AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 03, Issue: 11 (November, 2026)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Struvite: A Slow- Release Fertilizer from Wastewater Treatment Plant for Agriculture

*Mr. K. Bavapriyan
M.Sc. (Ag) Environmental Science, Department of Environmental Sciences,
TNAU, Coimbatore-641003, Tamil Nadu, India
*Corresponding Author's email: kulandai1303k@gmail.com

The recovery and use of struvite (magnesium ammonium phosphate hexahydrate) as a slow-release fertiliser derived from wastewater treatment plants for agricultural applications. The growing recognition of wastewater as a source of valuable nutrients, particularly phosphorus, nitrogen, and magnesium. The chemical process of struvite precipitation, conditions required for its formation, and methods of recovery in wastewater treatment plants, including chemical precipitation and specialised reactor systems. The benefits of struvite as a slow-release, multi-nutrient fertiliser are discussed, emphasising its potential to reduce nutrient leaching, improve fertiliser efficiency, and support sustainable crop production. The ecological advantages of phosphorus recovery are noted, such as reducing eutrophication and conserving finite phosphate rock resources.

Keywords: Struvite, Treatment plant, Phosphorus, Slow-release fertiliser

Introduction

Wastewater is increasingly recognised as a valuable resource. Domestic sewage and some industrial wastewater contain useful nutrients, including nitrogen, phosphorus, and magnesium. Although wastewater treatment traditionally focuses on removing contaminants, it can also recover these nutrients for agricultural use. Phosphorus is essential for plant growth, root development, and energy transfer, while current phosphorus fertiliser sources rely heavily on phosphate rock. However, excess phosphorus entering water bodies can cause eutrophication. Recovering phosphorus from wastewater can help limit this environmental pollution. Struvite (MgNH4PO4.6H2O) is a valuable product formed by precipitating magnesium, ammonia, and phosphate from wastewater. It contains phosphorus, nitrogen, and magnesium, making it a multi-nutrient fertilizer. Its low solubility allows nutrients to be released gradually, depending on soil type and crop. Ultimately, recovering struvite from wastewater can support sustainable agriculture.

Phosphorus recovery and sustainable fertiliser

Phosphorus is essential for plant growth, root development, and energy transfer. However, conventional phosphorus fertilisers depend heavily on phosphate rock, and excess phosphorus in water bodies can cause eutrophication. Recovering phosphorus from wastewater helps reduce nutrient pollution. The recovered phosphorus can supplement traditional fertilizers, improving resource efficiency and supporting a circular economy in the industry. Overall, phosphorus recovery is key to sustainable wastewater management.

Struvite

Struvite is a crystalline mineral composed of magnesium ammonium phosphate hexahydrate (MgNH4PO4.6H2O). During wastewater treatment, magnesium, ammonia, and phosphate ions react when the pH is suitable. Struvite contains phosphorus, nitrogen, and magnesium-nutrients that benefit plant growth. Its low solubility allows nutrients to be released gradually,

depending on soil pH. It can be a potential alternative to traditional phosphorus fertilizers and, under suitable conditions, support root development, plant growth, and nutrient uptake. Recovering struvite can recycle valuable nutrients, conserve phosphate rock, and reduce phosphorus entering water bodies. However, its effectiveness depends on the soil, crop, and fertiliser application.

Struvite Precipitation

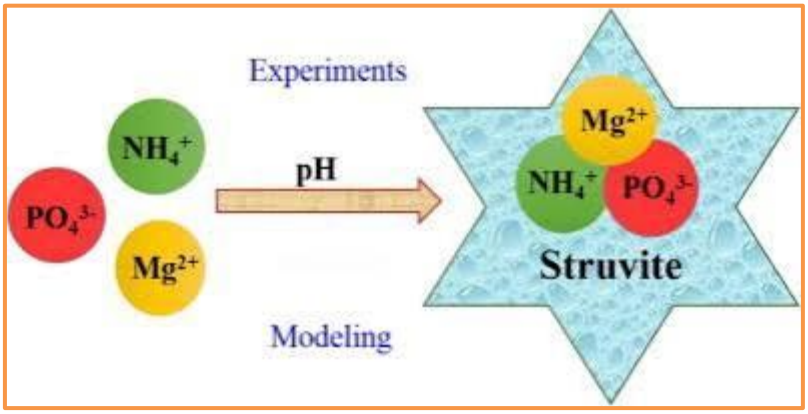
Struvite precipitation is a chemical process in which magnesium, ammonia, and phosphate ions react to create crystalline magnesium ammonium phosphate hexahydrate (MgNH4PO4.6H2O). This often occurs at an alkaline pH, usually between 8–10. Often magnesium salts will be added to the wastewater.

