UNDERSTANDING TURF MANAGEMENT

The seventh in a series by

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SOIL NITROGEN

Although there are some 14 elements required for the growth of grass, *NITROGEN* is the key to successful grass production.

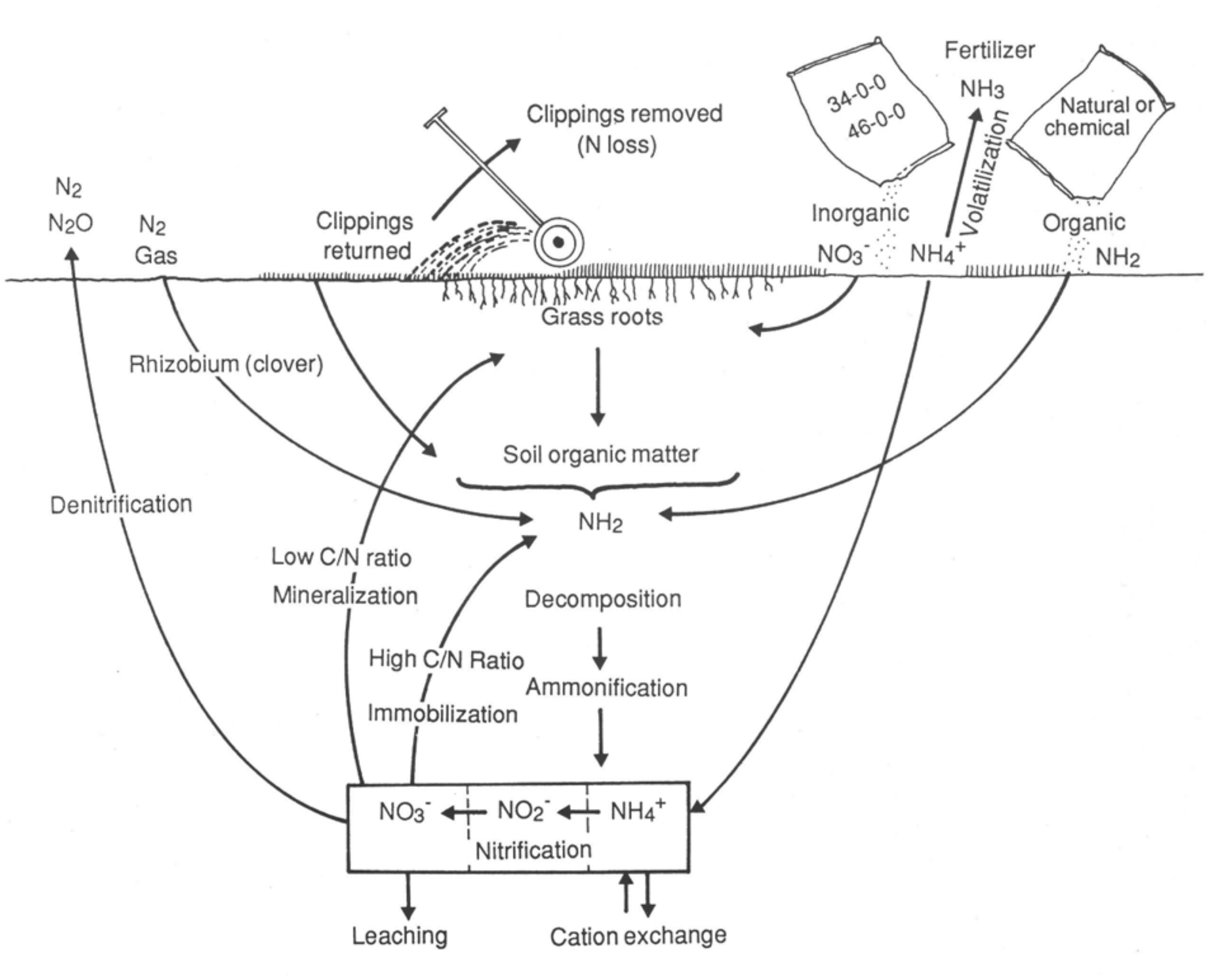
Nitrogen is found in all protein. Proteins are fundamental to life as all enzyme systems contain protein. Protein also functions as a storage of energy, such as in the seeds of some herbaceous plants.

