Opinion

Need to estimate the net global warming potential of nitrogenous fertilizers

Volume 6 Issue 4 - 2017

Fagodiya RK,[1] Pathak H,[2] Meena BL,[1] Meena RK,[3] Nagdev R[4]
[1]Project Coordinating Unit, ICAR-Central Soil Salinity Research Institute, India
[2]ICAR-National Rice Research Institute, India
[3]Agronomy Section, ICAR-National Dairy Research Institute, India
[4]ICAR-National Bureau of Soil Survey and Land Use Planning, RCD, India

Correspondence: Fagodiya RK, Project Coordinating Unit, ICAR-Central Soil Salinity Research Institute, Karnal-132 001, India, Tel 0184-2209348, Email ram.iari4874@gmail.com

Received: February 16, 2017 | **Published:** February 21, 2017

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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 increase 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 (N_2) 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.[1] During the nitrogen cycle many oxidised compounds i.e. nitrous oxide (N_2O), oxides of nitrogen (NO_x), and nitrate (NO_3–) and reduced compound i.e. ammonia (NH_3) are emitted into the atmosphere affecting the overall climate system.[2] Being a potent green house gas N_2O is directly contributed to global warming and its concern is greater than the NH_3, NO_x and NO_3- nitrate due to its higher global warming potential (GWP) i.e., 310 times of CO_2,[3] high global temperature change potential (GTP) i.e. 290 on 100-year time scale[4] and longer atmospheric life time i.e. about 116 years. In India agriculture is the major contributor with 70% of total N_2O emission and N fertilizer, contribute 77% of the total nitrous oxide emission from Indian agricultural soils.[5]

Besides N_2O emission, other oxidized and reduced N compounds (NH_3, NO_x, NO_3-) 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 NH_3 (about 95%) and NO_x (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 (CH_4).[6] Therefore, the emissions of NH_3 and NO_x have cooling effect on climate system through the process of aerosols formation and alteration of stratospheric ozone (O_3) and methane (CH_4) 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 (CO_2) and methane (CH_4) from soils. Application of fertilizers in nitrogen limited agriculture system, usually increases productivity of agricultural crops, by increasing the CO_2 fixation,[7] and it enhanced carbon (C) sequestration in agricultural soils due to increased crop residue production[8] which have cooling impacts on climate system. Soils, particularly aerobic soils are the major sink for atmospheric CH_4 and oxidation of CH_4 by methane oxidizing bacteria (MOB) is the important methane removal process. However, use of fertilizers have inhibitory effects on MOB through ammonium ions (NH_4+)[9] and nitrate ions (NO_3-),[10] thereby decreasing the total CH_4 uptake.[11,12] results into warming impacts on climate system.

There are many studies in which the warming impacts of N_2O emission alone as results of nitrogenous fertilizers use in agriculture is reported. If we consider only N_2O 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 N_2O emission from NO_3- leaching (warming), aerosols formation as results of NH_3 and NO_x emission (cooling), alteration of atmospheric O_3 and CH_4 (cooling), nitrogen induced carbon sequestration (cooling) and nitrogen induced CH_4 uptake (warming) should we 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.

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Citation: Fagodiya RK, Pathak H, Meena BL, et al. Need to estimate the net global warming potential of nitrogenous fertilizers. *Adv Plants Agric Res*. 2017;6(4):99–100. DOI: 10.15406/apar.2017.06.00220