Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2739

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 858-863 (2017)

International Journal of Pure & Applied Bioscience

Review Article

OPEN ACCESS

Recent Forms of Fertilizers and Their Use to Improve Nutrient Use Efficiency and To Minimize Environmental Impacts

Umesha, C.[1*], Sridhara, C. J.[2] and Kumarnaik, A. H.[3]

[1]Ph.D. Scholar, [2]Professor and [3]Assistant Professor

Department of Agronomy, Navile, UAHS, Shivamogga

*Corresponding Author E-mail: msbellary@gmail.com

Received: 22.03.2017 | Revised: 4.04.2017 | Accepted: 5.04.2017

ABSTRACT

Aim of fertilizer application is to provide nutrients to plants and to increase or sustain optimal crop yield. Thus, increasing fertilizer use efficiency in terms of indiscriminate use of fertilizer leads to environmental hazard by polluting soil, water and air. The main environmental impacts associated with fertilizer use have been linked to nitrate leaching into ground water, emission of greenhouse gases (nitrous oxides), soils polluted with toxic heavy metals, and surface runoff of N and P nutrients causing aquatic eutrophication. Proper use of fertilizer is beneficial to both crop production and the environment, wherein scientist have tried to many ways to achieve the newly defined goal of fertilizer use by improving fertilizer nutrient use efficiency and minimizing environmental impacts. Inefficient use of fertilizer use increased the cost of cultivation and pulling down the profitability in farming and total factor productivity (TFP). The fertilizer industry faces a new challenge to improve its products by increasing the efficiency of their use, particularly of nitrogenous fertilizers and to minimize any possible adverse environmental impact. This can be done either through improvement of fertilizers already in use, or through development of new specific fertilizer types. The purpose of this is to examine the literature reports of recent research and developments in technology for fertilizer production and to improve nutrient efficiency and minimize environmental impacts.

Key words: *Environmental hazard, Fertilizer nutrient use efficiency, Total factor productivity and profitability*

INTRODUCTION

Dr. Norman Borlaug, an Nobel Laureate (1970) who contributed for the green revolution has given the call for new kinds of fertilizers as follows. "I am concerned about the state of the fertilizer industry itself. With the price of energy increasing, we need to find cheaper, more effective ways to nourish food crops… the fertilizer industry needs to do everything in its power to minimize that cost. Farmers are paying way too much for fertilizer products …… because much of the nutrients in applied fertilizers are never used by the crop. Nutrient losses to the environment are high with consequences for global warming and water pollution."

Cite this article: Umesha, C., Sridhara, C. J. and Kumarnaik, A. H., Recent Forms of Fertilizers and Their Use to Improve Nutrient Use Efficiency and To Minimize Environmental Impacts, *Int. J. Pure App. Biosci.* **5(2):** 858-863 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2739

Environmental problem associated with fertilizers and mitigation strategies

Fertilizer use efficiency in Indian agriculture is quite low even with good management practices. Efficiency of N fertilizer use seldom exceeds 40 %. P and micronutrients the efficiency is only 20 % and 2 %, respectively and for K, the efficiency is about 50 %. The loss of nutrients, particularly N, from the agriculture system into the environment has several adverse effects, including eutrophication of surface water, pollution of groundwater due to nitrate leaching, global warming due to nitrous oxide emission, decreased plant species diversity in natural terrestrial ecosystems and increased local air pollutant by ozone, for which NO_2 is a precursor.

Concept of ideal fertilizer

Ideal fertilizer is the fertilizer which release nutrients in a sigmoidal pattern for optimal plant nutrition and reduction in nutrient losses by processes that compete with the plant's nutrient requirements.

Enhanced-efficiency fertilization (EEF) concept

Plants demands for the mineral nutrients during specific times during which there is need to supply the required amount of nutrient. At this point, split application of nutrient is really a tedious task because of this scarcity of labours and high cost of labour wages making the agriculture non remunerative. Because of that those reasons the concept of EEF came into existence. In EEF concept fertilizer formulations are capable of minimizing the various losses and enhance the use efficiency of the nutrients by providing the continuous availability of the plant nutrients throughout the plant growth.

