ACADEMICIA

ISSN: 2249-7137 Vol. 11, Issue 10, October 2021 Impact Factor: SJIF 2021 = 7.492

ACADEMICIA
An International Multidisciplinary Research Journal
(Double Blind Refereed & Peer Reviewed Journal)

DOI: 10.5958/2249-7137.2021.02365.X

REVIEW ON ENVIRONMENTALLY FRIENDLY FERTILIZERS

Kusum Farswan*

*Department of Agricultural Sciences,
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, INDIA
Email id: kusum.agriculture@tmu.ac.in

ABSTRACT

Fertilizer is essential for maintaining soil fertility, boosting yields, and enhancing the quality of harvest. However, a substantial amount of fertilizer is wasted, raising agricultural costs, squandering energy, and damaging the environment, all of which pose difficulties to modern agriculture's long-term viability. Environmentally friendly fertilizers (EFFs) have indeed been created to satisfy the needs of increasing yields without harming the environment. EFFs are fertilizers that slow or even stop the flow of nutrients into the soil, thus reducing pollution caused by nutrient loss. The majority of EFFs are used as coated fertilizers. In this article, we look at current research on the materials in use in EFFs and their environmental impact. The following are the main results discussed in this review: 1) EFF coatings may act as a physical barrier to limit urea contact in water and soil, lowering the rate of urea hydrolysis and reducing nitrogen oxide (NO_x) and nitrogen dioxide (N_2) emissions. 2) EFFs may boost the amount of organic matter in the soil. 3) hydrogel/superabsorbent coated EFFs may buffer soil acidity or alkalinity, resulting in an optimum pH for plants; and 4) hydrogel/superabsorbent coated EFFs can improve soil water retention and holding capacity. Finally, EFFs play an essential role in improving nutrient efficiency and decreasing pollution in the environment.

KEYWORDS: *Agriculture, Environmentally friendly, Nutrient releases, Sustainability, Soil.*

INTRODUCTION

Over the last century, increased fertilizer, water, and pesticide inputs, as well as new technology, have resulted in enormous advancements in contemporary agriculture. Crop output per unit of land has significantly risen, allowing for more population and economic growth. However, although these advancements have been substantial, the environmental consequences have often gone unmeasured. Overuse of pesticides and fertilizers has resulted in water algal blooms and toxicity, groundwater pollution, air pollution, soil quality deterioration, and even ecosystem disruption, raising concerns about contemporary agriculture's sustainability[1].

Increasing agricultural output without harming the environment may be accomplished through improving fertilizer and water efficiency, reducing pesticide usage, and using integrated agricultural systems management. The focus of this review is on studies on the environmental consequences of improving fertilizer efficiency. Fertilizer applications are necessary for intensive high-yield agriculture. Higher fertilizer inputs are required for increased food production. These inputs have aided in keeping global agricultural production in line with human population increase, as well as improving rural economic development. In traditional agriculture, however, misuse of fertilizer, which is sprayed in surplus of plant need, is a very well inefficiency that presents a danger to the environment. Fertilizer efficiency must be significantly improved to prevent harmful environmental effects[2].

Improved recommended fertilizer methods, such as split or concentrated application, highly precise fertilization, fustigation-fertilization via irrigation, and use of environmentally friendly fertilizers (EFFs) are among the techniques used to increase fertilizer use efficiency and reduce negative environmental impacts. EFFs are a cost-effective method to increase nutrient efficiency, decrease fertilizer leaching and evaporation losses, and reduce environmental risks. They minimize pollution caused by nutrient losses by delaying or even regulating nutrient delivery into the soil. EEF is another name for them. EFFs are often designed in such a manner that nutrients are coated with ecologically beneficial compounds that can be decomposed in soil and turned into carbon. Due to the compound fertilizer's delayed release characteristic, it has water-holding and water-retention capabilities in soil. Using chitosan as a covering material may save manufacturing costs while also making the fertilizer more eco-friendly. The chitin was coated just on fertilizer cores with epoxy dissolved in acetone, which may be a possible drawback of this system. Because of the organic solvent emissions, this technique may pollute the environment[3].

