

Sustainable Nitrogen Management in Kharif Crops through Organic Amendments

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OPEN ACCESS

Keywords

Nitrogen use efficiency; Organic amendments; Green manuring; Integrated nutrient management; Leaf Colour Chart

How to cite this article:

Singh, P., Kaur, J. and Kaur, P. 2026. Sustainable Nitrogen Management in Kharif Crops through Organic Amendments. *Vigyan Varta* 7 (10): 81-84.

ABSTRACT

Nitrogen is a key input for kharif crops such as rice, maize, cotton and fodder, but is highly prone to losses through leaching, volatilization and runoff. Excessive reliance on chemical fertilizers has degraded soil health, polluted groundwater and raised cultivation costs, a concern sharpened by the ongoing fertilizer supply disruption in India. Drawing on Punjab Agricultural University recommendations, this article outlines integrated nitrogen management through organic amendments - farmyard manure, poultry manure, pressmud, gobar gas slurry, green manures, crop residues and prali char - combined with need-based fertilizer use guided by the Leaf Colour Chart. These practices can save 16-25 kg nitrogen per acre while improving soil organic carbon, structure and microbial activity, offering a practical path to profitable and sustainable kharif crop production.

INTRODUCTION:

Nitrogen is one of the most important nutrients required for obtaining higher productivity in kharif crops such as rice, maize, cotton and fodder crops. Nitrogen is the engine of vegetative growth, but in kharif conditions it is also the nutrient

most likely to be lost through leaching, volatilization, and runoff (Singh *et al* 2002). However, excessive and imbalanced use of chemical nitrogen fertilizers has created serious concerns including declining soil health, nutrient losses, groundwater pollution

and rising cultivation costs (Ali *et al* 2015). Therefore, integrated nitrogen management using organic amendments has emerged as an effective and sustainable approach for improving crop productivity while maintaining soil fertility. Organic amendments help reduce nitrogen losses by releasing nitrogen gradually and improving the soil's ability to hold nutrients.

Nitrogen should be applied according to the crop's requirement at different growth stages. Therefore, urea is generally recommended in split doses so that nitrogen availability matches the crop demand more efficiently. This practice also helps in reducing nitrogen losses caused by leaching, volatilization, decomposition, and other pathways, thereby improving nitrogen use efficiency (Ram *et al* 2022). Punjab Agricultural University has strongly emphasized the use of organic manures, green manuring and crop residue recycling for efficient nutrient management in kharif crops. Combining organic amendments with chemical fertilizers not only saves fertilizer nitrogen but also improves soil physical, chemical and biological properties (Kumari *et al* 2023). And also, owing to today's fertilizer crisis in India due to closure of Strait of Hormuz, it is high time to shift to organic sources from the chemical fertilizers.

Importance of Organic Amendments

Organic amendments improve soil organic carbon, water holding capacity, microbial activity and nutrient availability. They also help in reducing nutrient losses through leaching and volatilization. Regular use of organic materials enhances long-term soil productivity and supports sustainable agriculture (Bhat *et al* 2001).

The important organic amendments recommended for kharif crops include:

Farmyard manure (FYM), Poultry manure, Pressmud, Gobar gas slurry, green manures like dhaincha, sunhemp and cowpea, Crop residue incorporation, Prali char and summer moong residue incorporation.

Green Manuring: A Low-Cost Nitrogen Source

Green manuring is one of the most economical and eco-friendly methods of nitrogen management in rice-based systems. Farmers can sow dhaincha, cowpea or sunhemp after wheat harvesting and incorporate the green biomass into the soil before rice transplanting.

The recommended seed rates (per acre) for green manures are: 20 kg dhaincha, 12 kg cowpea, and 20 kg sunhemp seed.

The green manure crop should be incorporated 6-8 weeks after sowing, preferably one day before transplanting rice. This practice can save about 25 kg nitrogen per acre, equivalent to nearly 55 kg urea. Green manuring also improves soil structure and helps in managing micronutrient deficiencies, especially iron deficiency in rice. Dhaincha is particularly useful for kallar and newly reclaimed soils because of its better adaptability under problematic soil conditions.

Role of Farmyard Manure and Other Organic Sources

Application of organic manures before land preparation significantly improves nutrient availability and crop growth. In transplanted rice, PAU recommends (per acre application): 6 tonnes FYM, 6 tonnes pressmud, 2.5 tonnes poultry manure, 2.4 tonnes gobar gas slurry or 2 tonnes prali char. These amendments help reduce the requirement of chemical nitrogen fertilizers substantially.

