Biospectra : ISSN: 0973-7057, Vol. 17(1), March, 2022, pp. 83-88
An International Biannual Refereed Journal of Life Sciences

17(RA).
Review Article

ISSN : 0973-7057

Int. Database Index: 616 www.mjl.clarivate.com

Excessive use of urea is responsible for nitrogen pollution in India: A systematic review

Naina Srivastava[a] & Nikhil Agnihotri[b]*
[a]Department of Botany, DAV (PG) College, Dehradun, Uttarakhand, India
[b]Faculty of Science, SKJD Degree College, Mangalpur, Kanpur Dehat, U.P., India

Received : 17th January, 2022 ; Revised : 16th February, 2022

Abstract- Urea is the main source of artificial fertilizer in crops in India. Fertilizer sources of emissions to all the processes that cause it to reach the environment and cause pollution. It also includes nitrogen minimization measures which suggest that this can be largely prevented by reducing the use at the source. As per the review of literature, it accounts for 84 percent of the total nitrogen fertilizer produced in the country. The study found that nitrogen fertilizers in India reduced soil carbon by 28 percent of the original amount, while nitrogen, phosphorus, potassium, and organic manure combined reduced farm carbon by 2.9 percent has decreased. The impact of nitrogen pollution on the Himalayan forests and mountains has not been extensively studied. In its lower part lies the Gangetic plain, which is probably the global epicenter of nitrogen air pollution. Excess nitrogen in the atmosphere can produce pollutants such as ammonia and ozone, which can impair the ability to breathe, limit visibility and alter plant growth. When excess nitrogen comes back to earth from the atmosphere, it can harm the health of forests, soils, and waterways.

Key words: Nitrogen pollution, Urea in Agriculture, Chemical fertilizer.

INTRODUCTION

Nitrogen is essential for plants as it restricts nutrients. Plants prepare food from it through chlorophyll and protein synthesis.[1] Naturally, these essential nutrients are present in the soil through diazotroph bacteria. They are present in the roots of plants like pulses. But this natural presence was not sufficient after the Industrial Revolution as it was unable to provide food to the growing population.[2] For this reason, artificial fertilizers were invented to supplement the naturally present nitrogen.[3]

Urea was used throughout the country after the Green Revolution (1965-66) to make the country strong in the field of agriculture. In the initial years, farmers were not duly informed about this area in many areas of the country.[4] Rather, sacks of urea were quietly dumped in the fields at night, when this did not work out, through the sarpanch of the village, the farmers were urged to use urea in their respective fields. From 1966-1967, the government urged all the farmers to use urea but it seemed to us that the loss due to farming would be converted into profit by the use of urea.[5] It happened the same. We were happy with the increase in yield. Although initially, were also afraid that the use of urea might ruin the crop. For the first time in 1967, and when the harvest was ready, we could not believe our eyes. Because for the first time we're seeing that we got three times more wheat yield.[6]

*Corresponding author :
Phone : 9450349602
E-mail : nikhil.azolla@gmail.com

Around 1975, it had become a common practice by farmers in the country to apply three to five times the amount of urea in their respective fields. It is also true that their production was also increasing at the same rate.[7] But there was no program far and wide to give any official information from the government to the farmers in this regard. As a result, the farmer was continuously increasing the use of urea in his fields. Between 1985 and 1995, by adding 125 kg of urea per acre, the yield increased ten to 12 times.[8] From here we started descending. Yields started decreasing in agriculture while we kept increasing the amount of urea year after year. In 1997 we put 175 kg of urea and found what? That's just ten times.[9] That is, now due to increasing urea, the yield of the fields was not increasing but was decreasing.

