

Review Article

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A Review on Effect of Integrated Nutrient Management on Paddy

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ABSTRACT

Integrated Nutrient Management (INM) is an agronomic practice in which both organic and inorganic sources of fertilizers are used. The main aim of INM is to minimize the use of chemical fertilizers. It can reduce environmental pollution and help in maintaining soil fertility by fulfilling the plant nutrient requirement. It also helps in maximizing profitability and reducing environmental hazards. In plants, roots control nutrient conversions, microbial activity and plants absorb nutrients. Due to this, INM practice is applied to the root zone. It also enhances microbial activity. This strategy is essential to plummet the disease infestation through managing the level of potassium, nitrogen and other essential elements. The application of organic manure with recommended dose of fertilizers is useful to enhance soil organic carbon and productivity. INM enhances the profitability of farmer by reducing the cost of cultivation. However, many farmers face obstacles in obtaining organic manures because they have limited knowledge of organic waste recycling to produce high-quality compost. Moreover, biotic and abiotic factors, poor tillage, unavailability of extension services are some other problems due to which farmers are unable to follow integrated nutrient management. There are various benefits of using INM such as soil conservation, nutrient management, and restoration of ecological balance. Therefore, the government should focus to promote INM strategy to enhance farming yield with minimum deterioration of natural resources.

Keywords

Integrated Nutrient Management (INM), Paddy

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Introduction

Global population is increasing day by day. In order to fulfill the demand of growing population, global food production needs to be enhanced at least by 70% by 2050 (Bruinsma, 2009). Considering limited land resources, enhancing agriculture productivity is the only factor to fulfill the growing need for food (FAO, 2009). There is a need to grow agriculture to accomplish this target. Two main factors which influence the crop growth

and yield are soil nutrient content and nutrients, which are required for the crop (Ali *et al.*, 2010). In the present scenario, many farmers apply excessive dose of chemicals in their paddy field which increases the overall cost and reduces the profit. Inorganic fertilizers help to increase the yield, but injudicious fertilizer application also have additional drawbacks such as micronutrient deficiency, soil and water contamination, and alteration in soil physico-chemical properties (Selim, 2018). Some chemical fertilizers also

results in buildup of heavy metal such as Cd, Pb etc. in the soil. To obtain desired crop productivity the usage of inorganic fertilizers must be reduced. Combined use of natural and chemical fertilizers is the only solution for all the problems. Organic manures such as animal and plant waste products, composts, recycled waste organic material, and inorganic fertilizers such as urea, DAP, etc. can be used together to meet the objective of enhancing yield with minimum environmental degradation (Zhang *et al.*, 2012). Integrated Nutrient Management (INM) plays a crucial role in sustainable production system by supplying both micro and macronutrients in appropriate quantity at low cost. INM is the main key for proper management and utilization of agriculture residues (Ogunwale *et al.*, 2002).

Definition of INM: Integrated nutrient management is the combined use of both organic and inorganic fertilizers which reduces the usage of chemicals in agriculture. It fills the gap between the nutrient requirement of the crop and fertilizer inputs. INM also plays significant role in improving soil fertility. Organic matter addition through organic manures enhances nutrient cycling and improves physical, chemical and biological properties of soil. INM practices elevate the yield and enhance the overall income of farmer. Apart from this, it also lower the environmental contamination (Zhang *et al.*, 2014). Thus, INM is a technique of improving soil health at a low cost.

Objectives of INM

The basic aim of INM is to maintain a profitable yield for a longtime without diminishing the soil physico-chemical properties and environmental quality. It guides farmers towards eco-friendly techniques so that every citizen can obtain a good quality of food without any contamination.

The main strategies of INM are:

Rational use of both organic and chemical fertilizers is necessary as it lowers the cost of cultivation and environmental contamination.

INM practices should be chosen according to the local farming system. Soil characteristics, sand, silt, and clay composition, availability of water, insects and disease infestation, implements, and climatic conditions must be given due consideration during planning.

Nutrients must be applied according to crop demand.

Control nutrient conversions and microbial activity (Selim and Imhoff, 2020).

INM in Paddy

INM is the best practice in which plant takes nutrient through organic and inorganic fertilizer. These are helpful to maintain ecological balance and to enhance soil fertility. Apart from this, it is used to improve rice productivity. To achieve maximum crop productivity the combination of both natural and manmade sources is imperative (Gruhan *et al.*, 2000; Mahajan *et al.*, 2008).

Four management practices are necessary to regulate INM in paddy are:

- Need-based fertilizer use
- Apply accurate amount of fertilizer
- Correct placement
- Right time for fertilization

Smart nitrogen fertilizer management

The application of nitrogen influences the number of tillers, which affects rice grain yield. In rice, doses of nitrogen are highly dependent on soil. To achieve equal grain yield, clay soil needs 40-60kg more nitrogen

than silty loam soil. There are various sources of nitrogen fertilizers such as neem coated, sulphur coated, polyamine coated. These sources play a vital role to enhance the yield of rice under tough soil and climate condition (Fageria *et al.*, 2010).

