CRIMSON PUBLISHERS
Wings to the Research

Environmental Analysis & Ecology Studies

ISSN 2578-0336

Review Article

The Nitrogen Cycle in the Soil, Impact on the Environment

Monica Butnariu*

Banat's University of Agricultural Sciences and Veterinary Medicine, Romania

***Corresponding author:** Monica Butnariu, Department of Chemistry & Biochemistry, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, 300645, Calea Aradului 119, Timis, Romania

Submission: October 12, 2018; **Published:** November 26, 2018

Abstract

Environmental problems caused by nitrogen are generally associated with nitrate movement through drainage water to groundwater. They can reach fountains or surface waters, such as rivers, lakes and estuaries. Nitrate can contaminate drinking water and cause eutrophication and associated problems that may endanger the life of fish and other aquatic species. The amount of nitrate in drainage water depends on the speed of water percolation across the soil and the nitrate concentration in these drainage waters. Precipitation and irrigation rules, along with texture and soil structure, influence leaching. Leaving can also be accentuated by the use of soil conservation systems, which increase the infiltration of water and thereby increase leaching and, at the same time, losses of nitrates. Major losses can arise from the agricultural system where nitrogen inputs are usually in excess of plant and crop consumption. Nitrogen fertilization goes beyond what plants are capable of using and may be a major cause of excessive nitrate percolation. Efficient management of manure from livestock manufacturing facilities is another common case of nitrate contamination of groundwater and surface water. When it is added to the excess application of nitrogen fertilizers, manure can provide this element in much greater quantities than the need for plant consumption, which causes water and atmosphere pollution.

Keywords: Soil, Nitrogen, Environment, Nitrification, Denitrification

Background

Nitrogen is an essential nutrient for plants. It can be found primarily in organic forms in soil and moves into soil and plants mostly in anionic form. Very much money and a great deal of effort have been spent on nitrogen, more than any other mineral. All this for a good reason: global ecosystems are more influenced by deficiencies or excesses of nitrogen than any other essential element. As it moves through the nitrogen cycle, a nitrogen atom can occur in several chemical forms, each with its properties, behavior and consequences for the ecosystem [1]. The cycle explains why vegetation can continue to extract nitrogen from the soil indefinitely without leaving poor soil in this nutrient [2]. The biosphere is not nitrogen-free because it uses the same nitrogen at its endless.

Immobilization and Mineralization

Most of the nitrogen in the soil is found in organic compounds that protect it from washing but makes it unavailable to plants. Much of this nitrogen is found in amine groups ($R\text{-}NH_2$), largely in proteins or as part of humic compounds [3]. When soil microorganisms attack these compounds, simple amine compounds are formed. Then the amine groups are hydrolysed, and the nitrogen is released as ammonium ions (NH_4^+), which can be oxidized to the nitrate form. This enzymatic process called mineralization can be indicated as follows using an amine compound ($R\text{-}NH_2$) as an example of an organic nitrogen source. $R\text{-}NH_2 \leftrightarrow OH^- + R\text{-}OH + NH_4^+ \leftrightarrow 4H^+ + energy + NO_2^- \leftrightarrow energy + NO_3^-$ Many studies have shown that only 1.5-3.5% of organic nitrogen in soil is mineralized annually [4]. Even so, this rate of mineralization provides enough mineral nitrogen for normal growth of natural vegetation in most soils except those with low organic matter content, such as desert soils and sandy areas. Moreover, studies of indicator isotopes in agricultural land that have been fined with synthetic nitrogen fertilizers show that mineralization of nitrogen in the soil constitutes a major part of the nitrogen absorbed by crops. If the organic matter content of the soil is known, an approximation of the amount of nitrogen that could be released by mineralization in a normal vegetation season can be made [5-7].

