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Techniques For Improving Fertilizer Use Efficiency –A Review

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ABSTRACT: Nitrogen, phosphorous and potash are the most restricting nutrient in the soil and are commonly essential plant macro nutrients. They are the commonly additionally added input for production of crops. Three Major Cereals - Rice, Wheat and Maize are utilizing huge amount approximately 90% of total nitrogenous fertilizers used in cereals. Because of growing population and decreasing agricultural land area food security has become a serious global problem. External application of the fertilizers has improved the crop yield during the past 60 years there was adverse effects of this on the environment. Under use of the fertilizers, results in the less crop production simultaneously over use of nitrogenous fertilizers have several soil and environmental consequences. Therefore new solutions are required to increase the yields with reduced fertilization, by increasing the fertilizer use efficiency there by maintaining the Agricultural Sustainability. In this paper we are going to propose some techniques that enhance the fertilizer use efficiency (FUE).

KEY WORDS: Nitrogen, Fertilizer Use Efficiency (FUE), Agricultural Sustainability, Nitrogen Responsive Chromatin Modulation, Integrated Nutrient Management (INM), Precision farming, Nitrification Inhibitors.

1. INTRODUCTION

Some researchers have predicted that the human population of world is going to cross 9 billion and the supply of food are supposed to enhance by 70% - 100% by 2050 (3, 4). For more than half of the global population Rice is the staple food for half of the world's population (32-45). Hence in order to fulfill the demands of the growing population rice production must be enhanced. But we are also facing many challenges like Global climate change, occurrence of pests and diseases frequently, intensified natural disasters and decreased land area under cultivation (5). Nitrogen and phosphorous are highly demand for growth and development of plant, the soil nitrogen-phosphorous availability commonly restrict the crop productivity (6). Adding more and more fertilizers to increase crop yields have showed plateau, so excess dose of fertilizers may not result in improving the yield but it will responsible for several environmental issues (7, 8). Nitrogen, phosphorous is most commonly deficient in all the soils and world's cropping system. So in order to fulfill the demand of the emerging population external application of nutrients in form of fertilizers are required (9). Though the nitrogen gas shares about 78% of the atmospheric gases composition crops are unable to use it unless and until they are transformed into the plant usable forms. In simple way we can define Fertilizer Use Efficiency (NUE) as the biomass productivity per unit fertilizer absorbed from the soil. Majorly Nitrogen loss occurs through Volatilization, denitrification, leaching and erosion.

STRATEGIES FOR IMPROVING FERTILIZER USE EFFICIENCY (FUE)

1. INTEGRATED NUTRIENT MANAGEMENT

The combination of indigenous components like organic manures, crop residues, Biological nitrogen fixation and Chemical fertilization is termed as Integrated Nutrient Management (10). In simple terms we can say it as usage of nutrients from several sources (Organic, inorganic and biological sources). The advantage of the integrated use is that it provide physico-chemical environment for better root growth and development and increase supply of the nutrients (11). In the Integrated Nutrient Management interaction of nutrients with several other macro and micro nutrients could considerably improve the production and fertilizer utilization efficiency (46-67). Therefore judicious and optimum of nitrogen from all the available sources leads to higher productivity.

2. IMPROVED FERTILIZER APPLICATION METHODS

Although there are several methods of application of nitrogenous fertilizers, Among them use of large granules, deep placement and foliar spray of fertilizers can improve the utilization of given fertilizer, whereas spreading of nitrogenous fertilizers which is a very basic process which leads to huge nitrogen losses (12). In Australia from the large scale field demonstrations it has been demonstrated that the nitrogen utilization efficiency in case of Broadcasting of Urea super granules in rice was 37%, whereas in case of deep placement it was 49%, Hence usage of modified fertilizers – sulphur and polymer coated urea super granules with deep placement in case of rice has more nitrogen recovery thereby increasing use efficiency (13). Foliar spray of fertilizers through spray can also improve the fertilizer use efficiency as it reduces volatilization, denitrification and immobilization prior being absorbed by the plant (13). The technique of placing the mud balls of urea in the reduced zone of puddled rice field has also reported greater nitrogen recovery there by increase in the nitrogen use efficiency.

