut with high nitrates retain most of it, especially hay, however, good sweet (high in sugars) hay can be a buffer to animals on high nitrate feeds by feeding it before grazing. The maximum amount in silage to be fed with safe pasture is about 3,000 ppm (0.3%), but if it is fed to cows on high nitrate pasture it could aggravate the nitrate problem. 1,000 ppm (0.1%) is absolutely safe.

Making high nitrate feeds into silage can reduce nitrate concentration by up to one third if the process is done correctly (adequate moisture content to achieve good packing and air exclusion to promote proper fermentation). However, be careful and get it tested before feeding it.

Spread animal manure sparingly over a wide area on poor pastures rather than heavily over a small area of fertile pasture.

Feeding safe hay before and during the change to lush pasture reduces the incidence which is

increased by sudden changes.

Supply SMM in the drinking water to aid digestion. Many soluble minerals are in sulphate form so will have sulphur which helps counter nitrates.

When grazing paddocks for 24 hours, it is best to move the animals in to the paddock in the afternoon. When leaving them in paddocks for several days deaths can occur on even the third day when they are eating the base of pastures where sun has not raised the energy levels. Back grazing of any plant regrowth is about the most dangerous.

Oats is one of the worst crops and can cause deaths within hours, so change to it gradually. and graze in sunny afternoons when sugars are higher.

When sugars are low, digestion is less effective, so where supplements such as magnesium are necessary they are more use if fed in the evening.

Feeding good quality low nitrate (high energy) hay and/or silage before grazing nitrate pastures help, and reduces scouring.

Cultivate and sow within a day or two to beat the weeds, and if necessary mow the tops of toxic weeds if they get higher than the pasture. Do this in the heat of the day because hot pasture doesn't suffer from physical damage as much as when cold.

If nitrate poisoning is suspected, a veterinarian should be contacted immediately and animals handled as quietly as possible - no dogs rushing them off. Feed low nitrate items like barley grain and/or safe hay or safe barley straw immediately in the paddock - you may have only minutes to save some animals.

Water

Some species of algae produce nitrates. Nitrite in water is ten times more toxic to animals than when in feeds due to the rapid absorption through the rumen wall into the bloodstream. Polluted water containing effluent can contain nitrites.

Keep troughs clean.

Treatment

Feeding barley grain and safe hay and/or barley straw in the paddock can help if done soon enough. Affected animals are likely to eat them enthusiastically.

A 4% or 5% solution of methylene blue and saline administered intravenously by a veterinarian aids the oxygen carrying capacity of blood. Levels to be administered are critical so it is not the job for an amateur. Treatment may need to be repeated every six to eight hours as nitrates will continue to be absorbed from the rumen.

The difficulty in saving animals shows how important prevention is - especially when numbers are large because of the physical work involved and the time in getting a vet. Some farmers learn the technique and carry stocks.

Vaughan Jones, ONZM Queen's Honour 2013, for services to the farming industry. NZ M.Mkt.I. Dairying 99% Honours Award 1948. Waikato Most Improved Dairy Farm Award 1959. International Agricultural Consultant & Journalist. Represented NZ in Agricultural Journalist Congresses in USA in 1992 & Austria in 1994. Managing Director of the free GrazingInfo Ltd, compiled since 1970.