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Integrated Nutrient Management for Sustainable Rice Production

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Introduction

Lowland rice accounts for 14.0% of the total global fertilizer consumption, which is likely to increase due to increasing demand for rice. Non-judicious and unbalanced application of NPK fertilizer not only deplete the native soil nutrient reserve but also cause environmental damages viz. greenhouse gas (GHG) emission, acidification, eutrophication, etc. posing a serious threat to sustainability of rice production. Integrated application of organic manures and chemical fertilizers could be the best option to overcome the adverse impacts associated with use of chemical fertilizer alone.

Integrated Nutrient Management

Integrated nutrient management (INM) is the judicious use of all possible nutrient sources to meet the plant nutrient requirement at an optimum level to sustain the desired crop productivity with minimal impact on environment.

In INM, the immediate nutrient requirement of the crop is met through chemical fertilizers. Thus, the rate and time of chemical fertilizer application should synchronise with the real time need of the crop. Whereas, the slow and long-term release of nutrients from organic sources helps in meeting the long term need of the crop.

Goal

- Optimization of the benefits from all possible sources of plant nutrients in an integrated manner to achieve a given level of crop production
- Maintenance of plant nutrient supplying capacity of soil to ensure sustainable crop productivity
- Ensuring higher nutrient use efficiency, minimization of nutrient loss and mitigation of harmful environmental impacts
- Minimizing the use of chemical fertilizers thereby reduce the cost of cultivation and enhancing profitability

Components

- Organic manures: Farmyard manure (FYM), compost, vermicompost, biogas slurry, poultry manure, crop residues and biowastes like press mud, sugarcane bagagges etc.
- Biofertilizers: BGA, azolla, phosphate solublizers, etc.
- Green manures & Green leaf manures: Dhaincha (Sesbania aculeata), Sesbania rostrata, Sunhemp (Crotalaria juncea), Pongamia globra, Leucaena leucocephala, Azadiracta indica
- Crop rotation with legumes.
- Chemical fertilizer like urea, single super phosphate, di-ammonium phosphate, muriate of potash.

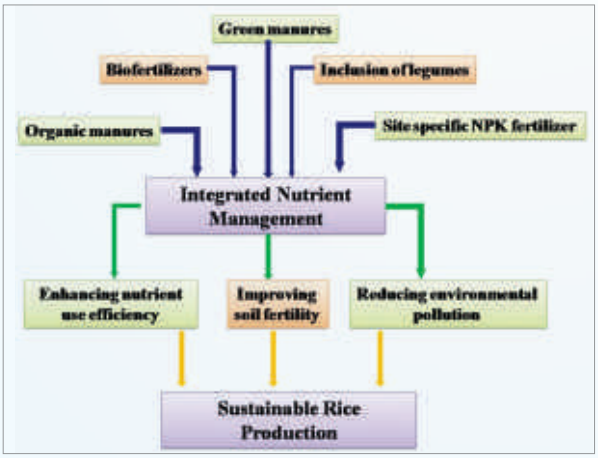

Fig.1.
Components and objectives of
INM for sustainable rice production

Approaches in INM

There are two approaches of including organic manuresin INM i.e., additive and substitutive.

Additive approach

- Full NPK requirement of the crop is supplied by chemical fertilizer and additional organic manure is applied at a given rate.
- This approach apart from enhancing productivity and nutrient use efficiency also helps maintaining and/or improving quality and fertility of soil.

Substitutive approach

- Part of recommended dose of fertilizer is replaced by organic manures.
- The extent of replacement depends on crop need, type of organic manure, its decomposition rate and C:N ratio.
- This approach aims at meeting nutrient requirement of crop in current season, improving or maintaining soil fertility and reducing use of chemical fertilizer.

Important INM components for rice production system:

Components	Description
 FYM	Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with their litter and left over material from roughages or fodder fed to the cattle. The N, P, K content of FYM is 0.5%, 0.2% and 0.4% respectively. Apart from supplying essential plant nutrients, FYM also improves/maintains the quality of soil.
 Green manuring with Dhaincha	Incorporation of Dhaincha *(Sesbaniaaculeata)* at 30-45 days adds about 14to 15t ha^{-1} of organic matter and supplements about 25% of the N requirement of the rice crop.
 Blue green algae	Blue green algae (BGA) also known as Cyanobacteria has been reported to promote the nitrogen economy of the soil through biological N fixation and can provide 25-30 kg N ha^{-1}season^{-1}

Site specific nutrient application (SSNM) involves nutrient application based on soil test, yield goal, and factors influencing crop response to fertilizer application. It involves feeding the crop with nutrients as and when needed. Rice Crop Manager is a web based decision support tool developed on the basis of SSNM approach that gives region specific NPK recommendation on the basis of cropping history.

Synchronization of supply with demand

The customized leaf colour chart (CLCC) is an effective, low-cost, easy tool for real time N management. It considers the relative greenness of rice leaf as an indicator of the leaf N status and decides when and how much N should be applied to the crop. The CLCC based N application synchronizes N supply to the real time need of crop hence increases uptake and reduces N loss and improves yield.

Recommended INM practices for rice based production system

- Combined application of FYM at the rate of 5 t ha-1 and Fertilizer NPK at the rate of 80:40:40 kg ha-1ensure optimum crop productivitywith moderate emission of GHG, soil organic carbon sequestration and maintained soil fertilityin lowland rice ecology.
- INM including green manuring with Dhaincha supplemented with topdressing of urea at the rate of 15kg N ha^{-1}at three weeks after rice transplanting and 15 kg N ha^{-1} at panicle initiation was found to be at par with the prilled urea applied alone in favorable low land of eastern India.
- The system productivity of a rice-rice system in eastern India under INM practice that involved application of 50% recommended doses (RD) of nutrients through chemical fertilizer along with 50% recommended doses of nutrients through Dhaincha green manuring during wet season and 100% recommended doses of nutrients through chemical fertilizer during boro season was found at par with that 100% RD as fertilizer in both wet and boro season.
- Application of Dhaincha at the rate of 8.25 t + 100 kg N ha^{-1}(urea) in four equal splits (basal, 21 days after transplanting , panicle initiation and first flowering to rice) produce higher grain yield than urea alone at the rate of 100 kg N ha^{-1}.
- Integrated application of 75% inorganic N + 12.5% N through FYM + 12.5% N through well decomposed poultry manure was found to be superior over 100% N applied through inorganic N.
- Application of soil based BGA biofertilizer at the rate of 10 kg ha^{-1} along with 90 kg urea produced 16% higher yield than 90 kg urea-N alone and at par with 120 kg urea-N alone.

Conclusion

The INM practice involving judicious combinations of inorganic fertilizer and organic manure can meet the real time nutrient need of the crop as well as sustain soil fertility and reduce environmental pollution. However, the practical constraints related to availability of FYM, practical difficulties in using BGA, azolla and green manure crops that hinder widespread adoption of INM practices by rice growers. It is essential to devise and evaluate cropping system and region specific INM package keeping in view locally available resources. Policy support and systematic extension will help popularization of this technology among the farmers.

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