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Effect of Reactive Nitrogen on Soil Microbiology

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The close interaction of plants with fungi is very old phenomenon. The fossil records provide evidence that the fungi have been symbiotically associated with plants, since 400 million years ago the period when the plants first established on land. Many fungi may evolve their lifestyles as saprophyte-endophyte-pathogens to adapt to various changes in host and environmental conditions. Many of those interactions are beneficial to the host plants and a few are detrimental to life. There may be interconversion of one fungal lifestyle into another while interacting with the plant system; meaning endophyte may become parasite or vice versa. The endophytic stage represents a balanced interaction between fungal virulence and host defense factors. When this balance is disturbed or the host dies, endophytes may become pathogens or saprotrophs, respectively. Saprotrophs and pathogens may switch their lifestyles to endophytes/pathogens and endophytes/saprotrophs, respectively, in the presence of appropriate environmental factors. The physiological, biochemical or molecular studies are the routes to identify the factors that trigger the change in fungal lifestyle, which is entirely different than the earlier one and affects the host plant significantly. The molecular and biochemical basis for the switching of lifestyles from endophytic to parasitic are characterized by an imbalance in nutrient exchange between the plant and fungus. Other factors influencing life style switching in fungus are single gene mutation, light-induced production of H_2O_2 by the fungus, unbalanced interaction with the host etc.

Human activities associated with industrialization, urbanization and agriculture have greatly altered global nitrogen (N) cycle and atmospheric N deposition. Ecosystems worldwide are receiving increasing amounts of reactive nitrogen (N) through anthropogenic activities. Although the effects of increased N inputs on plant communities have been reasonably well studied, few comparable studies have examined impacts on whole soil bacterial communities, though they play critical roles in ecosystem functioning. Nitrogen management in soils has been considered as key to the sustainable use of terrestrial ecosystems and a protection of major ecosystem services. However, the microorganisms driving processes like nitrification, denitrification, N-fixation and mineralization are highly influenced by changing climatic conditions, intensification agriculture and the application of new chemicals Soil biogenic NO emissions account for ~20% of the total NO sources to the atmosphere and vary as a function of microbial activity and physicochemical soil properties. Soil microbial activity is recognized as an important factor affecting nitrogen release from slow-release fertilizers.

Worldwide demand for nitrogen (N) fertilizer is projected to increase at a rate of approximately 1.6 Tg (160,000 metric tons) of N per year, with much of the increase expected to occur in China (18%), India (17%) and Latin America (18%) (FAO, 2015). Production of N fertilizer via the Haber-Bosch process accounts for approximately 45% of global terrestrial N2 fixation annually (Canfield et al., 2010).Recent reporting by the United Nations Food and Agriculture Organization1 indicated that approximately 80% of the total N fertilizer used worldwide in 2014 (113 Tg N) was in the form of urea (FAO, 2017). It is well known that application of N fertilizers is a major source of reactive N in the environment and contributes to several deleterious ecological outcomes. Negative effects include increased greenhouse gas com position of the atmosphere, stratospheric ozone depletion due to nitrous oxide (N2O) emissions, water quality impairment due to nitrate (NO^{3-}) entering ground and surface waters, and various impacts of atmospheric N deposition to terrestrial ecosystem. Nitrogen species which are biologically, photochemically, and radiatively active. Such as nitric oxide (NO), nitrous oxide (N_2O), ammonia (NH_3), and ammonium ion ($NH^+{}_4$). Mainly the intermediate or by-product of different nitrogen cycles. NO is produced and consumed as an intermediate during nitrification and denitrification, respectively. Nitrous oxide (N_2O) is also produced mainly as a by-product of nitrification and as an intermediate product in denitrification is mainly dependent on O_2 availability. Ammonification is carried out by bacteria as well as by actinomycetes and fungi, which help in converting organic-N to inorganic-N. Nitrification is a major source of N_2O production under aerobic conditions. Denitrification is the process which permanently removes reactive nitrogen anaerobic condition, facultative aerobic bacteria and aerobic microorganisms convert NO_3 to N_2, producing N_2O as an intermediate product.

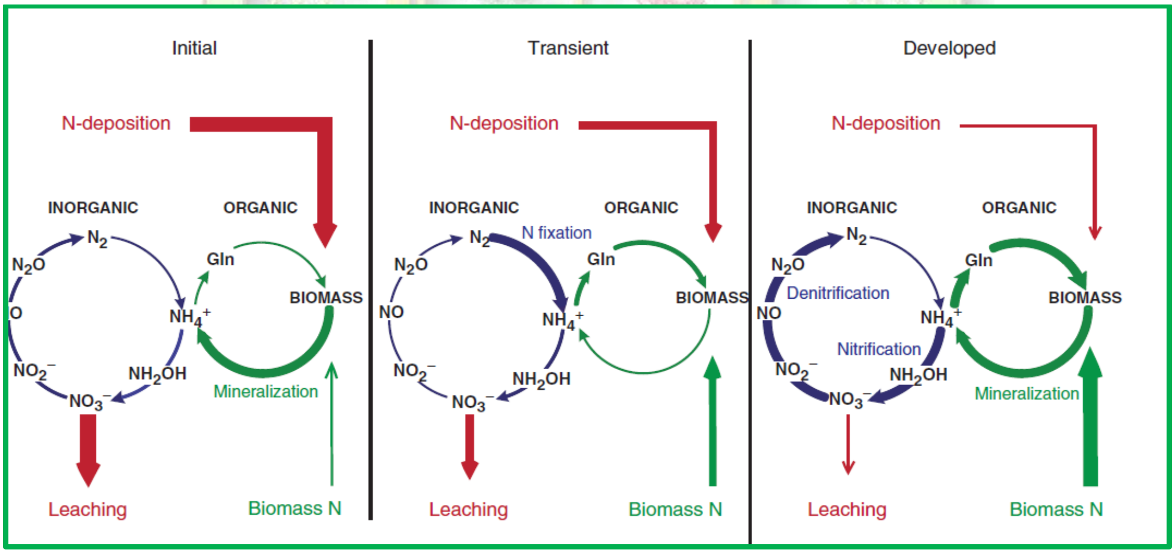

Fig.: Scheme of the development of the nitrogen cycle during ecosystem development

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