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Impacts of Excessive Nitrogenous Fertilizer Use

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Impacts of Excessive Nitrogenous Fertilizer Use

More nitrogen fertilizer sounds like more growth. **Past a point, it brings acid soil, leached nitrate and fewer helpful microbes.**



Urea, India's most widely used nitrogenous fertilizer, photographed in Kolkata. Photo by Biswarup Ganguly, CC BY 3.0, via Wikimedia Commons.

At a Glance

Four facts to hold on to.

01
Real impacts

Soil acidification and nitrate leaching.

02
False claim

More nitrogen-fixing microbes.

03
Why

Fixing is most useful when soil nitrogen is scarce.

04
Downstream

Algal blooms and eutrophication.

NitrificationMicrobes convert ammonium to nitrate. This releases hydrogen ions.
LeachingWater carries a dissolved nutrient down through soil.
RhizobiumA bacterium that fixes nitrogen for legume roots.
EutrophicationNutrient overload that fuels algal blooms in water.

What Excess Nitrogen Fertilizer Does

Must Know

Not more microbes, and acid soil

- Excess nitrogen does **not** make plants rely more on nitrogen-fixing microbes.
- When soil nitrogen is plentiful, biological nitrogen fixation can **fall**. This is clearest in the plant-Rhizobium partnership.
- Microbe numbers differ from their activity. Counts of some microbes can vary with soil, treatment and time.
- Nitrification turns ammonium into nitrate and releases hydrogen ions.
- Over time this makes the soil more acidic.

Nitrate leaches away

- Nitrate dissolves easily in water.
- It does not bind well to soil particles.
- So extra nitrate leaches down into groundwater.
- Only two of the three classic claims are real: acidification and leaching.
- Source: US EPA on agriculture and nutrient pollution.

> **Quick check 1.** Heavy nitrogen fertilizer makes plants rely more on nitrogen-fixing microorganisms. *(True or False?)* See answer ↓

Why Nitrogen-Fixers Decline

Good to Know

Rhizobium needs scarcity

- Plants partner with Rhizobium to solve a shortage of usable nitrogen.
- The bacteria fix nitrogen. The plant feeds them sugars.

- Cheap fertilizer ends the shortage. The plant stops paying for the partnership.
- So the bacteria decline.

A downstream health risk

- Nitrate in drinking water is a recognised health concern.
- Infants are the main worry.
- Source: WHO drinking-water guidance.

> **Quick check 2.** The plant-Rhizobium nitrogen-fixing partnership matters most when soil nitrogen is scarce, not abundant. *(True or False?)* See answer ↓

Exam Edge

Previous Year Questions

UPSC asked about nitrogen twice.

Asked before

PYQ 1 · UPSC CSP 2019, Q41

Consider the following statements:

(a) 1 and 3 only
(b) 2 and 3 only
(c) 2 only
(d) 1, 2 and 3

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Quick check 3. UPSC's 2015 question confirmed that excess nitrogen fertilizer genuinely increases nitrogen-fixing microorganisms. *(True or False?)* See answer ↓

The Bigger Picture

Great to Know

Eutrophication, and India's subsidy problem

- Nitrate reaching rivers and lakes can trigger algal blooms.
- This is eutrophication, a related effect of runoff.
- Cheap, subsidised urea has long encouraged over-application in India.

- Nitrogen leaves farms in other forms too. Soils release nitrogen oxides, and cattle urine breaks down into ammonia.
- Urea from urine meets the enzyme urease in dung and releases ammonia gas.
- Read about policy in the Green Revolution and crop policy.

Exam traps

- Excess nitrogen can reduce nitrogen fixation. It does not make plants need fixers more.
- Nitrate leaches. It binds poorly to soil.
- Nitrification acidifies soil.
- All three sources in UPSC 2019 were correct.

> **Think it through: why can excess nitrogen reduce nitrogen fixation instead of boosting it?**
>
> Rhizobium exists because usable nitrogen is scarce. The plant pays the bacteria with sugars for nitrogen. Once fertilizer floods the soil, the plant can absorb nitrogen directly. It can scale back the partnership, so less nitrogen is fixed. How many bacteria remain depends on soil, treatment and time. The trap works because intuition says more nitrogen should help them.