Yields have been declining steadily since 1995. Indiscriminate use of urea for forty years has left the fields barren.[10] After all, once again the farmers started putting manure of cow dung, etc. in their fields. This did not increase the yield but also reduced the yield. But by 2010, even cow dung manure was not easily available.[11,12] Today's situation is such that farmers are not deterred even by putting 225 to 250 kg of urea in one acre of land. The reason is that in any case, the 12 times the yield of 15-20 years ago is what is needed. Now all the efforts are proving to be in vain.[13]

Ironically, a single farmer has used more than 6,610 kg of urea in five decades. Whereas till now 195.88 million tonnes of urea have been used in the entire country.[14] Now the side effects of nitrogen have started coming to the fore. Nitrogen pollution has been assessed for the first time in India by more than 120 scientists. The objective of this study is to assess the impact of urea use on the nitrogen cycle.

METHODS

This paper has earned the adjective systematic if it is based on a formulated question, identifies relevant studies, appraises their quality, and summarizes the evidence by use of the explicit methodology. It is the explicit and systematic approach that distinguishes systematic reviews from traditional reviews and commentaries. Whenever we use the term *review* in this paper it will mean a *systematic review*. The process is given below:

Step: 1	Framing questions for a review
Step: 2	Identifying relevant work
Step: 3	Assessing the quality of studies
Step: 4	Summarizing the evidence
Step: 5	Interpreting the findings

Inclusion/exclusion criteria: Inclusion criteria for refereed study samples included original research articles published in a research journal. Other articles types such as conference abstracts, communications, commentaries, editorials, brief reports, position, and hypothesis-generating statements were excluded. Non-refereed publications were also excluded. A flowchart of the study screening and selection is presented in Fig. 1.

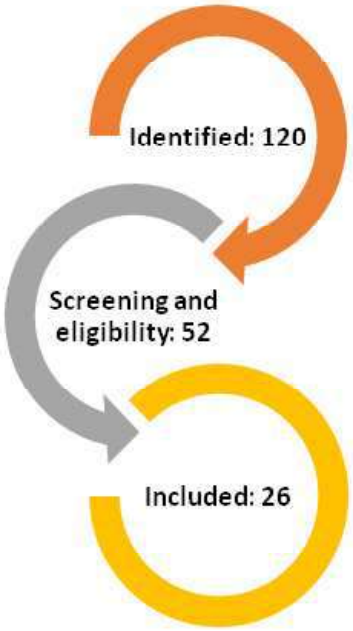

Figure 1: Process of included research articles

After applying searching strategies by using keywords Nitrogen pollution, Urea in Agriculture, and chemical fertilizer and Nitrogen pollution in India, we have found 120 articles. The 52 articles remained after screening for the eligibility check; overall 26 research articles were included in the study.

RESULT

According to Hua *et al.,* (2020)[1] by reducing the use of nitrogen fertilizers and recycling organic manure, Indian farmers have a better chance of producing safe food grains. This will also benefit the government will also save a huge amount of money. Carbon and nitrogen-

saving practices also need a lot of attention at this time. Doing so will help in better nitrogen management and improve soil structure. At the same time, drought resilience, soil erosion, and other climate-related hazards can be reduced." According to him, by adopting these methods, India can lead the world in the field of global nitrogen management. India is already working in this direction through ING, which has published the assessment and leads the South Asian chapter in the International Nitrogen Initiative.[15]

How is India's nitrogen pollution different from the world's?

The contribution of nitrogen pollution sources may vary from country to country. Sources can be from agriculture, domestic and municipal sewage to fossil fuels, automobiles, industries, and stubble fires.[16] The biggest man-made source of nitrogen pollution is unused farm fertilizers, whether organic or chemical in origin. Precision agriculture is unaffordable in India and labor cost is high for the precise use of fertilizers. Therefore, farmers use more fertilizers. But crops are not able to make full use of fertilizers, so they contribute to nitrogen pollution. Most of the pollution comes from cereals, while in other countries such as China, horticulture crops and cash crops contribute the most.[17] In Europe, it is more polluting than fodder, cattle, and animal husbandry. Africa has a negative contribution. This means that due to the non-availability of chemical fertilizers, in sufficient quantity, farmers are exploiting the nitrogen available in the soil, which is reducing the quality of the soil.[18]

