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The Green Guardian of the Field: Neem in Natural Nitrification Inhibitor

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For centuries, Indian farmers have sat under the shade of the neem tree. Today, with pesticide costs rising and soil should be degraded. So, the growing of neem tree is the environment friendly and act as a pesticide. Neem (*Azadirachta indica*) is a fast-growing evergreen tree that grows well in hot, dry regions with little water. Every part of it is useful: the seed, leaf, bark and oil. Its bitter taste comes from natural compounds, the best-known being Azadirachtin, which insects dislike. Chemical pesticides and fertilizers are costly, and overuse harms soil life, water and human health. Neem products are plant-based and break down quickly in the field. They offer a safer, cheaper option, especially for small and marginal farmers.

Neem

Character	Description
Common Name	Neem
Botanical name	Azadirachta indica
Family	Meliaceae
origin	Indian subcontinent
Nature	Evergreen to semi-evergreen tree
Plant type	Multipurpose tree
Major Importance	Medicinal, Agricultural and environmental uses

Guardian of the Field

Neem (*Azadirachta indica*) truly deserves the popular title "Guardian of the Field" because of its multifaceted contribution to agriculture. Its bioactive compounds, particularly azadirachtin and other limonoids, help protect crops against insect pests by interfering with their feeding and development. Neem seed cake enriches the soil with organic matter and nutrients, while neem-based fertilizer coatings help regulate nitrogen transformation and reduce potential nitrogen losses. From traditional botanical pest management to modern neem-coated urea technology, neem connects indigenous agricultural wisdom with scientific innovation. Thus, neem stands as a natural ally of farmers and a valuable resource for sustainable agriculture.

Different parts of Neem and their uses

Neem part	Agricultural Application
Leaves	Green leaf manure, compost and botanical extracts
seeds	Neem oil and biopesticide production
Seed kernel	Source of azadirachtin

Neem part	Agricultural Application
Neem oil	Botanical insecticide formulations
Neem cake	Organic manure and soil amendment
Bark	Contains biologically active compounds
Twig	Traditional agricultural and household uses
Flowers	Traditional uses and biological research

Neem – A natural Nitrification Inhibitor

Neem plays an important role in sustainable nutrient management by act as a natural nitrification inhibitor. Nitrification of biological conversion of ammonium nitrogen into nitrate and subsequently nitrate by soil microorganism. Although nitrate is readily absorbed by plants, it is highly susceptible to leaching and denitrification losses. Neem seed cake, Neem oil and neem-based coatings contain bioactive compounds that can suppress nitrification activity and slow down the nitrate formation. This help retain nitrogen in ammonium form for a longer period and may improve Nitrogen use efficiency. Neem coated urea is an important example of integrating traditional plant-based resources with morden fertilizer-based technology. Thus, Neem offers a promising approach to reducing nitrogen losses and promoting sustainable nutrient management**.**

Plants mainly absorb nitrogen from the soil in two inorganic forms:

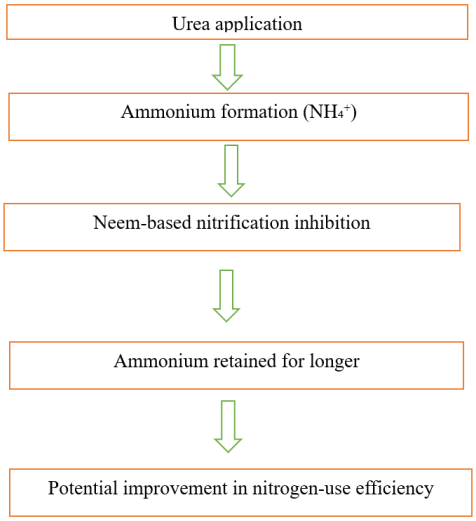
- Ammonium (NH_4^+)
- Nitrate (NO_3^-)

Which is better for agriculture?