Immobilization is the opposite of mineralization by the conversion of inorganic ions (NO_3^- and NH_4^+) into organic forms. Immobilization can be achieved by both biological and nonbiological processes, the latter being of considerable importance in forest soils. However, biological processes such as the decomposition of carbonic organic residues by soil microorganisms can require more nitrogen than is contained in the residue itself [6]. The microorganisms then incorporate nitrogen mineral nitrogen in their cellular components as proteins, leaving the NO_3^- and NH_4^+ ion-free soil solution. When organisms die, part of the organic nitrogen in cells can be transformed into forms that make up the humus complex, and the rest can be released as NO_3^- and NH_4^+ ions. Mineralization and immobilization occur simultaneously in the soil irrespective of whether the net effect is an increase or decrease in the available mineral nitrogen depending primarily on the carbon nitrogen ratio in the organic decomposition residues [8,9].

Nitrification

The conversion of ammonium into nitrate is primarily carried out by soil-borne bacteria and other nitrifying bacteria. The first stage of nitrification, ammonium oxidation (NH_4^+), is carried out by the bacteria of the Nitrosomonas species, they convert ammonium into nitrites (NO_2^-). Other bacterial species, such as Nitrobacterial, are responsible for oxidation of nitrates in nitrates (NO_3^-). It is important that nitrites are converted to nitrates because the accumulation of nitrites is toxic to plants [10].

Denitrification

Denitrification is the reduction of the nitrate back into inert gaseous nitrogen (N_2), ending the nitrogen cycle. This process is carried out by bacterial species such as Pseudomonas and Clostridium under anaerobic conditions. They use nitrogen as an electron acceptor instead of oxygen during breathing. These optionally anaerobic bacteria can also live in aerobic conditions [11].

Nonbiological Reactions Affecting the Internal Nitrogen Cycle

Not all soil transformations are mediated by microorganisms, some reactions are chemical by nature. These nonbiological reactions play a prominent role in the internal nitrogen cycle in soils. Chemical reactions of inorganic forms of nitrogen are of three major types:

1. Filling of NH_4^+ on interlame surfaces of mineral clay,

2. NH_3 fixation by the organic soil fraction, which complements the biological immobilization by which the fixed nitrogen is not immediately available to the plants or microorganisms, and

3. NO_2 reaction-with organic constituents, including humic and fulvic acids. Part of NO_2^- is converted into organic and part is lost from the soil through nitrogen-containing gase.

The fate of inorganic forms of nitrogen in the soil, including the absorption by plants, is influenced by the magnitude of these processes, which vary from one soil to another and from one culture to the next [12].

Nitrogen Losses in the Soil

Of all the nutrients required for plant growth, N is by far the most mobile and most likely to be lost through physical, chemical and/or biological processes in the plant soil system. Even under the best circumstances, no more than two-thirds of the nitrogen added as a fertilizer can be considered for plant use or recovered from the soil at the end of the growing season, losses of up to half of the amount applied are not unusual [6]. Numerous attempts have been made to understand low recoveries and it is known that the available forms of mineral nitrogen either added as a fertilizer or produced by the decomposition of organic matter or landfilled waste will not remain in much of the soil for too long. As a general rule, the losses of nitrogen in any given soil occur in several forms, for example a combination of leaching and denitrification for coarse soils of wet and semi-wet areas [3].

Leaching

In contrast to positive-carrying ammonium ions, nitrate ions having a negative charge are not adsorbed by the negatively charged kolies that dominate most soils. That is why nitrate ions move freely, descended, with water draining the soil and are thus easily washed out of the soil. Losses in this manner of nitrogen are of interest for two basic reasons: such a loss is an impoverishment of the ecosystem, whether crops are grown or not, and leaching of nitrates causes serious environmental problems [2,9].