According to Brunekreef (2020)[19] "The annual limit for nitrogen was set at 44 teragrams (Tg). He said that the use of nitrogen mainly as a fertilizer is about 150 teragrams per year, which is three times more than the limit of the earth. Artificial nitrogen through fertilizers has exceeded Biological Nitrogen Fixation (BNF) globally. DLN Rao, a member of the Indian Institute of Soil Science and contributing to the assessment, says, "The global ratio of BNF to fertilizer will be around 1.4:1.[20]

Problems due to nitrogen pollution

Reduction in yield:

Yields have been declining steadily since 1995. Indiscriminate use of urea for forty years has left the fields barren. After all, once again the farmers started putting manure of cow dung, etc. in their fields. This did not increase the yield but also reduced the yield. But by 2010, even cow dung manure was not easily available.[21] Today's situation is such that farmers are not deterred even by putting 225 to 250 kg of urea in one acre of land. The reason is that in any case, the 12 times the yield of 15-20 years ago is what is needed. Now all the efforts are proving to be in vain. Recalling the old times, Poddar says that 50 years ago today, the Prime Minister of our country was chirping us to use urea.[22] Today, after five decades when farms are about to be completely exhausted, the present Prime Minister is now appealing to us (in Mann Ki Baat aired on December 26, 2017) to minimize the use of urea.[23] Not only this, but now the government is also reducing the subsidy on urea. 72,438 crore subsidy was earmarked for urea in the 2015-16 budget, which was reduced to Rs 70,000 crore during 2016-17. Poddar gave an estimate and said that in the last 50 years; we used about 6,610 kg of urea in one acre of land and got about 5,337 quintals of yield (wheat and rice).

Nitrogen pollution is dangerous for children:

Nitrates in drinking water can cause a blue baby syndrome in babies up to six months old.[24] The amount of oxygen in the blood of children suffering from this disease decreases because nitrates interfere with the effect of hemoglobin. Hemoglobin is the carrier of oxygen. This can lead to frequent diarrhea in children. It also impedes respiration. It also increases high blood pressure and blood pressure in school children.[25]

Potassium deficiency in food:

Excessive use of urea reduces the amount of potassium in food grains. Along with controlling high blood pressure, potassium also keeps the heart-healthy. He says that the rapid increase in the number of blood pressure and heart patients across the country is a result of the Green Revolution.[26] He says that this revolution increased the production of wheat and paddy beyond expectation but the pulses sector was badly affected by it. Whereas, in the country it is a major source of protein. Due to its deficiency, malnutrition has become a serious problem in Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, and Odisha. The number of tuberculosis patients is also increasing due to malnutrition.[27]

Warming effects of nitrogen pollution:

Nitrous oxide is released in large amounts each year and has a positive radiative forcing, i.e. its molecules store thermal radiation from the sun, thus contributing directly to the warming of the atmosphere. Per unit of weight,

nitrous oxide is a more powerful GHG than CO_2. Galloway *et al.,* (2008)[28] calculate that over 100 years, nitrous oxide has a global warming potential 296 times larger than an equal mass of CO_2. Estimates vary as to how much nitrous oxide is released by the EU each year.[13] The United Nations Framework Convention on Climate Change estimates 819 gigagrams (Gg) per year, but this figure does not include emissions from EU Rivers, continental shelf, and estuaries, nor indirect emissions following nitrogen deposition and leaching. These indirect emissions of nitrous oxide have themselves been estimated at 71.1 gigagrams (Gg) and 34.6 Gg per year.[24]

Reactive nitrogen and its impact on methane from livestock Livestock:

Such as cattle emit methane from the methanogenic microbes that live in their digestive systems. With globally increasing demands for meat and dairy produce, methane emissions from livestock have been increasing.[26] Different livestock systems and animals emit different quantities of methane. The rearing of pigs, poultry, and dairy cattle emit the most methane, as they require large amounts of reactive nitrogen used as fertilizer to grow feed for the animals. These intensive forms of livestock production emit more methane than the rearing of cattle and sheep for meat production. Cattle and sheep tend to graze grass, and although pastures are often fertilized, this is not as nitrogen intensive as growing food crops, such as maize and soy, and feed does not need to be transported.[29]

