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Organic Management Practices to Enhance Nitrogen Use Efficiency in Rice

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ABSTRACT

Nitrogen is very important element and its losses from the soil are enormous. It is lost from the soil in different ways as leaching and erosion, volatilization and denitrification. In India managing organic farming systems is a major challenge due to strong N limitation. Our methodology is mainly based on a better utilization of the natural nitrogen resources from soil mineralisation and symbiotic fixation of legumes, and not by an increase in the use of organic fertilizer. The focus is also to increase production and productivity, maintain soil health, reduce nutrient losses, Organic farming offers alternative system for sustainable production and natural resource system. The aim of nutrient management in organic systems is to optimize the use of on–farm resources and minimize losses. Organic materials such as, biofertilizers and cover crops are other valuable source of nutrients to improve the growth and yield attributes, yields, nutrient uptake, grain quality and soil fertility. The rice (Oryza sativa L.) - wheat (Triticumaestivum L.) cropping system occupies about 28.8 million hectares mainly spread over Asia's five countries, namely, India, Pakistan, Nepal, Bangladesh and China. The paper outlines the organic farming management practices to enhance Nitrogen Use Efficiency (NUE) of rice-based cropping systems.

KEYWORDS : Organic management practices, Rice, Nitrogen Use Efficiency

Introduction:

Organic farming Systems focuses on management of soil fertility on long term basis rather than on short term basis as in conventional systems.In organic farming systems, plant nutrients can be supplied from different sources viz. farmyard manure, compost, vermicompost, biogas slurry, green manures, crop residues, bio-fertilizers and chemical fertilizers (in natural forms it is necessary to use these sources of nutrients in a combined manner which is called Integrated Nutrient Management (INM). These sources are used combined as per availability and feasibility of application under different conditions.

Biological and physicochemical management are fundamentally based on integrated approach to soil fertility management. It is abiological approach to soil fertility management, which has favoured balanced farming systems.

Among the causes attributed to yields decline under long term cultivation are changes in soil fertility associated with loss of organic matter and the accompanying decline in soil physical and chemical properties. The yield declines are further significant in monocropping systems as Rice- Wheat.

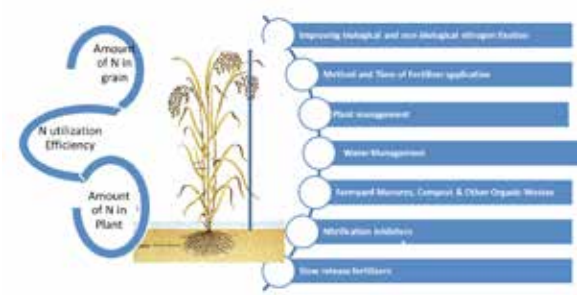
Symbionts such as rhizobia and mycorrhiza increase the efficiency of nutrient acquisition by plants. A wide range of fungi, bacteria and animals participate in the process of decomposition, mineralization and nutrient immobilization and therefore influence the efficiency of nutrient cycles. Soil organisms mediate both the synthesis and decomposition of soil organic matter (SOM) and therefore influence cation exchange capacity; the soil N, S and P reserve; soil acidity and toxicity; and soil water holding capacity. The use of biological inputs such as N-fixing bacteria, mycorrhiza are mean of enhancing NUE. Direct management is also achieved by the use of organic matter inputs. Management techniques such as tillage and fertilization also influence NUE by altering the physical and chemical environment of the soil.

Adopting appropriate N management strategies is crucial for improving NUE and efficient crop production. By adopting these practices, it is possible to improve crop yields and enhance NUE.

Approaches to improve NUE in rice :

The nitrogen utilization efficiency in rice is defined as the ratio of N content in grain to N content in plant. Nitrogen use efficiency (NUE) in plants is a complex phenomenon that depends on a number of internal and external factors, which include soil N availability, its uptake and assimilation of carbon and nitrogen. An increased awareness of the regulatory mechanisms controlling Nitrogen economy is imperative to enhance nitrogen uptake and use efficiency so as to reduce excessive input of fertilizers, while maintaining an acceptable yieldVijayalakshmi (2013). Fig 1 explicitly explains the various approaches to improve NUE in Rice which are discussed in detail hereunder:

Fig 1:NUE in Rice



1. Improving biological and non-biological nitrogen fixation

Biological N fixation (BNF) by legumes is a biological phenomenon in nature and its importance for adding N to agricultural systems is enormous. Quantity of N2 fixed by crop species varies according to soil-plant environmental factors.

Legume fixes atmospheric N and could potentially reduce N requirements of succeedingcereal crops. Crop rotation is an effective disease, insect, and weeds control practice. Furthermore, crop rotation benefits are improved water use efficiency, increased nutrient use efficiency.

Table 1: Biological Nitrogen Fixation by some legumes (Mohanty*et al.2012)*

Crop	Nitrogen Fixed (kg\ ha\ annum	Crop	Nitrogen Fixed (kg\ ha\ annum
Mungbean	70	Horsegram	40
Soybean	105	Groundnut	42
Beans	58	Cowpea	90
Peas	48	Lentil	130
Sesbania	30	Sunhemp	40

Free-living microorganisms or organisms not directly associated with higher plants are capable of non-symbiotic N fixation (Stevenson, 1982). Many heterotrophic bacteria are capable of fixing N including Beijerinckia and Azotobacter, which are aerobes and found in tropical and temperate soils, respectively (Davis et al., 2003).