> **Quick check 4.** Nitrate reaching rivers and lakes can trigger algal blooms, a downstream consequence of nitrogen runoff. *(True or False?)* See answer ↓

Quick check 5. India's heavily subsidised urea pricing has discouraged farmers from over-applying nitrogen fertilizer. *(True or False?)* See answer ↓

Quick Q&A

Does excess N boost nitrogen fixation?

Not usually. It can reduce it.

What acidifies the soil?

Nitrification.

Why does nitrate leach?

It dissolves easily and binds poorly.

What do cattle release?

Ammonia.

What does nitrate runoff cause?

Algal blooms.

Practice: Excess Nitrogenous Fertilizer

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Practice MCQs

1. Which claimed impact of excessive nitrogenous fertilizer use is actually FALSE?

A. It can do both of the above

B. It increases nitrogen-fixing microorganisms in soil

C. It increases soil acidity

D. It causes nitrate leaching to groundwater

See answer ↓

2. What process causes soil acidification from nitrogenous fertilizer?

A. Potassium depletion from repeated cropping

B. Nitrification releasing hydrogen ions

C. UV exposure breaking down the soil

D. Direct acid content in the fertilizer

See answer ↓

3. Why does nitrate leach easily into groundwater after fertilizer application?

A. It converts into nitrogen gas immediately

B. It is highly soluble and does not bind well to soil

C. It evaporates quickly into the air

D. It binds tightly to clay particles

See answer ↓

4. Why do nitrogen-fixing bacteria like Rhizobium decline under heavy nitrogen fertilization?

A. Fertilizer chemically destroys the bacteria

B. Plants stop relying on them once soil nitrogen is abundant

C. They die from excess soil oxygen

D. They migrate to deeper, cooler soil layers

See answer ↓

5. What downstream water-body problem can nitrate runoff from over-fertilized fields cause?

A. Ozone layer depletion

B. Algal blooms and eutrophication

C. Coral bleaching

D. Acid rain formation

See answer ↓

6. Consider the following statements:

1. Agricultural soils release nitrogen oxides into the environment.

2. Cattle release ammonia into the environment.

3. Poultry industry releases reactive nitrogen compounds into the environment.

Which of these are correct?

A. 1 and 3 only

B. 2 and 3 only

C. 2 only

D. 1, 2 and 3

See answer ↓

7. How does cattle urine and dung actually release ammonia into the environment?

A. Cattle exhale ammonia directly through respiration

B. Ammonia only forms from cattle feed additives, not waste

C. Cattle do not release ammonia; only poultry does

D. Urea in cattle urine mixes with the enzyme urease in dung and rapidly breaks down into ammonia gas

See answer ↓

Answer Key

1. **B.** Excess nitrogen fertilizer does not increase nitrogen-fixing microorganisms. It suppresses them, since plants stop relying on them when soil nitrogen is abundant. ↑ Q1
2. **B.** Nitrification, the conversion of ammonium to nitrate, releases hydrogen ions that genuinely increase soil acidity over time. ↑ Q2
3. **B.** Nitrate is highly soluble in water and does not bind easily to soil particles, letting it leach down into groundwater. ↑ Q3
4. **B.** Rhizobium and similar bacteria thrive when soil nitrogen is scarce. Abundant synthetic nitrogen removes their evolutionary advantage, so their populations decline. ↑ Q4
5. **B.** Nitrate reaching rivers and lakes can trigger algal blooms and eutrophication, a separate but related consequence of nitrogen runoff. ↑ Q5
6. **D.** All three are correct. Agricultural soils release nitrogen oxides through nitrification and denitrification, cattle release ammonia from urea breakdown, and the poultry industry releases reactive nitrogen compounds. ↑ Q6
7. **D.** Urea from cattle urine mixes with the enzyme urease present in cattle faeces, rapidly breaking down to release ammonia gas into the atmosphere. ↑ Q7

Quick-check answers

1. **False.** ↑ 1
2. **True.** ↑ 2
3. **False.** ↑ 3
4. **True.** ↑ 4
5. **False.** ↑ 5

Previous year answers

1. **(d) 1, 2 and 3**

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