Need to estimate the net global warming potential of nitrogenous fertilizers

Opinion

In several developing countries, including India, the production of food grain is mainly dependent on the use of fertilizers, particularly nitrogenous fertilizers which increases by many folds after industrialization and its use will further increase in future to meet the demand of increased food production. Use of fertilizer alters the global nitrogen (N) cycle resulting to decline in total factor productivity and decreased nitrogen use efficiency (NUE). The N cycle is the conversion or transformation of molecular nitrogen (N₂) to other reactive forms and back to its original state. The N cycle is completed in five different steps namely, nitrogen fixation, nitrification, assimilation, ammonification and denitrification. During the nitrogen cycle many oxidised compounds i.e. nitrous oxide (N₂O), oxides of nitrogen (NOₓ), and nitrate (NO₃⁻) and reduced compound i.e. ammonia (NH₃) are emitted into the atmosphere affecting the overall climate system. Being a potent greenhouse gas N₂O is directly contributed to global warming and its concern is greater than the NH₃, NO and NOₓ - nitrate due to its higher global warming potential (GWP) i.e., 310 times of CO₂, high global temperature change potential (GTP) i.e. 290 on 100-year time scale and longer atmospheric life time i.e. about 116 years. In India agriculture is the major contributor with 70% of total N₂O emission and N fertilizer contribute 77% of the total nitrous oxide emission from Indian agricultural soils.

Besides N₂O emission, other oxidized and reduced N compounds (NH₃, NOₓ, NO₃⁻) are also emitted from soils as result of use of N fertilizers which have short- and long-term, direct and indirect impacts on climate system. The emissions from agricultural soils is mainly dominated by NH₃ (about 95%) and NOₓ (about 5%) which results in formation of sulphur (S) containing aerosols having short term cooling impacts. These aerosols also regulate the oxidation capacity of the atmosphere by increasing the concentration hydroxyl radical (OH), which acts as sink for methane (CH₄). Therefore, the emissions of NH₃ and NOₓ have cooling effect on climate system through the process of aerosols formation and alteration of stratospheric ozone (O₃) and methane (CH₄) concentration.

Nitrogen application to agricultural soils affects not only the emission of nitrogenous compounds but it also affects the emission and uptake of carbon dioxide (CO₂) and methane (CH₄) from soils. Application of fertilizers in nitrogen limited agriculture system, usually increases productivity of agricultural crops, by increasing the CO₂ fixation, and it enhanced carbon (C) sequestration in agricultural soils due to increased crop residue production which have cooling impacts on climate system. Soils, particularly aerobic soils are the major sink for atmospheric CH₄ and oxidation of CH₄ by methane oxidizing bacteria (MOB) is the important methane removal process. However, use of fertilizers have inhibitory effects on MOB through ammonium ions (NH₄⁺)³⁰ and nitrate ions (NO₃⁻),⁴² thereby decreasing the total CH₄ uptake.⁴¹,⁴² results into warming impacts on climate system.

There are many studies in which the warming impacts of N₂O emission alone as results of nitrogenous fertilizers use in agriculture is reported. If we consider only N₂O emission there will be over estimation of the warming. To estimate the actual net warming caused by nitrogenous fertilizers use in agriculture the other impacts i.e. indirect N₂O emission from NOₓ - leaching (warming), aerosols formation as results of NH₃ and NOₓ emission (cooling), alteration of atmospheric O₃ and CH₄ (cooling), nitrogen induced carbon sequestration (cooling) and nitrogen induced CH₄ uptake (warming) should be considered which will provide the new dimensions to the climate studies and helps in better management of nitrogenous fertilizers use in agricultural system.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

References