Conclusion

Nitrogen circuit in nature takes place over several stages involving the development of several biochemical activities, some occurring in anaerobiosis and others in the presence of oxygen. These steps are: fixing N_2, ammonification, nitrification, denitrification. Using excessive doses of nitrogen leads to its washing and nitrate enrichment of the groundwater canvas that can be used as drinking water or in the adaptation of animals. Also, the intensive use of chemical fertilizers leads to the increase of soil content in some elements (Zn, Pb, Ni, Cr etc.) which previously were found in soluble forms only as traces. Increasing their concentration over a certain limit, having toxic effects on plants and microorganisms. Due to the energy crisis and the side effects of chemical fertilizers with N, more and more attention is being paid to the natural mechanisms of nitrogen fixation in the soil and especially the biological fixation. By biological fastening processes very high amounts of nitrogen are introduced into the soil. Nitrogen fixative microorganisms possess an enzyme complex called nitrogenase capable of activating the triple bond of the nitrogen molecule, which can thus be reduced to ammonia. The process is carried out at a relatively low temperature of 15-40 °C commonly encountered in soil and at normal atmospheric pressure. Depending on many factors, but especially on the crop, the amount of biologically fixed atmospheric nitrogen varies between very wide limits..

References

1. Coroian A, Miresan V, Cocan D, Raducu C, Longodor AL, et al. (2017) Physical-chemical parameters and the level of heavy metals in cow milk in the Baia Mare area. Banats J Biotechnol 8(16): 69-74.
2. Umeghalu ICE, Okonkwo JC (2016) Comparative evaluation of cumulative biogas yield of yellow yam brute co-digested with cow paunch manure in batch mode. Banats J Biotechnol 7(14): 89-96.
3. Ghasemi E, Kohnehrouz, BB (2016) Cloning the cotton rrn23-rrn5 region for developing a universal interfamily plastidial vector. Banats J Biotechnol 7(14): 81-88.

How to cite this article: Monica B. The Nitrogen Cycle in the Soil, Impact on the Environment. Environ Anal Eco stud. 4(4). EAES.000593. 2018.
DOI: 10.31031/EAES.2018.04.000593

4. Dyakova G, Uzunova K, Mincheva R (2016) Study on the influence of rupestris du lot rootstock on some technological traits of muscat rusenski and super ran bolgar table grape cultivars. Banats J Biotechnol 7(13): 41-48.

5. Zarkani AA (2016) Antimicrobial activity of Hibiscus sabdariffa and Sesbania grandiflora extracts against some G-ve and G+ve strains. Banats J Biotechnol 7(13): 17-23.

6. Olufeagba SO, Okomoda VT, Okache W (2016) Growth performance of all male tilapia (oreochromis niloticus) fed commercial and on–farm compounded diet. Banats J Biotechnol 7(13): 70-76.

7. Alwabr GMA (2016) Prevalence and associated factors of schistosomiasis among primary school children in Al-Mahweet Governorate, Yemen. Banats J Biotechnol 7(13): 24-33.

8. Idris A (2016) Comparative analysis of 16srrna genes of Klebsiella isolated from groundnut and some american type culture collections. Banats J Biotechnol 7(13): 34-40.

9. Zhekova ED (2016) Entomological monitoring in ecological crop rotation. Banats J Biotechnol 7(13): 77-81.

10. Bojkovska K, Angeloska DM, Petkovska MT, Jankulovski N, Petkovska T, et al. (2016) Challenges and perspectives for application of sustainable marketing in order to increase the consumption of organic dairy products in the Republic of Macedonia. Banats J Biotechnol 7(13): 49-60.

11. Peighambarzadeh SZ, Tavana M (2017) Effects of electromagnetic field radiation on biochemical parameters in swiss albino mice. Banats J Biotechnol 8(16): 48-53.

12. Hassan SA, Soleimani T (2016) Improvement of artemisinin production by different biotic elicitors in Artemisia annua by elicitation-infiltration method. Banats J Biotechnol 7(13): 82-94.

How to cite this article: Monica B. The Nitrogen Cycle in the Soil, Impact on the Environment. Environ Anal Eco stud. 4(4). EAES.000593. 2018.
DOI: 10.31031/EAES.2018.04.000593