Reaction:

$Mg2+ + NH4+ + PO43- + 6H2O \rightarrow MgNH4PO4.6H2O\downarrow$

(Note: Phosphate will be in different forms depending on pH in real wastewater.)

There are three stages to struvite precipitation: nucleation, growth, and separation. The first stage creates small crystals. Next, the crystals grow as more ions bond. Finally, the crystals are separated from the wastewater. Struvite precipitation depends on many factors, such as pH, magnesium to phosphate ratio, nutrient concentrations, temperature, and mixing. If these are properly managed, nutrient recovery can be increased.



Source: https://ars.els-cdn.com/content/image/1-s2.0-S0021979716302272-fx1.jpg

Struvite Recovery in Wastewater Treatment Plants (WWTP)

In WWTP, struvite is recovered by extracting phosphorus, nitrogen, and magnesium. There are several ways to increase nutrient recovery:

Chemical precipitation: Magnesium salts can be added to wastewater to create struvite. For example, magnesium chloride can be added (MgCl2).

Crystallization reactors: Specialised reactors provide the correct conditions for crystal formation.

Fluidized Bed Reactors: Wastewater is passed through seeded materials to allow crystal growth.

Nutrient Recovery: Using technologies like PEARL process to recover phosphorus from WWTP.

The crystals will be separated, cleaned, dried, and converted into fertilisers. This can aid in reducing phosphorus release, reduce unwanted scaling in pipes, and create a circular economy.

Slow-release fertiliser

Struvite is a promising slow-release fertiliser. Its low solubility allows phosphorus, nitrogen, and Mg to enter the soil gradually, reducing nutrient leaching compared with highly soluble fertilizers. In suitable soils, this can improve fertilizer efficiency. However, struvite's solubility depends on soil pH, microbial activity, and moisture. Overall, it offers an eco-friendly alternative to traditional phosphorus fertilizers and can support sustainable crop production.

Eco-friendly

Recovering phosphorus from wastewater can help reduce nutrient pollution. Recovering it as struvite lowers the risk of eutrophication and algal blooms by limiting the nutrients that enter water bodies. It also reduces our dependence on phosphate rock, a limited resource. Using recovered nutrients helps minimise waste and wastewater's environmental impact while supporting a circular economy. Overall, phosphorus recovery is an effective way to protect aquatic ecosystems and promote sustainable agricultural practices.

Conclusion

Recovering struvite from wastewater offers a sustainable way to reclaim valuable nutrients. As a slow-release fertilizer, struvite supplies phosphorus, nitrogen, and magnesium to support crop growth. Its recovery can help reduce water pollution, conserve natural phosphorus resources, and promote a circular economy. However, production costs and effectiveness remain challenges. Advances in technology and further research could increase struvite's use in agriculture. Overall, struvite offers a promising path toward sustainable wastewater management and eco-friendly fertilizer production.

References

1. Arcas-Pilz, V., Rufí-Salís, M., Parada, F., Petit-Boix, A., Gabarrell, X., & Villalba, G. (2021). Recovered phosphorus for a more resilient urban agriculture: Assessment of the fertiliser potential of struvite in hydroponics. *Science of the Total Environment*, 799, 149424.
2. Cordell, D., Drangert, J. O., & White, S. (2009). The story of phosphorus: Global food security and food for thought. *Global Environmental Change*, 19(2), 292-305.
3. Degryse, F., Baird, R., da Silva, R. C., & McLaughlin, M. J. (2017). Dissolution rate and agronomic effectiveness of struvite fertilisers—Effect of soil pH, granulation and base excess. *Plant and Soil*, 410, 139-152.
4. Ghosh, S., Lobanov, S., & Lo, V. K. (2019). An overview of technologies to recover phosphorus as struvite from wastewater: Advantages and shortcomings. *Environmental Science and Pollution Research*, 26, 19063-19077.
5. Hertzberger, A. J., Cusick, R. D., & Margenot, A. J. (2020). A review and meta-analysis of the agricultural potential of struvite as a phosphorus fertilizer. *Soil Science Society of America Journal*.
6. https://ars.els-cdn.com/content/image/1-s2.0-S0021979716302272-fx1.jpg