Reactive nitrogen, tropospheric ozone, and carbon sequestration:

Nitrogen contributes to the formation of tropospheric ozone. This affects the carbon cycle, as tropospheric ozone impedes photosynthesis and thus reduces carbon sequestration. Galloway (2008)[28] raises this possibility and draws attention to uncertainties in how tropical ecosystems will respond to rising reactive nitrogen inputs, as most research has been undertaken in northern latitudes.[30] This is an important question given that tropical ecosystems are expected to receive 'the most dramatic increases in reactive nitrogen in the future, and are already under pressure from a warming climate.[23]

Measures to reduce:

Based on its analysis, SCN recommends that India formulate such policies to increase its NUE. By doing this, the impact of nitrogen pollution on the environment, human health, and climate change can be reduced .[31] This can be significantly reduced by controlling the use of nitrogen. This will reduce the burden of subsidies given by the Government of India on fertilizers.[8]

After the liberalization of the economy in 1991, the government took control of other fertilizers, but urea, which contains the most nitrogen, is still being controlled completely. In other words, the government controls its production, import, and distribution.[32] The government also gives a subsidy to the farmers to buy urea. It is cheaper than other fertilizers, so farmers use it freely. The result is that the soil is deprived of other nutrients and this harms its health.[9]

The valuation found that based on the expected selling price of US$78.8 per tonne of nitrogen fertilizer, the cash subsidy amounts to around US$7 billion. This puts a heavy burden on the taxpayers of the country. Scientists estimate that India uses nitrogen worth about US$ 10 billion every year.[33] Whereas the impact of nitrogen pollution on health, ecology, and climate is as much as US$75 billion per year. They have also found that if the NUE is improved by 20 percent, there will be a profit of about US$ 170 billion every year globally.

CONCLUSION

Food production in India is not growing in the same proportion as fertilizers are being consumed. The contribution of nitrogen to grain production has decreased over the past two decades. Irrespective of other factors, increasing the use of fertilizers will only be seen in the form of low productivity of crops. The environment will also have to pay a price for this. Irrigated areas where many crops are grown in a year need a logical balance on the unbalanced use of nitrogen fertilizers. Ensure that only as much fertilizer is used in all areas as is necessary, even if the use of fertilizers has to be increased slightly in monsoon-dependent lands. Most importantly, need to curb non-agricultural sources of nitrogen which are increasing pollution at a very fast rate. The Government of India has inadvertently taken steps in the right direction by promoting neem-coated urea. This can reduce the crisis. Neem-coated urea releases nitrogen at a slow rate and gives the plants time to absorb it. It makes maximum use of nitrogen. Looking at the size of India, it can be said that Indian emissions are much less than America and China, but still, it contributes a lot to the world.