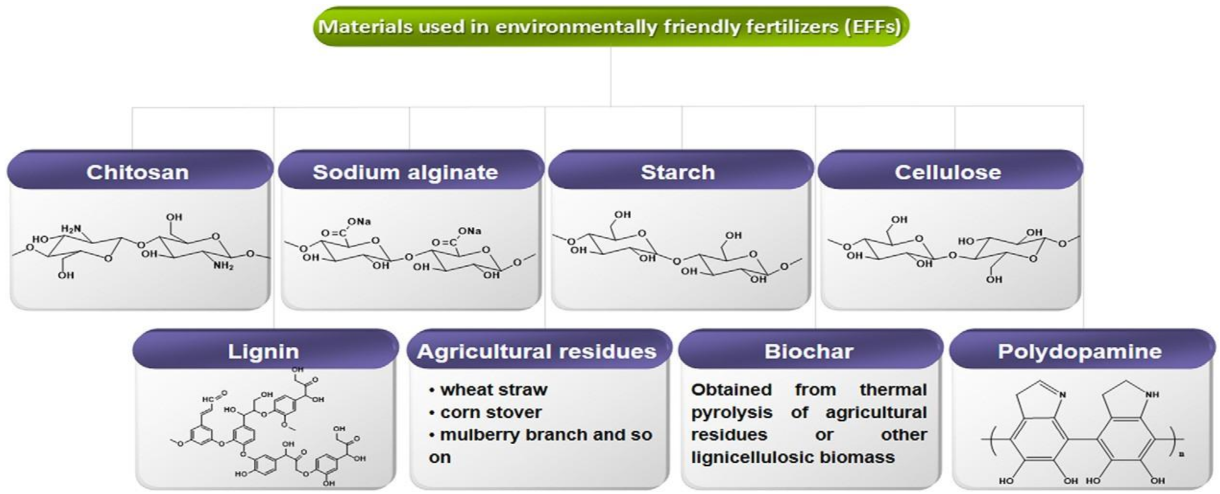

Figure1. The structures or sources of natural materials that are most used in EFFs are as follows: chitosan, sodium alginate, starch and its derivatives, cellulose and its derivatives, lignin, agricultural residues, biochar, polydopamine[1]

DISCUSSION

1. EFFs and natural materials:

To reduce nutrient release and improve fertilizer efficiency, several materials have been utilized as coatings. Environmentally friendly coating materials, the majority of which are derived from natural resources, have been developed as part of the development of EFFs. Due to their environmentally benign source, these natural materials have a number of benefits over synthetic polymers, including cheap cost, easy availability, and biodegradability. The positive and negative characteristics of the natural materials most often utilized in EFFs.

1.1 Chitosan is a kind of chitin:

Chitosan is a polysaccharide made by the (partial) n - deacetylation, which is a key component of the shells of crustaceans including crabs and shrimp. Chitosan is plentiful in this naturally renewing resource. It is also non-toxic and biodegradable. Chitosan has been widely utilized in a variety of industries, including agriculture, because to these characteristics. Because it is naturally occurring and biodegradable, it should not create pollution; as a result, it has been extensively used in EFFs. It has been created a nanocomposite films nitrogen, phosphorus, and potassium combination fertilizer. The inner coating of water-soluble nitrogen, phosphorus, and potassium fertilizer granule cores was chitosan, while the outside coating was strands acid-co-acrylamide) (P(AA-co-AM) hydrogel polymer. Nitrogen (N) 8.06 percent, phosphorus (P) 8.14 percent, and potassium (K) 7.98 percent made up the nutritional content. On the 30th day, the percentages revealed for N, P, and K were 79, 62, and 69 percent, respectively. On the 30th day, the percentages for N, P, and K were 79, 62, and 69 percent, respectively. The compound fertilizer has waterholding and water-retention characteristics in soil, in addition to its delayed release behavior. Using chitosan as a covering material may save manufacturing costs while also making the fertilizer more eco-friendly. The chitosan were coated on the fertilizer cores using epoxy dissolved in acetone, which may be a shortcoming of this method. Because of the organic solvent emissions, this technique may pollute the environment[4].

