The Nitrogen Cycle and Trees

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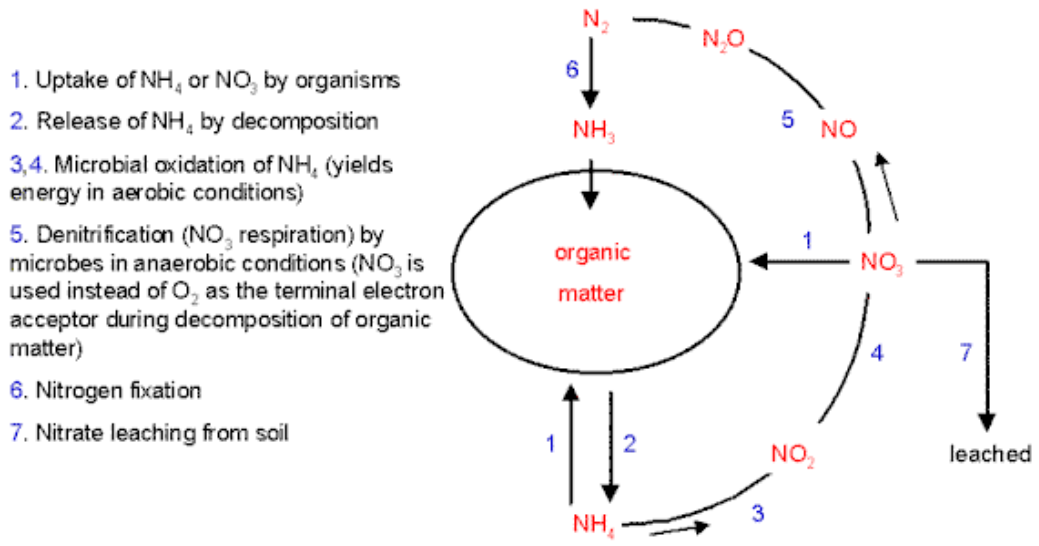
Trees like all living organisms need various nutrients to grow and survive. A tree will obtain these elements from the soil, water, or the atmosphere. Of all of the elements necessary for tree growth the one nutrient that is most often in short supply is nitrogen (N_2). This is because nitrogen, in its elemental form (N_2) is a gas, which makes it unavailable to most plants unless the plant can obtain it from the atmosphere. The two forms of nitrogen available to most plants in the soil and water are nitrate (NO_3) and ammonium (NH_4). The nitrate form of nitrogen is highly soluble in water and will often leach out of the soil before plants have a chance to fully utilize all of it. This form is also somewhat unstable so that nitrogen reverts back to a gaseous state in the atmosphere in a process known as denitrification. Ammonium (NH_4) on the other hand, is more readily available to plants because it is more stable, a plant has to decompose organic matter before it can extract nitrogen through ammonium.

Some plants can take nitrogen right out of the air. These plants are called nitrogen fixers and many of them are from the legume family and they are all characterized by producing seed ponds. Some examples of legumes include black locust, Kentucky coffee tree, soybeans, and clover. Legumes enrich the soil by taking elemental nitrogen from the air then depositing some in the soil in a form that is more available for plants.

Most plants however, have to obtain the nitrogen they use from the soil or water utilizing either the NO3 nitrate or NH_4 ammonium form. Nitrates are most often used in commercial fertilizer because they are readily available to plants and can be used to quickly correct a severe deficiency. The negative aspect of nitrates is that they will often be carried off in water to be deposited in waterways and ultimately in the Chesapeake Bay which contributes to the decline of these water bodies. Ammonium (NH_4) on the other hand is most often extracted from organic matter as it decomposes, so it provides a slow release form of nitrogen which is not easily washed away.



The nitrogen cycle as it pertains to a forest.

Plants oftentimes form mutually beneficial "symbiotic" relationships with small soil borne fungi called mycorrhizae. The mycorrhizae live on the plant's roots and are able to extract ammonium from organic matter to enrich to host plant. It is this breakdown of organic matter that provides most of the nitrogen for woodland inhabiting plants. Allowing leaves, twigs, branches, and fallen trees to accumulate on the forest floor helps provide the organic matter they need to recycle nutrients especially nitrogen in the form of ammonium. Clearing a significant amount of this material from the forest, or removing leaves depletes this important source of nitrogen from the ecosystem. The burning of organic material during a large scale forest fire also results in denitrification as it causes nitrogen to revert back to a gas. Another factor that has been shown to impact nitrogen's availability to plants is the presence of some invasive exotic species in the forest. Recent studies demonstrated how exotics like garlic mustard were able to secrete substances that were poisonous (allopathic) to mycorrhizae. The reduction of mycorrhizae will probably impact the plant's ability to extract ammonium from the decay of organic matter thereby reducing the available nitrogen to the plant.

If nitrogen is lacking in plants what can we do to assure that organisms get the nitrogen they need to grow? One way to do this is allow leaves, and other organic material to accumulate on the forest floor. An average of 2,000 lbs of organic material falls in a deciduous forest each year. Most of this biomass (70%) is leaf litter which contains many of the essential nutrients needed for plant growth. Most leaves will decompose within a year or two while larger woody material will take about 3 -5 years to rot. How often do we rake leaves from our lawn and burn them in piles next to a wooded area? Besides removing a source of nitrogen, this practice might also result in a forest fire if the fire escapes into the woods. Spreading these leaves in the forest will benefit the plant life by providing desirable nutrients and in most cases these leaves will be gone by the end of the summer. Removing invasive exotic species such as garlic mustard might also benefit trees by promoting the survival of beneficial fungi that help trees extract ammonium from organic material.

Leaves, sticks, and other woody debris are removed from lawns which slowly depletes nitrogen from these areas. As such, many of our landscape plants suffer from nutrient deficiencies. Placing wood or leaf mulch around trees will help replenish nitrogen and other nutrients into the soil. Another alternative is to fertilize. If you use the inorganic nitrate form then you should make sure that you add the correct amount so that excess does not leach away and create a pollution problem or burn the host plant. Some commercial fertilizers contain the organic, ammonium form of nitrogen which provides slow release and lessens the chance that you will burn the host plant by over fertilizing.