In the practical world nitrogen imparts the desirable green colour to turf, increases the growth rate of leaves, stimulates tiller initiation and improves root regrowth. Although nitrogen is a part of the chlorophyll molecule in grass, improving the nitrogen nutrition may improve colour more by increasing the rate of emergence of new leaf blade than by increasing the chlorophyll content of the leaf.

Excessive nitrogen, however, can be detrimental to turf. A high level of nitrogen may favour leaf development to such a degree that rooting is decreased. Likewise it may depress the storage of root reserves as more of the photosynthate is channelled into protein which will favour new leaf growth. Soluble nitrogen compounds may also accumulate in the leaves, which increases the likelihood of disease by being a ready source of nitrogen for the pathogen. This condition is often referred to as increasing the succulence of the plant.

In the last article of this series it was stated that soil organic matter supplied a major portion of the nitrogen required for turf growth. In fact, any area of turf not receiving nitrogen fertilizer is depending on the release of nitrogen

Fig. 1: *The Nitrogen Cycle:* an illustration of the processes involved in the conversion of organic to mineral forms.



from the organic matter for its growth. In the majority of cases the rate of release is not rapid enough to support a vigorous stand and the stand becomes thin and prone to weed invasion.

The release of nitrogen from organic matter is a dynamic process, dependent on the environmental conditions for the diverse population of microorganisms that live in the soil. Many of these environmental conditions are the same as the conditions which influence the growth of grass; such as temperature, moisture, even the supply of nitrogen.

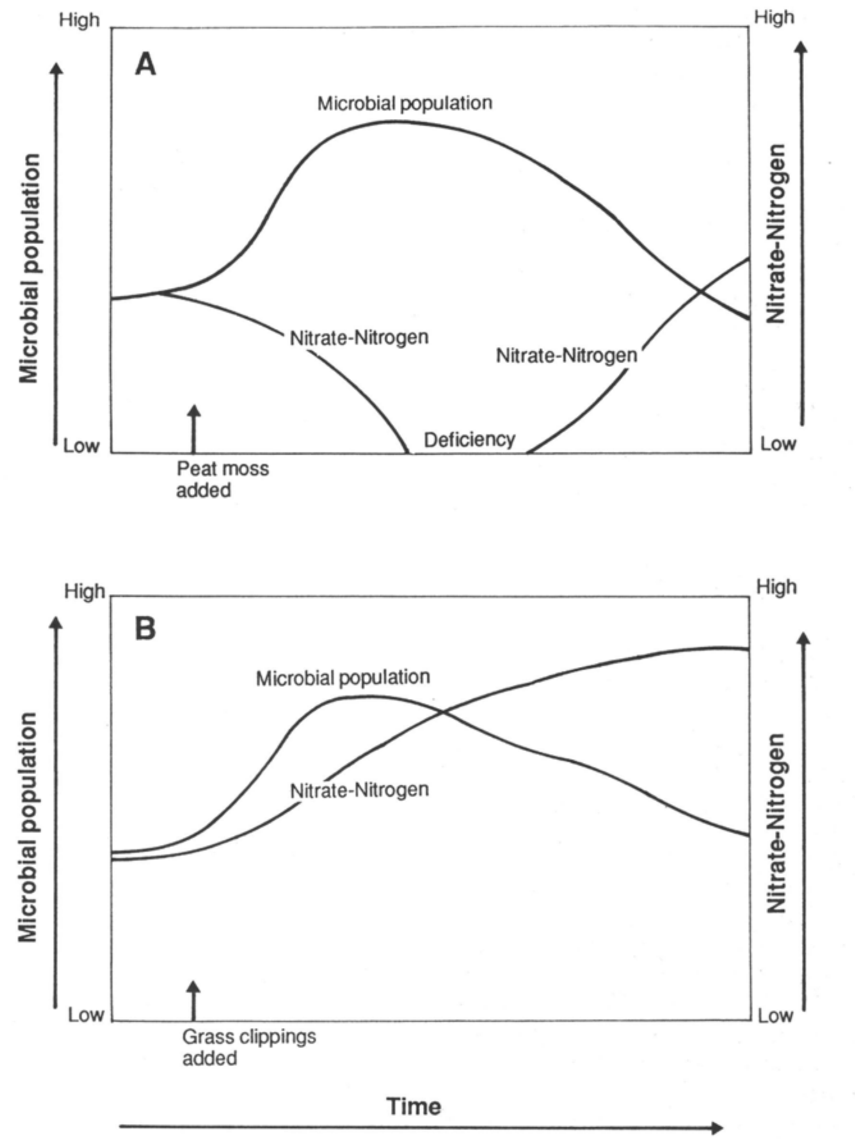
To illustrate the dynamic nature of nitrogen in the soil a diagram known as the *Nitrogen Cycle* is often used (Fig. 1).