1.2 Sodium alginate:

Sodium alginate (SA) is a brown seaweed-derived linear polymer with 1–4 linked -L-guluronic and -Dmannuronic acid moieties of various compositions. With the introduction of Ca^{2+} in an aqueous solution, it may be ionic crosslinked. It is extensively utilized as a controlled release fertilizer formulation because to its moderate gelation characteristic. However, in the absence of monovalent cations, the sodium alginate network has a low mechanical strength and is readily destructible. In addition, sodium alginate hydrogels do not always show controlled-release behavior, and instead show a burst supply of nutrients followed by a gradual of the remaining resources[5].

1.3 Starch and compounds of starch:

Starch is a polysaccharide made up of several simple sugars or sugar (glucose) molecules linked together by -1,4- and/or -1,6-glycosidic linkages. It is the most common storage polysaccharide in plants and the primary carbohydrate source in the human diet. Because of the vast variety of hydroxy groups accessible, there are many possibilities for starch derivatives. Starch and its derivatives have been extensively utilized in EFFs because to its ease of modification, environmental friendliness, and cost.

1.4 Biochar:

Biochar is a carbon-rich substance produced from the pyrolysis process of agricultural wastes or other cellulosic biomass at a relatively high temperature. Because of its positive environmental effects, such as increased agricultural profitability, reduced eutrophication risk, carbon sequestration from the atmosphere and restoration of degraded land, biochar has been used as a biofertilizer or a supporting document for the controlled release of fertilizer. A recent research used a polymer matrix made up of cotton stalks (CSs), acrylic acid (AA), 2-acrylamide-2-methylpropanesulfonic acid (AMPS), and bentonite (bent) to create biochar-based slow-release nitrogen fertilizers (BSRFs) in NH^{4+}loaded biochar (N-BC). These fertilizers had an increased nitrogen efficiency (64.27%), low nitrogen migrate-to-surface-loss (7.4%), and low nitrogen-leaching-loss percentages (10.3 percent). Furthermore, they successfully decreased nitrogen release (69.8% nitrogen released after 30 days) and, as a result, efficiently improved cotton plant development[6].

2. The environmental impact of EFFs:

Water contamination, air pollution, soil quality deterioration, and other undesirable consequences occur from fertilizer loss. EFFs help to reduce pollution by lowering nitrogen oxide (NO_x) and nitrogen dioxide (N_2) emissions, raising soil organic matter levels, changing soil pH to an optimum pH, and enhancing soil water retention and holding capacity.

3. Obstacles and prospects:

The expense of EFFs is the most significant impediment to their use. The following factors contribute to the high cost: coating ingredients are considerably costlier than fertilizer; the manufacturing process is complex; a size separation equipment is used to produce a flawless coating; and labor costs rise.

As a result, compared to traditional chemical fertilizers, EFFs have been and continue to be a tiny market. The deterioration of the materials on EFFs is another issue. Pure biodegradable organic polymers are vulnerable to microorganisms and enzymes, and thus are unable to properly regulate fertilizer release over time. There are two issues regarding the degradability of natural thermoplastic polymer blends or copolymers. The first is the maximum percentage ratio of synthetic polymer in blends or copolymers that may be used. Second, in asserting the degradability content of blends or copolymers, what is the permissible upper limit of degradability (percentage). EFFs should, in theory, be able to satisfy the crop nutrient requirement for the whole season with a single application. Plants need more nutrients throughout the growth phase, while they do not require any nutrients during the early stages of plant development or during maturity. However, the majority of EFFs do not directly react to plant nutrient needs[7].

Furthermore, no appropriate research of EFF release behavior under a variety of environmental circumstances, such as varying temperatures, ambient moisture, soil types, soil pH, soil bioactivity, and so on, has been conducted. The release behavior of fertilizers coated with hydrogels/super absorbents is particularly sensitive to water in the environment. During irrigation or rain, hydrogels/super absorbents expand, allowing nutrients to be released. Hydrogels/super absorbents dry up during irrigation or rain intervals, delaying nutrient delivery. This may not be in accordance with crop development cycles or nutritional requirements. What is apparent, however, is that the environmental advantages of EFFs are worth further investigation, particularly for high-value crops[8].