Clostridium is a heterotrophic bacterium that thrives only under anaerobic conditions. Azospirillum is a bacterium that has been found to live in the rhizosphere of tropical grass roots. Certain photosynthetic bacteria and cyanobacteria (blue green alga) live near the soil surface and can fix N non-symbiotically (Davis et a[., 2003).

Cyanobacteria contribute N to flooded rice by reducing N2 to NH3 (Kamuru et al., 1998). Improving mutant strains of cyanobacteria can potentially contribute more N to growth and yield of rice plants than wild types.

Non Biological N fixation can occur through lightening or by rain water.

2. **Method and Time of Fertilizer/ Manure application:**There is a need to increase the efficiency of use of applied nutrients by applying the right form, right quantity at the right time & by the right method**.** The main components of the N supply system are the organic manures green manures, crop residues, crop rotation and inter cropping involving legumes and cereals, bio-fertilizers including rhizobium, azotobacter, azospirillum, phosphorus solubilizing micro-organisms like mycorrhizal fungi, azolla, blue green algae and cyanobacteria. All these can serve as an important supplementary source of nutrients. Research findings have established that application ofOrganic (BGA@ 2.0 Kg/ha + Azolla @ 1.0 t /ha/Azatobactor @ 0.5kg/ha + FYM@ 5.0 t/ha + Vermicompost@ 5.0 t/ha) have achieved rice yields comparable to that achieved by chemical fertilizers.

3. Water Management

Irrigation along with modern cultivars and N fertilizers has made significant contributions to increasing production of crops. Oweis et al. (2000) defined supplemental irrigation as the application of a limited amount ofwater to rainfed crops when precipitation fails to provide the essential moisture for nominal plant growth. Adequate soil moisture during crop growth and development is fundamental to obtain high NUEs. Water deficit during crop growth may limit N movement in soil and may reduce N uptake and UE .Excessive irrigation may cause leaching and denitrification and consequently lower NUE (Lehrsch et al. 2000).

Nitrogen supply has been considered to be the main benefits of legumesgrown before cereal crops in rotation. Internal efficiency of N and recovery efficiency of applied N were significantly different between genotypes, but were not affected by water availability or by water and nutrient availability (Haefelea,*et al., 2008)*Simple Agronomical practices like Tillage Practice, Fallowing mulching etc increase the water use efficiency which ultimately leads to fertilizer use efficiency.

4. Plant management

Plant management is a complementary practice to soil management to improve N use efficiency in crop plants. Principal plant management practices are crop rotation, crop residue management, green manuring, use of cover crops and efficient species/genotypes, and control of diseases, insects and weeds.

Rotation of legume and nonlegume crops has been recommended as an effective crop management practice. Appropriate sequences allow efficient use of soil resources, especially nutrients and water by crops to increase yields at a systems level (Gan et al 2003). Nitrogen requirements of cereals are reduced when grown after legume crops. One method for quantifying the N contribution of legumes is the estimation of fertilizer replacement value (FRV) (Iragavarapu et al. (1997). FRV is defined as the amount of inorganic N fertilizer required to produce yields in a nonrotated crop equivalent to that obtained in the same but nonfertilized crop following a legume

Crop residues are important in nutrient distribution and plant growth. Residues allow N to be available to plants through immobilization, and mineralization process.

Legume species have potential as green manures. Beneficial effect of green manure on succeeding crops depend largely on residue quantity and quality, soil type, soil fertility, soil acidity, biological activity, soil moisture, and temperature (Thonnissen et al., 2000).

Cover crops are close-growing plants that provide soil protection and soil improvement between periods of normal crop production Cover crops have special importance for reducing NO3-N leaching duringfallow periods when precipitation is high.

5. Farmyard Manures, Compost & Other Organic Wastes

Soil gains nitrogen from fertilizers, farmyardmanure, crop residue organic waste rain water and Biofertilizer. The commonly used organic sources arefarmyard manure and compost with nitrogen content 0.5-1.5% N and 0.5-2%N respectively. As the source contains less nitrogen as compared to chemical fertilizers, they are required to be applied in large amount to meet the need of nitrogen requirement. With upcoming of poultry and piggery farming large quantities of this manures are being used, as these manures contain 1-3% N and they release mineral nitrogen on mineralization. Agricultural crop residues are also good sources of nitrogen and other nutrients. The extent of addition of nitrogen through these materials is highly variable and may vary from 5-20 kgN\ ha.

Table 2 Effect of different levels of fertilizer Nitrogen application on grain yield of Rice and Wheat crops in India. (Source : Rao & Murthy 1995)

	Nitrogen Level (kg/ ha)	Yield of rice (t\ha)	Yield of wheat (t\ ha)
1.	0	3.32	1.82
2.	40	5.09	2.61
3.	80	5.54	3.60
4.	120	4.93	4.25

Conclusion:

The nutrient balancing strategy will improve crop yields as well as NUE, and also help in avoiding soil depletion. In modern agriculture,N is the key nutrient limiting yields of most crops grown in most agroecological regions. For efficient nitrogen use, it is important that there is synchrony between crop demand and nitrogen supply. Management practices such as adequate rates. Appropriate sources, efficient methods of application. and application timing when crops absorb maximum amounts are important N management strategies. NUE can be increased by focusing on:

1. Increasing fertilizer –N-efficiency during the growth period of crop/
2. Reducing different N losses so that crop uptake may be more and more N is retained in the soil.

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