Central to the cycle is the soil organic matter. Organic matter contains protein; hence it contains nitrogen. Grass roots can not absorb the nitrogen as protein, therefore it must be converted to a form which the roots will absorb. This form is *nitrate-nitrogen*. The conversion from protein nitrogen to nitrate-nitrogen is carried out by the microbial population which decompose the organic matter, convert the amino-nitrogen of the protein to ammonia-nitrogen, which in turn is converted to nitrate-nitrogen.

An interesting comparison of the plant and animal systems is found in their use of nitrogen. Man must obtain his nitrogen in what the chemist calls the reduced form as protein, either from a plant or an animal source. Nitrate-nitrogen is toxic to man. In contrast a plant can not use protein nitrogen, but must have its nitrogen in the oxidized nitrate or ammonium form. Furthermore the grass plant does not have direct access to the 87% of the atmosphere which is nitrogen. The essential intermediary in these vital conversion is the soil microbe.

The pivotal point in the nitrogen transformations in the soil is the step called *nitrification*. Nitrification is a two-step conversion of ammonia-nitrogen (NH_4^+) to nitrite-nitrogen (NO_2^-) and then to nitrate-nitrogen (NO_3^-). Very low levels of nitrite-nitrogen are found in soils because it is very rapidly converted to nitrate- nitrogen. Two specific bacteria, found in all aerated soils, carry out these conversions.

Fig. 2: The influence of the carbon/nitrogen ratio on the soil microbial population and the availability of nitrogen.



With the exception of nitrate forms such as calcium nitrate, all fertilizer added to the soil must go through this pivotal conversion. Even one half of an ammonium nitrate source of nitrogen, the ammonium, must go through this process to be available for uptake by the grass. The oft stated claim that organic sources of nitrogen are non-chemical and hence superior to 'chemical fertilizers' is not the full truth because the soil microbes must convert the organic material to nitrate-nitrogen before it is of any value to the grass. They do, however, have an advantage of restricting the rate of conversion to nitrate-nitrogen and hence reduce the potential for leaching.

The reliance on microbial conversion imparts the 'slow release' properties on many nitrogen sources. Under favourable conditions of temperature and moisture the conversion of ammonium-nitrogen to nitrate-nitrogen will be complete in 7-10 days. The conversion of ureaform or 'Milorgonite' to nitrate-nitrogen will take weeks or months and may never be complete.

When nitrogen is in the nitrate form it is highly soluble in water and will be carried downward in the percolating ground water. It should be the objective of every turf manager to not add to the amount of percolating ground water by excessive irrigation. Likewise it should be his objective to minimize the amount of excess nitrate-nitrogen that exists in the rooting zone by careful attention to the rate, frequency and form of nitrogen he uses.