Furthermore, governments may find the environmental advantages helpful in calculating cost-sharing to encourage farmers to adopt EFFs in their agricultural production systems. In light of the aforementioned difficulties, the authors make the following recommendations: Although different natural materials have been used as coatings to slow the release of nutrients and improve fertilizer effectiveness, they must be processed and produced in an environmentally friendly and cost-effective manner[9]. Plants need more nutrients throughout their growth phase, however most EFFs release nutrients quickly during the early stages of plant development. The insufficient hydrophobicity of these natural-materials-based coating compounds is always the source of this imbalance. To synchronize nutrient release with crop development timelines or nutrient requirements, novel biodegradable and renewable coating materials with extreme hydrophobicity should be researched and developed[10].

CONCLUSION

Fertilizer losses not only lower nutrient efficiency, resulting in lower plant yields, but they also have negative environmental consequences. Efforts to address these issues have resulted in a wide range of solutions. Eco friendly fertilizers (EFFs) in particular are an efficient method to increase nutrient-use efficiency, decrease fertilizer leaching and volatilization losses, and reduce environmental risks by delaying or even regulating nutrient release into soil. However, there are still certain obstacles to overcome. The following factors should be taken into account. To begin, coating material should be biodegradable and inexpensive. In order to promote large-scale fertilizer production, the preparation procedure should also be easy and cost-effective. Degradable natural fibres, which have sparked interest in covered fertilizers, may be considered in the development of new kinds of EFFs in this regard. Second, good EFFs should be able to satisfy crop nutrient needs throughout the season with only one application. A better knowledge of the impact of different environmental factors including temperature, ambient moisture, soil type, soil pH, and soil bioactivity will open up new avenues for more efficient EFFs. However, although the use of EFFs has not been connected to the development of sustainable modern agriculture, it has been linked to advancements in the sustainability of water and pesticide usage, energy input, manufacturing, and other economic sectors that have a major effect on the environment.

REFERENCES

1. T. Thomidis, N. Karagiannidis, and C. Karagiannidis, "Effect of New Environmentally Friendly Fertilizers in a Commercial Vineyard," *J. Agric. Sci.*, 2015, doi: 10.5539/jas.v8n1p132.
2. K. Tanaka, "Functional Biodiversity Indicators and their Evaluation Methods in Japanese Farmlands," *Challenges Agro-Environmental Res. Monsoon Asia*, 2016.
3. J. Leifeld, "How sustainable is organic farming?," *Agric. Ecosyst. Environ.*, 2012, doi: 10.1016/j.agee.2012.01.020.
4. D. Kempa, "Environmental services coupled to food products and brands: Food companies interests and on-farm accounting," *J. Environ. Manage.*, 2013, doi: 10.1016/j.jenvman.2012.06.006.
5. M. Fernández-Delgado Juárez, S. Waldhuber, A. Knapp, C. Partl, M. Gómez-Brandón, and H. Insam, "Wood ash effects on chemical and microbiological properties of digestate- and manure-amended soils," *Biol. Fertil. Soils*, 2013, doi: 10.1007/s00374-012-0747-5.
6. A. Balasus, W. A. Bischoff, A. Schwarz, V. Scholz, and J. Kern, "Nitrogen fluxes during the initial stage of willows and poplars in short-rotation coppices," *J. Plant Nutr. Soil Sci.*, 2012, doi: 10.1002/jpln.201100346.
7. Q. Song *et al.*, "Effect of straw retention on carbon footprint under different cropping sequences in Northeast China," *Environ. Sci. Pollut. Res.*, 2012, doi: 10.1007/s11356-021-14316-4.
8. Y. Sugihara, H. Ueno, T. Hirata, M. Komatsuzaki, and H. Araki, "Contribution of N derived from a hairy vetch incorporated in the previous year to tomato N uptake under hairy vetch-tomato rotational cropping system," *Hortic. J.*, 2016, doi: 10.2503/hortj.MI-073.
9. E. Pelzer *et al.*, "Pea-wheat intercrops in low-input conditions combine high economic performances and low environmental impacts," *Eur. J. Agron.*, 2012, doi: 10.1016/j.eja.2012.01.010.
10. S. K. Tanveer, X. Wen, X. L. Lu, J. Zhang, and Y. Liao, "Tillage, Mulch and N Fertilizer Affect Emissions of CO2 under the Rain Fed Condition," *PLoS One*, 2013, doi: 10.1371/journal.pone.0072140.