3. USAGE OF SLOW RELEASE FERTILIZERS

Nitrogen fertilizers containing nitrate are more prone to leaching whereas nitrogenous fertilizers containing amide and ammonium are more prone to volatilization; slow release nitrogen fertilizers reduce the nitrogen losses and increase the nitrogen recovery and thereby increasing the nitrogen use efficiency (14). Slow release nitrogen fertilizers can reduce the nitrogen losses due to the delayed nitrogen release pattern which synchronizes the crop demand and soil nitrogen supply. In India the widely used slow releasing fertilizers coated fertilizers, but due to high manufacturing cost and their non-availability paves the way for their limited usage (15).

4. USAGE OF INHIBITORS

Conversion of ammonia to NO_2^- and then NO_3^- to nitrate is termed as nitrification; nitrification is a natural phenomenon, where conversion of ammonium to nitrite by nitrosomonas and nitrobacter converts NO_3^- to. NO_2^-. Ammonium might be absorbed by the colloids of the soil and preserved for long periods which can enhance the nitrogen use efficiency by minimizing the leaching and denitrification. Amendment of inhibitors can check the process of conversion of NH_4^+ to $NO_3^-$and can ensure higher amount of ammonium in the soil, where FUE and crop yield increases (16). DCD (Dicyandiamide) is commercially available inhibitor suitable for rice cultivation (17).

5. CROP ROTATION

Change the sequence of crops in the same period of year after year on same piece of land is known as crop rotation. (18).Addition of legumes with cereal is a traditional practice and considered as an old age practice for better utilization of resources(19). The legume crops fixes the atmospheric nitrogen in the soil and increase the nitrogen amount in the soil, where following crop during next time would automatically require less external application of fertilizers.

6. PRACTICING CONSERVATIONAL AGRICULTURE

Adoption of Conservational agricultural practices may improve the nutrient supplying power of soil due to the better soil health which leads to higher nutrient availability to the plants (20). Intensive tillage practices accelerate the diminishes the soil organic carbon because of higher oxidation rate which enormously increased the susceptibility of soil to erosion (21). Adoption of modern concepts of Zero tillage and bed planting with residue incorporation has been popularized, if these technologies are adopted for long term purposes then it leads to the enhancement in soil health (22). Long term implementation of such technologies improves the physical, chemical and biological characteristics of the soil including higher soil carbon content (23).

7. CROP RESIDUE MANAGEMENT

The portion of crop that is remaining in the field after cutting is termed as crop residue (24). Crop left over material has the capacity of supplying the nutrients for longer duration. It has been reported that residues of various cereal crops can supply 40 – 100 kg/ha nitrogen in a season, which also increases soil organic carbon and leads to the improvement of soil health (25). Legume crop residues are the most efficient sources of nitrogen as they have low C/N ratio and higher nitrogen content on comparison to cereal crop residues (26).

8. GREEN MANURING

In green manuring crops the legumes are superior to non-legumes because they also have the capacity of fixing the atmospheric nitrogen in the soil (27). Green manuring legume crops must possess some characteristics like fast growing, short duration, produce more biomass, fix nitrogen of atmosphere and most importantly with least cultural practices (28). Annual nitrogen storage by legumes ranges from 20 – 300kg/hectare. (29).

9. PRECISION FARMING

This is a farm inputs management system depends upon information, technology, which identifies, analyze, and demonstrate the variability in time and space in agriculture operations which are managed for maximum production and gain ,save the resources and protect the environment. (30). By the precision farming we quantify the variation in field with respect to nitrogen and apply exact fertilizers in appropriate quantity at the appropriate time. This can be done by the usage of GPS and GIS remote sensing technologies.

10. ENHANCING FERTILIZER USE EFFICIENCY THROUGH CHROMATIN MODULATION

Nitrogen fertilization supports the genome reframing of H3K27me3 methylation with NGR - 5 (Nitrogen mediated tiller growth response 5 gene) based on PRC – 2. Methylation represses in rice those genes that prevent tillering and consequently increase in number of tillers. Proteasomal destruction is influenced by NGR5 is a target of gibberellin-GID1. Modulation of competitive linkage among NGR5, DELLA proteins, and GID1increase economic yield in rice species and reduces nitrogen fertilization. This type of increase in production and decrease in inputs maintain sustainability.

CONCLUSION

Integrated Nutrient Management, Improved fertilizer application methods, usage of slow release fertilizers, usage of inhibitors, crop rotation, conservational agriculture, crop residue management and precision farming improve the fertilizer recovery there by improving the fertilizer Use Efficiency, which leads to the agricultural sustainability.

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