Fertilizer Nitrogen Saving through Organic Amendments in Rice

Organic Amendment	Recommended dose	Nitrogen Saving per acre
Farmyard manure	6 t/acre	16 kg N
Pressmud	6 t/acre	25 kg N
Poultry manure	2.5 t/acre	25 kg N
Gobar gas slurry	2.4 t/acre	16 kg N
Prali char	2 t/acre	16 kg N
Green manure	—	25 kg N

This reduction in fertilizer requirement lowers production costs and enhances nutrient use efficiency.

Prali Char: Turning Crop Residue into Wealth

Punjab generates huge quantities of paddy straw every year. Burning of paddy straw leads to nutrient loss and environmental pollution. PAU recommends converting paddy straw into “Prali Char,” a carbon-rich porous material produced through partial combustion under limited oxygen conditions.

Prali char contains: 30-36% carbon, 0.5-0.6% nitrogen, 0.16-0.22% phosphorus, and 1.6-2.2% potassium. Application of prali char at 2 tonnes per acre: saves about 16 kg nitrogen, improves soil health, enhances crop productivity and reduces environmental pollution. This technology provides an effective alternative to residue burning while supporting sustainable nutrient management.

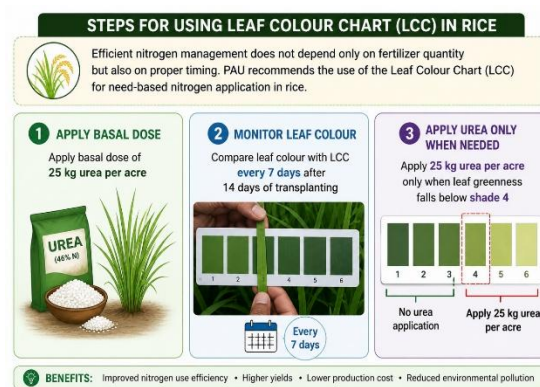
Leaf Colour Chart for Efficient Nitrogen Use

Efficient nitrogen management does not depend only on fertilizer quantity but also on proper timing. PAU recommends the use of the Leaf Colour Chart (LCC) for need-based nitrogen application in rice.

Farmers should:

- Apply basal dose of 25 kg urea per acre
- Compare leaf colour with LCC every 7 days after 14 days of transplanting
- Apply 25 kg urea per acre only when leaf greenness falls below shade 4

This technique prevents unnecessary fertilizer application and improves nitrogen use efficiency, especially in fields receiving organic amendments.



Crop Residue Recycling and Soil Health

Continuous incorporation or retention of rice straw improves soil organic carbon and enhances soil fertility. According to PAU recommendations, after continuous residue incorporation for several years, urea requirement in rice can be reduced by about 20 kg per acre. Similarly, incorporation of summer moong residues before rice transplanting saves nearly one-third of fertilizer nitrogen. Crop residue recycling therefore serves as an important component of integrated nutrient management.

Nitrogen Management in Cotton and Other Kharif Crops

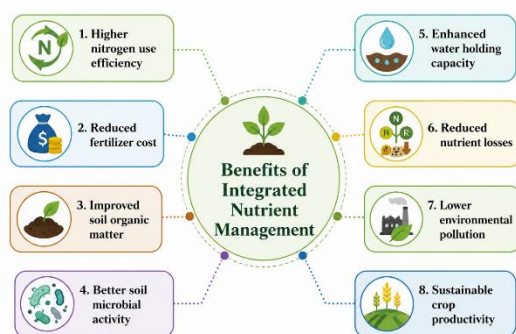
Integrated nutrient management is equally important in cotton and maize. PAU has recommended incorporation of wheat straw before sowing cotton using rotavator or super seeder. Sunhemp intercropping in cotton

followed by its incorporation as green manure after first irrigation improves soil physical properties and increases cotton yield.

In maize and fodder crops also, the addition of organic manures improves nutrient availability and maintains soil productivity under intensive cropping systems.

Benefits of Integrated Nitrogen Management

The combined use of organic amendments and chemical fertilizers provides several advantages:



CONCLUSION

Sustainable agriculture in Punjab requires a shift from excessive dependence on chemical fertilizers toward integrated nutrient management. Organic amendments such as FYM, poultry manure, green manures, crop residues and prali char can play a major role in improving nitrogen use efficiency and restoring soil health. The broader lesson is that nitrogen management should be viewed as a system, not a single input. When farmers add organic amendments, retain residues, grow green manures, and apply nitrogen in splits only when needed, they improve soil health and reduce waste. Farmers adopting these practices can reduce fertilizer costs, improve crop productivity and protect the environment simultaneously. Scientific nitrogen management using organic sources along with

need-based fertilizer application is therefore the key to profitable and sustainable kharif crop production in the future.

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