When nitrogen is in the ammonium form (NH_4^+) it is known as a cation, a positively charged ion which may be absorbed by the clay and humus in the soil. In this form the nitrogen is not subject to leaching, however, the soil microbes still have the opportunity to convert it to nitrate which will subsequently be absorbed by the grass.

Nitrogen which is in the ammonia form (NH_3), a gas often called anhydrous ammonia, may be lost to the atmosphere by a process called *volatilization.* The loss is only of concern where urea fertilizer is the nitrogen source. The process is intensified where urea is applied to grass in warm, humid weather and the loss can reach values of 12-15% of the applied nitrogen. The conversion may be avoided by application immediately prior to a rain or where irrigation is applied within 24 hours.

Under poorly drained conditions nitrogen may also be lost to the atmosphere through a process called *denitrification.* A group of microbes which flourish in soils devoid of oxygen convert nitrate-nitrogen to elemental nitrogen (N_2) or nitrous oxide (N_2O) which are gases and diffuse to the atmosphere. Thus good drainage contributes significantly to the efficiency of nitrogen use.

Although a grass plant is not capable of using the bountiful supply of nitrogen in the atmosphere, plants known as legumes can. They are plants which have growths, known as nodules, which form on the root and which are the habitat of a special bacteria, Rhizobium. The plant serves as the host for the bacteria and through the symbiotic relationship of providing food to the bacteria, receives a major portion of its nitrogen from the atmosphere. Clovers are a typical legume. When the clover plant dies and becomes part of the organic matter the nitrogen becomes available to the grass through the decomposition and nitrification processes described above. The source is of little value to turf managers as they frequently remove the clover as a weed.

An important factor in grass nitrogen nutrition is the relative amount of carbon and nitrogen in any organic amendments which may be top dressed onto the turf. The relative amount is commonly referred to as the C/N ratio.

In Table 2 of the last article of this series, humus, the stable end product of decomposition, is listed as having a C/N ratio of 10/1. That is, on analysis it will be found to have 10 parts of carbon to every one part of nitrogen. This ratio is approximately the same as found in the microbial cells which break down the organic matter and they are unable to reduce the amount of carbon below the level in their own protoplasm. Whenever the carbon content of the soil is increased above this level microbial activity is also increased because the carbon acts as their food source and they multiply.

When an organic source high in carbon is added to the rooting zone an explosion in the microbial population can occur, if there is sufficient nitrogen available to allow them to generate the protein needed for their cells. When the organic source is low in nitrogen, such as in sphagnum peat, the microbes will absorb the majority of the nitrogen in the rooting zone and the grass will become nitrogen deficient through a process known as immobilization (Fig. 2). The condition is known as induced nitrogen deficiency and will continue until the C/N ratio drops below 20. To speed up recovery or to counteract the deficiency, supplemental nitrogen in an inorganic form should be added.

When a source of organic matter with a low C/N ratio, such as grass clippings, is added a similar explosion in the population may occur (Fig. 2). However, no deficiency of nitrogen is seen in the grass because there is sufficient nitrogen in the clippings to provide the requirements of the microbes without withdrawing any from rooting zone. The process is often referred to as mineralization of nitrogen. As the carbon breaks down and the microbial population returns to normal the extra nitrogen from the clippings returns to the soil, to be utilized by the grass to absorb.

Induced nitrogen deficiency may occur where excessive rates of peat are added to a rooting zone mix during construction in order to generate the required porosity and moisture characteristics in the mix. The nitrogen deficiency may be easily corrected by fertilizer use. As the carbon is converted to carbon dioxide and lost to the atmosphere, however, the space occupied by the organic matter is backfilled with mineral material and the density of the rooting zone will rise. The short term advantage in porosity and moisture characteristics will disappear and compaction becomes a more serious problem.