Classification of Enhanced-efficiency fertilization (EEF)

Nitrogen

⇛ **Slow released fertilizer**

- Urea super granules
- Urea formaldehyde
- Isobutylidene diurea
- Crotonylidene diurea

⇛ **Controlled-release fertilizers**

↬ Coated or encapsulated fertilizers

- S-coated urea
- Polymer-coated urea

⇛ **Stabilized nitrogen fertilizers**

➢ Treated with inhibitors

- Nitrification
- Urease

Phosphorous

⇛ Coating of WSP fertilizers with water-insoluble polymers

o DAP, MAP, TSP - DAP-Star by Hi Fert.

⇛ Urea super granules containing phosphorus and potassium

⇛ Fluid versus granular water-soluble phosphorus fertilizers

o Ammonium polyphosphates

o Fluid ammonium polyphosphates

⇛ Phosphate rock for direct application

- Phosphate rock-acid soil

Stabilized fertilizer

These are the fertilizer formulations or products which are stabilized with the treatment of urease and nitrification inhibitors to avoid probable loss due to sudden hydrolysis of urea and oxidation of ammonia in to nitrous oxide. The act of these enzyme inhibitors must function at appropriate situation.

Customized Fertilizers

Customized Fertilizers (CF) is a multinutrient carrier designed to contain macro and / or micro nutrient forms, both from inorganic and / or organic sources; Manufactured through a systematic process; satisfying the crop's nutritional needs, specific to its site, soil and stage; Validated by a scientific crop model developed by an accredited fertilizer manufacturing / marketing company.

The main objective of Customized Fertilizer is to promote site specific nutrient management so as to achieve the maximum fertilizer use efficiency of applied nutrient in a cost effective manner. The Customized Fertilizer may include the combination of nutrients based on soil testing & requirement of crop and the formulation may be of primary, secondary and micro-nutrients. It may include 100% water soluble fertilizers grades required in various stages of crop growth based on research findings.

Nitrification Inhibitor

Nitrification inhibitor is the substance that inhibits the biological oxidation of ammoniacal-N to nitrate-N.

Urease Inhibitor

Urease inhibitors are the chemical substances that inhibit the hydrolytic action on urea by the enzyme Urease.

Water Soluble Fertilizers

Fertigation leads to following advantages

1. Nutrient availability to the plant is improved
2. Nutrient uptake efficiency is increased
3. Fertilizer application rates & water requirements are reduced
4. Losses by leaching are minimized
5. Salt injuries & damages to root & foliage are prevented
6. Soil compaction is reduced due to less field operations
7. Weed population is decreased

Nano-Fertilizers

Nano fertilizer is a plant nutrient which is more than a fertilizer because of following characteristics.

They are of nano size (1 nm – 100 nm), contains over 200 types of nano size micro-organisms to effectively penetrate into the plant body e.g. leaves, trunks & roots within a short time, contains over 100 types of enzymes of various specific functions and non toxic.

Carbon nano-tubes are super fertilizer

Carbon nanotubes (CNTs) were found to penetrate tomato seeds and affect their germination and growth rates. Analytical methods indicated that the CNTs are able to penetrate the thick seed coat and support water uptake inside seeds, a process which can affect seed germination and growth of tomato seedlings.

Fluid Fertilizers

Fluid is the state of a matter which is neither a liquid nor a gas is called fluid state, fertilizer formulation in this states are called fluid fertilizers. Fluid fertilizers are available in a wide range of products to farmers. Although the term "liquid fertilizer" is commonly used to describe all fluid fertilizers, in reality the two terms do not imply the exact same meaning. Technically, all fertilizers of fluid consistency which can be transferred by pump are called "fluid fertilizers. This is the proper term to use in the broadest sense to describe such materials. There are two general types of fluid fertilizers. One group is called "suspensions" or "slurries", and the other group is referred to as "clear liquids".

Micronutrient Chelating Fertilizers

Though micronutrients are required by the crop in small quantity their role in production system is significant. During green revolution and early green revolution period micronutrient deficiency was not noticed but as a result of intensive agriculture system and excess mining of the nutrient from the soil resulted in to deficiency of micronutrient during post green revolution era leads to application of the micronutrient as a part of nutrient management. Application of micronutrient elements directly in their original form is not recommended because of toxicity excreted by the crops, therefore there is need to combine micronutrient with other compound to make their use safe that process called chelating.

Review findings:

[9]Showed that application of fluid fertilizer formulations recorded significantly higher grain yield of maize in all the times of applications in both the location tried it might be due to Carpramid or AmiSorb used in these trials is a synthetic thermal protein produced from the amino acid aspartic acid. Characteristics of the anionic polymer include its high cation exchange capacity arising from the carboxyl groups of amino acid molecules.