REFERENCES

1. **Hua, W., Luo, P., An, N., Cai, F., Zhang, S., Chen, K., Yang, J., & Han, X. 2020.** Manure application increased crop yields by promoting nitrogen use efficiency in the soils of 40-year soybean-maize rotation. *Scientific Reports*. **10(1):** 14882.
2. **Kumar, I; Gautam, M. 2021.** Correlation between Individual Dietary Diversity Score and Nutrients Adequacy Ratio in the Rural Community. *SPR*. **1(4):**258–263.
3. **Agnihotri, N and Singh, A. K. 2021.** Impact of Lockdown on Environment. *Advance Plant Science*. **1(12):**24-29
4. **Misra, P., Takigawa, M., Khatri, P., Dhaka, S. K., Dimri, A. P., Yamaji, K., Kajino, M., Takeuchi, W., Imasu, R., Nitta, K., Patra, P. K., & Hayashida, S. 2021.** Nitrogen oxides concentration and emission change detection during COVID-19 restrictions in North India. *Scientific Reports*. **11(1):** 9800.
5. **Chakraborty, P., Jayachandran, S., Padalkar, P., Sitlhou, L., Chakraborty, S., Kar, R., Bhaumik, S., & Srivastava, M. 2020.** Exposure to Nitrogen Dioxide (NO_2) from Vehicular Emission Could Increase the COVID-19 Pandemic Fatality in India: A Perspective. *Bulletin of Environmental Contamination and Toxicology*. **105(2):** 198–204.
6. **Kumar, I., Gautam M. 2022.** Determinants of Dietary Diversity Score for the Rural Households of Uttar Pradesh State. *Int J Food Nutr Diet*. **10(1):**9-16.
7. **Balamadeswaran, P., Karthik, J., Ramakrishnan, R., & Bharath, K. M. 2021.** Impact of COVID-19 outbreak on tropospheric NO_2 pollution assessed using Satellite-ground perspectives observations in India. *Modeling Earth Systems & Environment*, 1-11.
8. **Agnihotri, N. 2022.** Utility of Self-Grown Medicinal Plants as Traditional Remedy In Farrukhabad District. *European Journal of Agricultural and Rural Education* (*EJARE*). **3(2):** 79-86.
9. **Aneja, V. P., Agarwal, A., Roelle, P. A., Phillips, S. B., Tong, Q., Watkins, N., &Yablonsky, R. 2021.** Measurements and analysis of criteria pollutants in New Delhi, India. *Environment International*. **27(1):** 35-42.
10. **Agnihotri, N., Sharma, T.K. and Sippy, D. 2020.** Population Growth Food Security Biodiversity and Covid-19. *The Biobrio*. **7(3-4):**503-508
11. **Ahada, C., & Suthar, S. 2018.** Groundwater nitrate contamination and associated human health risk assessment in southern districts of Punjab, India. *Environmental Science and Pollution Research International*. **25(25):** 25336–25347.
12. **Kumar, I., Gautam, M., Srivastava, D., Yadav, R. 2019.** Assess the Diet Diversity Score along with the availability of food variety for a rural household in the Banda and Kannauj districts of Uttar Pradesh. *American International Journal of Research in Formal, Applied & Natural Sciences.* **25(1):** 14-18.
13. **Shehzad, K., Sarfraz, M., & Shah, S. 2020.** The impact of COVID-19 as a necessary evil on air pollution in India during the lockdown. *Environmental Pollution* (*Barking, Essex : 1987*), **266(Pt1):** 115080.
14. **Guha, T., Gopal, G., Mukherjee, A., & Kundu, R. 2022.** Fe_3O_4-urea nanocomposites as a novel nitrogen fertilizer for improving nutrient utilization efficiency and reducing environmental pollution. *Environmental Pollution* (*Barking, Essex : 1987*), **292(Pt A):** 118301.
15. **Ibrahim, K. A., Naz, M. Y., Shukrullah, S., Sulaiman, S. A., Ghaffar, A., & AbdEl-Salam, N. M. 2020.** Nitrogen Pollution Impact and Remediation through Low Cost Starch Based Biodegradable polymers. *Scientific Reports*. **10(1):** 5927.
16. **Guo, J., Fan, J., Zhang, F., Yan, S., Zheng, J., Wu, Y., Li, J., Wang, Y., Sun, X., Liu, X., Xiang, Y., & Li, Z. 2021.** Blending urea and slow-release nitrogen fertilizer increases dryland maize yield and nitrogen use efficiency while mitigating ammonia volatilization. *The Science of the Total Environment.* **790:**148058.
17. **Campos, O. R., Mattiello, E. M., Cantarutti, R. B., &Vergütz, L. 2018.** Nitrogen release from urea with different coatings. *Journal of the Science of Food and Agriculture*. **98(2):** 775–780.
18. **Zhou, L., Zhao, P., Chi, Y., Wang, D., Wang, P., Liu, N., Cai, D., Wu, Z., & Zhong, N. 2017.** Controlling the Hydrolysis and Loss of Nitrogen Fertilizer (Urea) by using a Nanocomposite Favors Plant Growth. *ChemSus Chem*. **10(9):** 2068–2079.