- Ammonium: Useful because it is retained by soil particles and is less susceptible to leaching.
- Nitrate: Easily absorbed and transported within plants, but can be lost through leaching

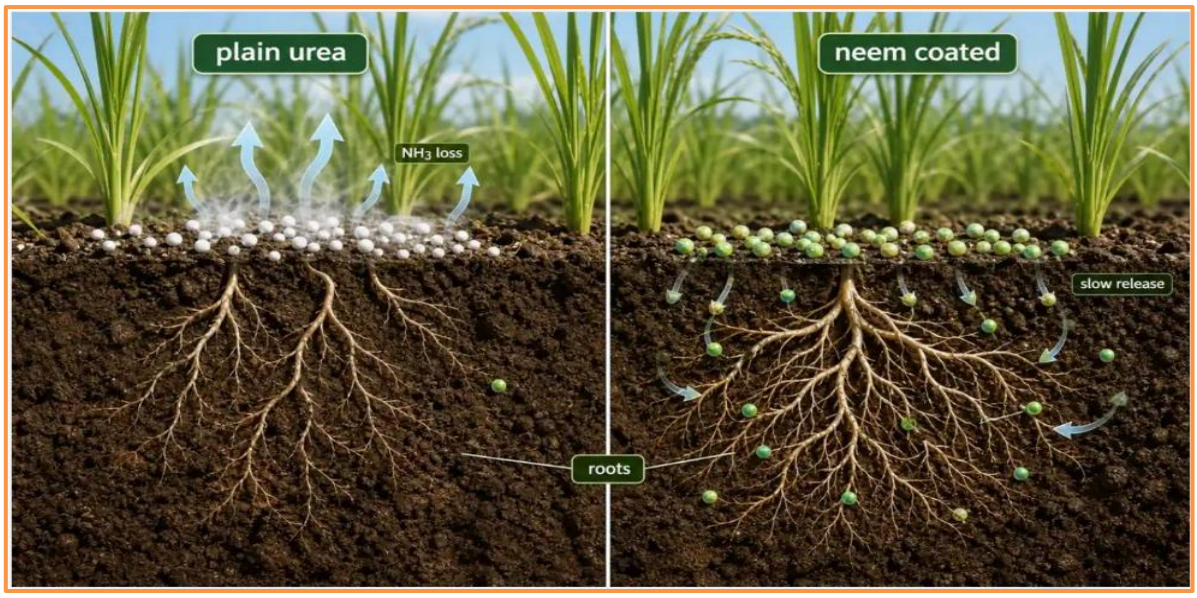
Once urea is applied, soil microbes quickly convert it into ammonium and then into nitrate. This conversion is called **nitrification**. Nitrate is easily washed away by rain or irrigation, and it can also escape as gas. The nitrogen then leaches into groundwater and becomes an environmental hazard. The farmer loses money and the environment pays the price. Neem contains natural compounds that slow down the nitrifying bacteria. Azadirachtin is one such compound, and it works as a nitrification inhibitor as well as an insect killer. Other neem compounds, such as meliacins, also matter. In rice, coating prilled urea with meliacins gave the best yield and nitrogen use efficiency among the neem oil components tested. When urea is coated with neem, nitrogen stays in the ammonium form for longer, and the crop gets a steadier supply. Lab work shows the effect clearly. Neem coated urea reduced nitrate formation by 60% at its highest concentration, and by 52.5% on average, compared with normal urea.

Neem and nitrogen-use efficiency



Comparison of Neem coated urea with plain urea

- Urea supplies nitrogen.
- Urea is converted into ammonium.
- Neem coating helps slow nitrification.
- More nitrogen can remain in ammonium form for a longer period.
- Nitrogen losses may be reduced.



Research evidence

Important finding	Reference
Neem seed kernel powder inhibited nitrification by 4–28%, depending on soil and environmental conditions.	Mohanty *et al.* (2008)
Neem seed cake treatment inhibited nitrification by 54% in a laboratory soil incubation study.	Abbasi *et al.* (2011)
Neem-coated urea reduced nitrate formation by an average of 52.5% in their laboratory experiment.	Sridharan *et al.* (2017)
Neem oil-coated urea showed up to 40% nitrification inhibition in a soil incubation experiment.	Ali *et al.* (2020)

Conclusion

Neem is more than a roadside tree. It is a pest manager, a soil feeder and a nitrogen saver in one. By using neem in a planned way, farmers can lower costs, protect their health and keep their land productive for the next generation. A few neem trees on the farm is a good investment. It is mainly used in the pesticide and nutrient management of nitrogen and also reduce the nitrogen losses and make a sustainable Agriculture