THE ECOLOGY OF NITROGEN ACTIVITY IN TURF SOILS

by

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Nitrogen is a major constituent of all living things; it is an important part of protoplasm which is essential for biochemical processes in all living plant and animal cells. After entering plant cells, nitrogen combines with organic acids (breakdown products of sugars) to form amino acids, the building blocks of proteins. Some of these amino acids then combine to form proteins and protoplasm. The growth rate of plants is dependent on the production of new protein, which in turn is related to the amount of nitrogen taken into plants by the roots. A cell cannot divide nor increase in size until new proteins are produced.

Nitrogen is the key mineral nutrient in growth and quality control of turf. Having nitrogen available a little before growth conditions are favourable for a given grass, stimulates growth competition to crowd out weeds, and is the best way to keep the sod pure. For example, applying nitrogen liberally to bluegrass lawns during the cool late summer and/or spring stimulates growth and sod thickness. Dense sods then shade out crabgrass seedlings which germinate in late spring and early summer. Liberal fertilisation with nitrogen during the summer months would favour crabgrass encroachment, as crabgrass grows better under high summer temperatures than bluegrass. On the other hand, for summer growing grasses such as zoysia, bermuda, and centipede, most of the nitrogen should be available in late spring to mid-summer, the favourable growing period of these grasses. If nitrogen for summer grasses is applied in the autumn, it will simply encourage growth of weeds and grasses that grow at lower temperatures in autumn when summer grasses stop growing with bentgrass greens. Where *Poa annua* (annual bluegrass) is invading, it is best to use most of the nitrogen in early autumn and early spring, the time when bentgrass grows better than *Poa*. *Poa annua* grows better at lower winter temperatures than bentgrass; thus, it is wise for the available nitrogen to be low in the late fall and late winter in areas where *Poa annua* invades bentgrass.

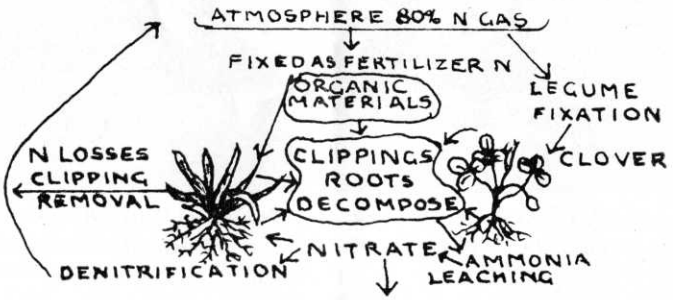

FIGURE 1- THE NITROGEN CYCLE

The Nitrogen Cycle

Nitrogen is needed in greater amounts than any other fertiliser element, yet the

soil is a poor nitrogen storehouse. Turf-grasses absorb nitrogen from soils as ammonia or nitrate, but these nitrogen salts are usually very low in soils. Most of the soil nitrogen is bound in organic matter in various protein stages of decomposition, in plant residues or micro-organisms. The protein nitrogen in organic matter must be oxidised by micro-organisms which release ammonia. Such released ammonia is then absorbed by plant roots or further oxidised and absorbed as nitrate nitrogen.

A simplified chart showing nitrogen "breakdown" as it applies to turf-grasses is shown in Figure 1. It is interesting to note that about 80 per cent of the atmosphere is made up of free nitrogen gas (mostly N_2), but nitrogen gases cannot be used by grasses, except through nodule bacteria on legume roots which can reduce the free nitrogen to ammonia. The change of nitrogen from one form to another, its utilisation by the plant, and its later return to the soil as plant and animal residues is called the nitrogen cycle. Animal and plant residues in various stages of decomposition are also used as sources of nitrogen fertiliser.

Dead roots and shoots, without clipping removal, make much organic matter available for decomposition; the protein nitrogen in plants is released and reuitilised. However, this scheme does not make nitrogen available when plants need it. Decomposition is slow during cool temperatures. Micro-organisms grow fastest when grass growth is also rapid; thus soil microbes "tie up" nitrogen causing a shortage of nitrogen for grasses. Nitrogen is also lost from the nitrogen decomposition cycle in two ways : (1) some nitrogen goes back to the atmosphere as nitrogenous gases, and (2) nitrate is leached out of soils.