19. **Brunekreef, B., & Holgate, S. T. 2020.** Air pollution and health. *Lancet* (London, England), **360(9341):** 1233–1242.

20. **Yang, B. Y., Qian, Z., Howard, S. W., Vaughn, M. G., Fan, S. J., Liu, K. K., & Dong, G. H. 2018.** Global association between ambient air pollution and blood pressure: A systematic review and meta-analysis. *Environmental Pollution* (Barking, Essex: 1987), **235:** 576–588.

21. **Aaron, C. P., Hoffman, E. A., Kawut, S. M., Austin, J., Budoff, M., Michos, E. D., Hinckley Stukovsky, K., Sack, C., Szpiro, A. A., Watson, K. D., Kaufman, J. D., & Barr, R. G. 2019.** Ambient air pollution and pulmonary vascular volume on computed tomography: the MESA Air Pollution and Lung cohort studies. *The European Respiratory Journal*, **53(6):** 1802116.

22. **Dechorgnat, J., Francis, K. L., Dhugga, K. S., Rafalski, J. A., Tyerman, S. D., & Kaiser, B. N. 2018**. Root Ideotype Influences Nitrogen Transport and Assimilation in Maize. *Frontiers in Plant Scien*. **9:** 531.

23. **Harty, M. A., Forrestal, P. J., Watson, C. J., McGeough, K. L., Carolan, R., Elliot, C., Krol, D., Laughlin, R. J., Richards, K. G., & Lanigan, G. J. 2018.** Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations. *The Science of the Total Environment*, 563-564, 576–586.

24. **Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. 2020.** Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in Public Health*, **8:**14.

25. **Ward, M. H., Jones, R. R., Brender, J. D., de Kok, T. M., Weyer, P. J., Nolan, B. T., Villanueva, C. M., & van Breda, S. G. 2018.** Drinking Water Nitrate and Human Health: An Updated Review. *International Journal of Environmental Research and Public Health*. **15(7):**1557.

26. **Atkinson, R. W., Butland, B. K., Anderson, H. R., & Maynard, R. L. 2018.** Long-term Concentrations of Nitrogen Dioxide and Mortality: A Meta-analysis of Cohort Studies. *Epidemiology* (Cambridge, Mass.), **29(4):** 460–472.

27. **Ritz, B., Hoffmann, B., & Peters, A. 2019.** The Effects of Fine Dust, Ozone, and Nitrogen Dioxide on Health. *Deutsches Arzteblatt Inte.* **51-52:** 881–886.

28. **Galloway, J.N., Townsend, A.R., Erisman, J.W., Bekunda, M., Cai, Z., Freney, J.R., Martinelli, L.A., Seitzinger, S.P. and Sutton, M.A., 2008.** Transformation of the nitrogen cycle: recent trends, questions, and potential solutions. *Science*, **320(5878):** 889-892.

29. **Sun, Y., Gu, B., van Grinsven, H., Reis, S., Lam, S. K., Zhang, X., Chen, Y., Zhou, F., Zhang, L., Wang, R., Chen, D., & Xu, J. 2021.** The Warming Climate Aggravates Atmospheric Nitrogen Pollution in Australia. Research (Washington, D.C.) 9804583.

30. **Agnihotri, N. 2018.** Effect of Pollution on Human and Environment. *Trends in Biosciences.* **11(25):**3411-3417

31. **Agnihotri, N. 2019.** Hazards of Chromium Pollution and It's Prevention. *Bulletin of Environment Pharmacy & Life Sciences.* **8(8):**1-5

32. **Nasrin, M., Bauer, S., & Arman, M. 2019.** Dataset on measuring perception about fertilizer subsidy policy and factors behind differential farm level fertilizer usage in Bangladesh. *Data in brief*. **22:**851–858.

33. **Kishore, A., Alvi, M., & Krupnik, T. J. 2021.** Development of balanced nutrient management innovations in South Asia: Perspectives from Bangladesh, India, Nepal, and Sri Lanka. *Global Food Security*. **28:**100464.

***