[13]They found that N loss is significantly reduced, which results in a significant increase in rice grain yield under flooded conditions compared with split applied PU. For example, the average rice grain increase over control with USG was significantly greater than that with split-applied PU (Prilled urea) in 29 irrigated rice trials (Fig. 5). Deep placement of USG essentially cuts off NH3 volatilization and also significantly reduces denitrification N loss compared to surface application of PU.

[12]Conducted an experiment to evaluate Pusa neem micro emulsion coating at three levels of nitrogen with coating and without coating they have tried. Results on grain yield

reveals coating of Pusa neem coated emulsion recorded significantly higher grain yield compared to respective uncoated levels of fertilization and no nitrogen application its due to neem coating slow release of nutrients by control rate of water penetration and thus dissolution rate , nutrient release and duration of release hence achieving higher nutrient use efficiency.

Results of the on farm trails conducted at nearby villages of Delhi indicated that in all villages urea fertilizers coated with Pusa neem emulsion excelled over uncoated urea fertilizers and increase with Pusa neem emulsion coated urea in all the village is on an average to the tune of 10 per cent, it might be due to control release of nutrients by Pusa coated urea through crop requirement[12.]

Grain yield of rice (4.60 t ha^{-1}), N uptake (74.2 kg ha^{-1}), N use efficiency (30 kg grain kg N $applied^{-1}$) and apparent N recovery (61 %) were significantly higher in the treatment where urea super granules were applied at the time of tillering compared to other sources of nutrient. Thus might be due to slow release and USG at tillering stage and throughout crop period coincide with nutrient requirement of crop[11].

[6]conducted an experiment to study the effects of different nitrogen rates on maize yield with and without nitrogen inhibitor (nitrapyrin), at all the levels of nitrogen from 90kg ha^{-1} recorded numerically higher levels of maize grain yield, its mainly because N-Serve when applied at surface of soil in zero tillage system.

[2]Reported that application of 100 kg N fed-1 as SRF recorded significantly higher grain yield (4.23 t fed-1), biological yield (7.98 t fed-1) and N uptake (99.46 kg fed-1) and which was significantly higher than 120 kg N fed-1 as urea its mainly due to more uptake of nitrogen through Slow gradual release over period of time of crop requirement.

[14]Reported that among the different coating material used lac coated urea recorded significantly higher grain yield of rice and wheat and nitrogen use efficiency, and was comparable with other coating materials used and was significantly superior over prilled urea, because lac coated urea there was control release of nutrients with slow decomposition rate hence uptake rice crop increased high nutrient use efficiency.

[8]Showed that Application of avail along with the MAP or DAP induced the yield and P uptake in all test crop compared to alone application of fertilizers, it might be due to coating more P uptake rather than P- fixation resulted in extended availability of phosphorus.

[3]Studied on method of placement of phosphorous fertilizer in the form of mono ammonium phosphate with and without polymer coating irrespective of method of placement MAP with polymer coating recorded significantly higher grain yield of maize, it's because of since soil fixation of water soluble fertilizers higher with broadcasting than banded application WSP adsorbed on the solid surface of Fe, Al oxides in acid soil and minimizing P fixation.

[10]Reported that fruit yield, water use efficiency and nutrient use efficiency of tomato was highest in the treatment where water soluble fertilizers were applied compared to normal fertilizers usage, because of radially availability and fast translocation into plant body which is required by plant for growth and development.

[7]Revealed that application of nano iron spray at the rate of 2 g per liter has recorded significantly higher number of fruit yield, plant height, number of branches per plant and fruit length due to high stability and gradual release iron anf iron chelate increase ratio of ferrous ion into ferric ion which is available to plant uptake as it helps in synthesis of chlorophyll content in plant.

[4]Conducted an experiment to study the efficacy of urease inhibitor at different concentration, from their study it was concluded that at all the concentration of NBPT grain yield of rape seed was significantly higher over unfertilized control and NPK application alone at recommended dose, its mainly due to the application of

NBPT benefited as reducing ammonia volatilization and increase e yield, improve NUE and decrease emission of nitrous oxide.

[1]Reported that usage of nano coated iron fertilizers thrives in spinach compared to the no unsprayed control of nano fertilizers due to iron act as effective chelating agent hence availability of nutrients slowly occurs as growth of spinach.

