SOIL FIRST FARMING

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Nitrogen Notes

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The new fertiliser nitrogen season is now upon us and CF fertilisers are offering some very attractive prices, but is Ammonium Nitrate the best source of plant nitrogen, or could we do better?

Initially, let us look at how plants take up and utilise Nitrogen. Plants can take up nitrogen in the Ammonium (NH4+) and Nitrate (NO3-) forms, but have to convert both of these forms to amide (NH2) to be able to utilise the N in plant growth.

You can see from the chemical formula's that ammonium is much more similar to amide than nitrate is. Consequently it takes considerably more plant energy to convert the nitrate into useable nitrogen than ammonium, 16 % more energy to be precise. This energy demand for nitrate conversion diverts energy away from other plant processes and must reduce the plants overall growth rate and yield potential!

As the plant metabolises ammonium into amide it releases Hydrogen ions back into the soil via the roots for nutrient exchange (cation exchange) with other minerals such as magnesium, potassium, more ammonium and other trace elements. The hydrogen ions exuded by the plant roots have a micro-acidifying effect on the rhizosphere which then allows other minerals to become more plant available as they are reduced into plant available forms. When the plant converts nitrate it releases bicarbonate (HCO3-) into the soil. Bicarbonate is alkaline which then micro-alkalises the rhizosphere and restricts the uptake of many plant nutrients such as; magnesium; manganese & zinc etc. This is particularly important for those farming high pH, calcareous soils.

Ammonium and nitrate both move into the plant via mass flow, i.e. in the soil water. Ammonium can also be exchanged for hydrogen ions, as mentioned above, where the root surface meets with the soil.

Plants ideally need a combination of both ammonium and nitrate for best results.

However the following points need to be considered when making your choice. Ammonium being positively charged will bind to the negatively charged soil at the exchange sites on the clay or organic matter and so uptake of ammonium is controlled by the plant via the process of cation exchange.

Nitrate being negatively charged doesn't bind to the negative sites in the soil so makes it very prone to leaching or soluble in the soil water. If nitrate is present in this soil water and the plant is taking up water due to transpiration then the plant has no control as to how much nitrate it takes in. In this situation the plant will 'store' the nitrate in its leaves, giving them that blue-green colour seen so often in winter wheat crops in April and May. This storage requires more water so the plants expand their leaves to dilute the nitrate. This 'stored' nitrate is then a very attractive food source to fungal disease and pests which also have easier access to this 'food' as the cell walls of the plant have been made thinner as the plant expands its leaves to store the nitrate! This is a further stress to the plant when taking the alkalising effect nitrate has on nutrient availability as discussed above!

Some would say using just ammonium producing fertilisers like urea is irrelevant any way as soil ammonium is broken down in the soil by Nitrosomonas bacteria converting ammonium to nitrite, and then Nitrobacter bacteria converting nitrite to nitrate. These two processes, called nitrification, happen concurrently.

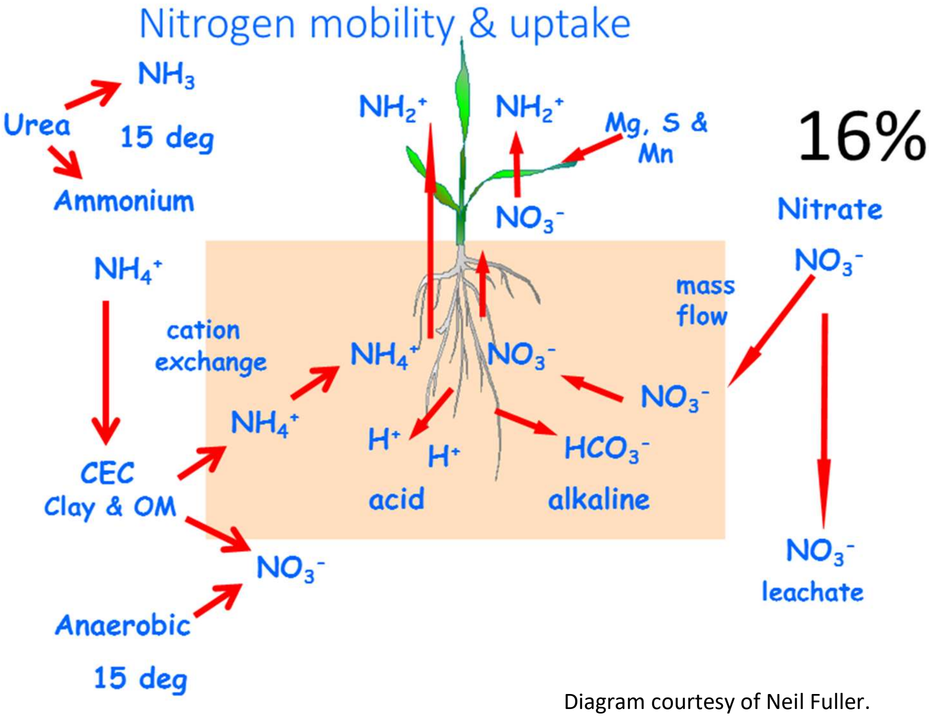

Diagram courtesy of Neil Fuller.

Let's consider the following. Cultivation aerates the soil speeding up the nitrification process. So are you cultivating? No-till crops are always shorter in their growth than tilled crops, expressing the effect of stem elongation or the slowing down of the nitrification process. And like all biological processes they are speeded up by temperature, again no-tilled crops with their potential for residue cover have a much better moderating effect on soil temperatures thus again slowing down this potentially negative process.

What does all this mean in practice, ammonium based or producing fertilisers gives the crop less stress and if applications are timed correctly to match bio-mass growth, this all leads to more efficient nitrogen use by the plant. With the use of urea we hope that the plant will take up more of the available nitrogen as ammonium while allowing for the fact that some will be converted to nitrate, this will allow for a more balanced ammonium/nitrate nutrition.

We need to be careful though, with large single applications of artificial Nitrogen, Large amounts of ammonium can be toxic to sail fauna such as earthworms, which we are trying to promote. Nitrate can be quickly leached or taken up by the crop (see above). Nitrate leaching usually removes calcium from the soil. Unused nitrogen can promote microbial activity which then breaks down the SOM if it has nothing else to digest. A little and often matched to plant requirements is so much better than single large applications.