Smart phosphorus fertilizer management

There are various functions of phosphorus in rice. Phosphorus is used for energy storage in plants and transfers this energy to different parts of plants. Therefore, the right dose of phosphorus is necessary. Besides this, in rice, phosphorus is responsible for early maturity, straw strength, crop quality, and disease resistance. In industrial agriculture, at the grain filling stage, the foliar application is necessary (Savant *et al.*, 1982).

Smart potassium fertilizer management

If potassium is not available in sufficient amount it will lead to occurrences of disease like, kernel smut, stem and sheath rot in rice plant. Therefore, to protect plant from diseases recommended dose via foliage produces better result.

Smart micronutrients management in rice growth

There are certain micronutrients, which are essential for paddy crop such as zinc, iron and manganese. In rice production, micronutrient deficiencies are becoming more common. In high pH soils, deficiency of Zn and Fe are very common. Green manuring is also helpful to alleviate the deficiency of micronutrients (Fageria *et al.*, 2008).

Beneficial plant nutrient management and rice growth

Silicon is observed as a beneficial element beneficial for rice growth. Rice is considered as Si-accumulator species. In some areas of

United States, application of Si-amendments has shown to be beneficial for rice growth, yield and pest resistance (Gruhan *et al.*, 2000).

Effect of INM on Diseases in Paddy

INM is helpful to reduce the disease infestation by managing the level of nitrogen, phosphorus, potassium, and other essential elements. In general, the overall health of plants can also have an impact on disease occurrence (Nas *et al.*, 2012).

Role of organic fertilizers and biofertilizers on rice disease

If straw compost is mixed with consortia of biofertilizers, it remediates and improves soil health. It also increases rice productivity in a sustainable manner (Simarmata *et al.*, 2015). Additionally, the biodiversity of beneficial microbes is raised by straw bacteria and promote induced systemic resistance (ISR). ISR creates an important mechanism in selected plants through this whole plant body to defend itself from pathogens and insect herbivores (Gandhi *et al.*, 2011).

An experiment was conducted to study about the effect of composted straw, consortia of biofertilizers, and combination of consortia of biofertilizers with *Trichoderma* species on the intensity of brown spot (*Helminthosporium oryzae*), narrow brown spot (*Cercospora janseana*), sheath rice blight (*Rhizoctonia solani*), and bacterial leaf blight diseases (*Xanthomonas oryzae*) of rice at 7 weeks after transplanting (Simarmata *et al.*, 2011).

They concluded that by applying 400g per ha of consortia of biofertilizers or 400g consortia of biofertilizers combined with *Trichoderma* combined with 2.5-7.5 ton per ha of composted straw (bioameliorant) had increased the ISR and rice productivity.

Intensity of brown spot diseases reduced from 16.7 to 3.3-8.0%, narrow brown spot diseases from 20% to 4-10%, sheath rice blight from 24% to 2.7-4.7% at 7 weeks after transplanting (Simarmata *et al.*, 2011).

Role of inorganic fertilizers

Nitrogen deficiency in paddy leads to chlorosis in older leaves, necrosis and retarded growth of plants. Excessive application of nitrogen increases the disease and insect susceptibility, weakens the stem and led to patchy appearance of the crop. However, some other diseases that occur due to excessive nitrogen fertilizer such as bacterial leaf blight (BLB), bacterial leaf streak, false smut, leaf blast, sheath blast, and sheath rot, etc. During monsoon season, BLB is even worst. Due to this, in monsoon season application of nitrogen should be lower than in dry season. Therefore, accurate amount of nitrogen is necessary to avoid the problems in paddy. Accurate amount of N leads to better growth and keeps plant healthy and prevents from injury.

Phosphorus regulates the root and tissue development, enhance flowering under cool temperature and thus maximizes the paddy yield and quality. There are several other problems, which can be seen if phosphorus is applied insufficiently such as Fe toxicity at low pH, Zn deficiency, Fe deficiency and soil becomes saline. Phosphorus plays a crucial role to minimize the incidence of BLB, but on the other hand, it encourages other diseases in rice such as leaf blast and sheath blight (Nas *et al.*, 2012). Excessive use of phosphate fertilizer hampers the growth and development of paddy.

Excessive potassium increases the quantity of inhibitory amino acid. It also affects proper functioning of stomata, enhances grain weight and prevents disease incidences. Deficiency

of potassium leads to necrosis, dark green appearance of plants, yellowing of leaf margins, curling and wilting of leaves.