The return of clippings is usually not a good source of available nitrogen because of laying on the soil surface where the organic nitrogen compounds are not decomposed into mineral nitrogen. When clippings are removed, more nitrogen fertiliser is needed than when they are returned to the soil.

Form of Nitrogen Fertiliser

The three major forms of fertiliser nitrogen are : (1) Soluble nitrogen fer-

tiliser salts that are immediately available for root absorption, such as ammonium nitrate, sodium nitrate, urea, sulphate of ammonia, and others; (2) Organic nitrogen (plant and/or animal residues), such as sewage sludge, tankage, protein meals, tobacco stems, etc. which must be decomposed by micro-organisms to become available; and (3) Urea-formaldehyde (U-F) nitrogen fertilisers, consisting of urea combined with organic materials to form plastic-like compounds. A little of the nitrogen in U-F is readily available; but most of the nitrogen is made available by decomposition of microbes. In addition to these three forms, quickly available nitrogen, such as urea, is being compounded within long-chain hydrocarbons in pellets to bring about slow nitrogen release.

We have found all of these forms of nitrogen satisfactory for different grasses used on golf course greens and lawns when properly used. Soluble nitrogens ought to be applied every two weeks during the spring and autumn cool season to supply one pound of nitrogen per month or more during the cool season. These soluble sources are utilised quickly so they must be "rationed" to avoid overstimulated growth. Soluble nitrogen should be withheld or used sparingly during the summer months for cool season grasses. With cool season grasses, urea-formaldehydes have given excellent results when applied twice yearly, in late winter and in mid-to-late August. During the first year when U-F nitrogen is used, growth may be a little slow at times; thus, a very light rate of soluble nitrogen (one-fourth to one-half lb./1,000 sq. ft.) may be applied to "perk up" growth.

Organic nitrogens should be applied at monthly intervals for best growth control with little nitrogen used during the summer months. Even though organic nitrogens must be decomposed to release ammonia, they should be rationed to supply enough for 30 to 60 days growth per application.

Soluble nitrogens should be applied when the grass is dry and watered in immediately to avoid burning. The burning effects of quickly available nitrogen may be minimised by using hard pellets; pulverised soluble fertilisers cause more burning than pellets. All nitrogen fertilisers must be thoroughly and evenly distributed; spreaders without deflecting boards cause serious burning in such "row" applications.

When buying nitrogen fertilisers don't look only at the price per sack, consider other factors too; the potential useful nitrogen per sack, how you are going to use it, and what you want it to do for the grass.

Nitrogen and Thatch

Nitrogen must be used to stimulate grass growth to cover injured turf areas, produce dense sods to exclude weedy growth, and to maintain a pleasing uniform foliage colour. It is necessary to manage turf areas much more carefully with liberal nitrogen as compared to low nitrogen fertilisation. Very liberal nitrogen fertilisation stimulates thatchiness.

Nitrogen stimulates top growth (leaves and shoots) that makes beautiful dense turf. Some of the older shoots, leaves, and roots keep dying and are replaced quickly by new growth. The more nitrogen that is available, the greater the amount of growth which results in more dead and decaying plant material. The larger the accumulation of such decaying material, the quicker buildup of thatch (dead to slightly decomposed plant materials). Such accumulating thatch restricts water and air movement into soils; thus, with low soil air (oxygen) and water, the roots get shallow. Thatchiness and shallow rootedness also occur with liberal nitrogen fertilisation because of less oxygen in soils. Nitrogen stimulates formation of many roots with high respiration rates. This causes an accumulation of carbon dioxide and a reduction of soil oxygen ideal for thatch and shallow roots.

Such undesirable thatch occurs on all turf areas; diseases of grasses are also apt to be serious where surface organic matter accumulates. Through judicious and frequent vertical mowing; aerifying; soil top-dressing; light liming; a balanced and controlled fertiliser programme; and proper watering, thatch can be controlled.

(To be continued in February)