[5]Revealed that amino acid chelated micronutrients recorded significantly higher single fruit yield and single fruit weight compared to the untreated control, per cent increase of amminoacid chelated micronutrient to the tune of 17 to 55 percent in varied treatments its mainly due to chelating agents of metal ions protect from unfavorable chemical reactions and hence increase availability ions to plants.

CONCLUSION

Fertilizers, whether from inorganic or organic sources, will be continuously used to increase and sustain crop production in order to meet the demand of the growing population worldwide in the future. At the same time, however, the potential impacts of fertilizer use on environmental quality due to inappropriate application of fertilizers should also be addressed. All Enhanced Efficiency Fertilizers (EEF) fertilizers are more efficient compared to conventional fertilizer formulations with respect to nutrient uptake by the crops and persistent behavior in the soil for a longer period. They are economically quite expensive but that can be compensated through higher efficiency and because of higher nutrient use efficiency and environmental impacts due to fertilizers pollution can be effectively managed. Research and development shall continue to pursue new alternative innovative technology in terms of fertilizer production and use efficiency to sustaining crop production with minimum environmental hazards.

REFERENCES

1. Alireza Ladan Moghadam, Hesam Vattani, Nasim Baghaei and Narges Keshavarz, effect of different levels of fertilizer nano_iron chelates on growth and yield characteristics of two varieties of spinach (*Spinacia oleracea* L.): varamin 88 and viroflay. Res. *J. App. Sci, Eng. and Tech*. **4(12):** 4813-4818 (2012).
2. Amany, A. Bahar, Zeidon, M. S. and Hozayn, M, Yield and quality of maize as affected by slow release nitrogen in newly reclaimed sandy soils. *American-Eurasian J. Agric. & Environ. Sci.*, **1(3):** 239-242 (2006).
3. Chien, S. H., Prochnow, L. I. and Cantarella, H., Recent developments of fertilizer production and used to improve nutrient efficiency and minimize environmental impacts. *Adv. Agron*., **120:** 268-313 (2009).
4. Chuan Li-Min, Zhao Tong-K, An Zhi-Zhuang, Du Lian-Feng and Li Shun-Jiang, Effects of a urease inhibitor NBPT on the growth and quality of rape. 19th World Congress of Soil Science, Soil Solutions for a Changing World. Pp-50-52 (2012).
5. Datir, R.B., Laware, S. L. and Apparao, B. J., Effect of organically chelated micronutrients on growth and productivity in okra. *Asian J. Exp. Biol. Sci.* Spl. Issue: 115-117 (2010).
6. Frye, W.W., Nitrification inhibition for nitrogen efficiency and environment protection. IFA International Workshop on Enhanced-Efficiency Fertilizers, Frankfurt. International Fertilizer Industry Association, Paris, France (2005).
7. Hamid Reza Bozorgi, Study effects of nitrogen fertilizer management under nano iron chelate foliar spraying on yield and yield components of eggplant (*Solanum melongena* L.). *J. Agril. & Bio. Sci.*, **7:** 1-4 (2012).
8. Larry M. and Larry Sanders, Improving n and p use efficiency with polymer technology. *Proc. Indiana CCA Conf.,* pp - 1-13 (2007).
9. Larry M. and Larry Sanders, J., Crops respond to fluids in combination with carpramid polymer. *Fluid J.*, pp-1-3 (1998).

10. Nanda, R. S., Fertigation to enhance the farm productivity. *Indian J. Fert*., **6(2):** 13-16 (2010).
11. Nayak, S.C. and Panda, D., Transformation of applied urea and its efficient utilization in rainfed lowland rice (*Oryza sativa* L.). *Fert. News*, **47(2):** 47-48 (2002).
12. Prasad, R., Sharma, S, N., Harma, S, N., Singh, S. and Sexena, V, S., Pusa neema emulsion as an eco-friendly coating agent for urea quality and efficiency. *Ferti News*, **46(7):** 73-74 (2001).
13. Savant, N. K., and Stangel, P. J., Urea briquettes containing diammonium phosphate: A potential NP fertilizer for transplanted rice. *Fertil. Res*. **51:** 85–94 (1998).
14. Singh, M, K., Verma, U, N., Pal, S, K. and Thakur,R., efficiency of slow release fertilizer for rice and their residual effect on wheat. *Indian J. Agron*., **44(2):** 216-218 (2006.)