Effect of INM on Weeds in Paddy

Weeds are the major problem in paddy crops because they compete with the main crop for nutrients, water, light and space. Due to this, they hamper the product's quality. In certain cases, it has been observed that crop is damaged fully in critical condition (Gaiind *et al.*, 2011). Competition is high in direct-seeding rice than transplanting (Singh *et al.*, 1992).

A Study was carried out by Singh *et al.*, (2005) to demonstrate the effect of INM approach on weeds in upland rice. They observed that the dry weight of weed is increased remarkably with 100% recommended dose of nitrogen through FYM. On the contrary, the dry weight of weed was quite low by applying 100% RDN (Vermicompost). Hence, FYM, which is used in INM, should be well rotten so that the viability of weed seed must be lost during decomposition so that weed infestation is reduced (Rao *et al.*, 2007; Mishra *et al.*, 2008).

Effect of INM on Soil Fertility

In present scenario, the main reason of low fertile soil is injudicious use of chemical fertilizers (Bhattacharya *et al.*, 2007; Mahanta *et al.*, 2013). If natural resources are applied in combination with recommended dose of fertilizers, it directly elevates soil organic carbon, crop growth and productivity (Jat *et al.*, 2013; Meena *et al.*, 2013). Several studies demonstrated that INM is helpful to improve yield, reduce denitrification losses and leaching; reduces mineralization and enhances fertilizer use efficiency. Overall, it ameliorate the soil health, productivity with

long-term sustainability of the system (Kumar *et al.*, 2014; Rahman *et al.*, 2013). Judicious use of fertilizers enhances the soil organic carbon significantly. Kumar *et al.*, (2012) observed highest organic carbon in (50% RDF (NPK) + 50% N through FYM), while control was observed with lowest organic carbon. By applying 100% RDF alone through fertilizers, the availability of N, P and K increased. The application of manures along with inorganic fertilizers reduces the soil electrical conductivity.

Constraints of INM

Despite large number of advantages of INM, it is yet to fetch the pace in farmer's field. Because, there are some problems in the progress of integrated nutrient management such as: the unavailability of FYM and biofertilizers; lack of knowledge among poor farmers; availability of organic manure and limited know-how about recycling organic waste to produce high-quality compost. Moreover, biotic and abiotic factors, poor tillage, unavailability of extension services are some other problems due to which farmers are unable to follow integrated nutrient management. Therefore, to curb the problem of low soil productivity there is an urgent need to sustain soil health. Serious efforts should be made to promote integrated nutrient management rationally. So, in order to promote INM government should pay attention to the importance of using organic and inorganic fertilizers altogether and its benefit in conserving soil properties, nutrient balance, and minimizing the environmental impacts (Tirole-padre *et al.*, 2007).

Current status of INM in India

In this era, farmers mostly rely on manmade chemical fertilizers and have reduced the usage of natural resources drastically. Due to this, the level of organic matter is reducing

and soil is facing multi-nutrient deficiencies. Large amount of carbon and micronutrients are available in agricultural and domestic wastes. If these types of wastes are recycled properly, they will cut the rising cost of chemical fertilizers. To adopt INM approach incentives are required to promote the use of organic manure/fertilizers as well as biological sources like biofertilizers.

In India, many initiatives are taken by government of India to enhance agricultural productivity. During 12th plan, National Mission for Sustainable Agriculture (NMSA) in year 2017 is executed with the goal to make agriculture more productive. The most important discovery of INM is soil health management (SHM). The primary objective of SHM is promoting INM through:

Judicious use of manmade fertilizers including all the essential nutrients in combination with organic manures and biofertilizers, which is imperative for soil health and productivity.

Soil and fertilizer testing facilities are provided to the farmers for improving soil health.

This component is implemented by State Government., National Centre of Organic Farming (NCOF), Central Fertilizer Quality Control & Training Institute (CFQC&TI) and is sanctioned by INM division.

In conclusion the integrated nutrient management has remarkable benefits if farmers use this practice appropriately. Now-a-days, soil fertility is diminished day-by-day because of the excessive use of chemical fertilizers which leads to environmental contamination. In the upcoming years, food security will become the main issue because the soil would not be able to meet the growing food demand. Therefore, to preserve soil

fertility INM is the best option to protect soil from harmful chemicals. Several studies have revealed the effect of INM on weed reduction, diseases resistance, enhanced economic yield, and soil fertility improvement in paddy. Despite this, the judicious application of mineral and organic fertilization leads to better efficiency, enhance soil-plant-microbes-environmental sustainability. INM is a very effective method to reuse agriculture or other domestic waste. Many farmers and researchers are focused on INM due to large numbers of advantages, apart from this government has initiated many schemes such as soil health cards through which farmer can check out the soil fertility status.

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