APPLICATION OF NANOCOMPOSITE MATERIALS AND NANOFERTILIZER

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***Abstract* -** In the present article "composite is a combination of two or more different materials that are mixed in an effort to blend the best properties of both." A nanocomposite is a composite material, in which one of the components has at least one dimension that is nanoscopic in size that is around 10^{-9} m. Nanocomposites are high performance materials which reveal rare properties. Nanocomposites have an estimated annual growth rate of 25% and fastest demand to be in plastics and elastomers. The use of fertilizers, especially Nitrogen (N) and Phosphorus (P) are two important macronutrients responsible for the growth and yield of agricultural crops. Developing efficient fertilization practices has become more and more important due to the ever-increasing global demand for food products.

***Keyword* -Nanocomposite, Nanofertilizer, Carbonnanotubes, Zeolite, Agrochemical.**

I. INTRODUCTION

A composite material consists of an assemblage of two materials of different natures completing and allowing us to obtain a material of which the set of performance characteristics is greater than that of the components taken separately. [1] A nanocomposite is a composite material, in which one of the components has at least one dimension that is nanoscopic in size that is around 10-9 m. Scaling might be helpful: a coin is on order of 1-2 mm thick, or 10-3 m; a carbon fibre, commonly used as a reinforcement in sporting goods, is approximately 7 µm in diameter, or 10-6 m; a carbon-carbon chemical bound, the basic unit of life, is about 1.5 Å, or 10-10 m. (Thomas E. Twardowski ,2007)[2] Today agriculture in the world is facing major tasks are reduction in yield, shrinking in the cultivable land due to globalization, less efficiency of nutrient, lack of nutrient availability and uptake is poor in soil, decreasing organic matter in soil, deficiency of water accessibility. In this critical situation it is more challenging to produce adequate food to feed the increasing populaces, which is projected to pass 9 billion by 2050. The nanofertilizer is ecologically safe and increase soil fertility, crop productivity and nutrient use efficacy. Nanofertilizer deals with atom-by-atom manipulation and the processes and products evolved are quite precise. Despite the fact that the nanotechnology is greatly exploited in the field of energy, environment and health, the research is agricultural sciences had just scratched the surface. Conversely, the importance and potentials of nanotechnology in agricultural sciences had been reviewed [3]. The nanofertilizers technology is very inventive and known to show economic benefit if the products evolved are economically viable and socially maintainable. These customized nanofertilizers are reported to decrease nutrient loss due to leaching, emissions in soil ecosystem. [4] Nanocomposites suggest rare properties that ascend from their small size, large surface area, and the relations of phases at their interfaces. They are striking for their prospective to develop performance of drugs, catalysts, biomaterials and other high value added materials. It has been reported that deviations in particle properties can be observed when the particle size is less than a particular level, called 'the critical size' [5,6]. As dimensions reach the nanometre level, interactions at phase interfaces become mostly enhanced. Additionally, unearthing of carbon nanotubes and their successive use to formulate composites demonstrating some of the unique carbonnanotubes related mechanical, thermal and electrical properties added a new and fascinating dimension to this area. Currently, nanocomposites offer new technology and business opportunities for all zones of industry, in addition to being environmentally friendly [7-9].

II. Prospects of nano-composites:

Nanocomposites offer an exceptionally extensive range of prospective applications from electronics, optical communications and biological systems to new materials. Many possible applications have been explored and many devices and systems have been considered. More potential applications and new devices are being proposed. It is evidently impossible to recapitulate all the devices and applications that have been studied. It is interesting to note that the applications of nanocomposites in diverse fields have clearly different demands, and thus face different challenges, which necessitate different approaches [10-12]. Understanding specific applications of nanomaterials in fertilizer is critical to preventing inadequately researched, field tested and regulated products from exacerbating current environmental and public health problems associated with industrial scale use of synthetic chemicals. Scientists are under enormous pressure to deliver technologies to increase yields that are not only technically reliable but cost-effective for the fertilizer industry and for farmers.6 The public has an important role to play to ensure that any new nano-fertilizer products are not rushed to market before their environmental and public health impacts can be determined, reliably validated, and diminished, if not eliminated, through regulation and product re-design. [13]

III.Technology of nano fertilizers:

The nano-fertilizer denotes in nano scale range to deliver nutrients to plant and also present invention which substitutes conventional fertilizer the nanofertilizer release and uptake of nutrients in the soil and crop is high [14]. The nano fertilizer will improve absorption of nutrient, potentially enhance photosynthesis, enhances the crop production [15]. The encapsulation technique is used to hold nutrient inside the carrier with polymer and steadily release nutrient to crop. The zeolite based nano porous fertilizer utilization and interest will increasing within young researchers in nano technology field [16, 17] nanofertilizer can enable nutrient carriage to the rhizosphere region and minimize nutrient loss and further improve use efficiency of applied fertilizer. The nano fertilizers work carried out by [18] reported that using silica nano mesoporous particle to encapsulate urea and produce nano nitrogen slow release fertilizer [19] found that apatite as a source of nano phosphatic fertilizer will reduce the hazard and eutrophication problem in water ecosystem. The nano size in nature of fertilizer will enter into the plant cell is very easy without creating any ill effect [20] research reported that chitosan biodegradable polymeric molecule has been used as a source to produce nitrogen, phosphorous and potassium based nanofertilizer.

IV. Important of nanofertilizers:

Nanofertilizer innovative needed products for fertilizer industry and it's having higher surface area and auspicious picking for improving the quality and quantity of plants and seeds grown for consumption, to minimize production cost as well as ecofriendly to sustainable food production. The nanofertilizer are smaller in size, shape, charge of particle this will synthesized based on crop specific and demand oriented. Abundant particle like silver, titanium, zeolite, copper, silica, aluminum, carbon, zinc, and nitrogen based nanofertilizer is available. Generally nanofertilizers are slow release: over a period of time the nutrient will available to crop at entire life cycle. Quick release: the outer most shell of the nano particle it breaks easily and quick release of nutrient in to the soil. Specific release: some specific chemicals molecules involve breaking shell of the nano particle. Moisture release: in the presence of water molecules in nanofertilizer release nutrient in easy manner. Heat release at a particular temperature nano particle gets released. pH release specific alkaline or acidic condition favor the slow release of nanofertilizer. The nano composite and fertilizers efficiently reduce nutrient loss from environment and increase use efficiency of nutrient [21, 22] found that nanofertilizer play important in agriculture production up to 35–40% to effectively reduce chronic problem, eutrophication, and nano fertilizer are alternative for conventional fertilizer.

V. Formulation and preparation of nanofertilizer:

1. Nitrogen:

The urea treated with hydroxyapatite nanoparticles is attained by controlled adding of phosphoric acid into a suspension of $Ca(OH)_2$ and urea, monitored by fast drying using spray dryer. The research found that release of urea from the nanohybrids with a 1:6 hydroxyapatite to urea ratio released urea 12 times more gradually associated to pure urea. Additionally, the nanohybrid confined very nearly the same quantity of available nitrogen as pure urea [23].

2. Phosphorus:

The encapsulated unmodified zeolite potassium dihydrogen phosphate release phosphorus from fertilizer and the percolation reactor used to test release pattern of surface modified zeolite from soil. The research found that the phosphorus source from fertilizer-loaded surface modified zeolite was accessible 1080 h of constant percolation; however phosphorus from potassium dihydrogen phosphate was arrest 264 h. This study confirmed that surface modified zeolite act as a potential nano fertilizer for phosphorus.

3. Potash:

Li and Zhang [24] described that potassium encapsulated with zeolite as a controlled release fertilizer and observed the hot pepper growth parameter and potassium dynamics in soil. The high cation exchange capacity of the nano clays is produced when silica (Si4+) is replaced by aluminum (Al3+) increase negative charge in the clay lattice. This negative charge is composed by cations such as ammonium, sodium, calcium, and potassium, which are interchangeable with other cations. Potash fertilizer is directly involved in photosynthesis process, it assist stomata opening in leaves and water storage. Potash fertilizer is released slowly by using Polyacrylamide-based coated pellets. The fertilizer contributes 35–40% of crop productivity along with seed and proper irrigation. The imbalance use of fertilization especially urea it may create surface water nitrate pollution and deficiency of nitrogen in soil. In the earlier few decades, use efficiencies of nitrogen, phosphorous and potassium fertilizers have continued stable as 30–35%, 18–20%, 35–40% respectively. To overcome multi-nutrient deficiencies, imbalanced fertilization, low fertilizer use efficiency and decreasing soil organic matter it is crucial to develop a nano-based fertilizer for smart delivery of nutrient to targeted site. The application of nanofertilizer in foliar spray of 640 mg/ha foliar application (40 ppm concentration) of nano phosphorous gave 18 kg/ha phosphorous equal yield of cluster bean and pearl millet in arid environment condition. The research data propose that stable fertilization can also be delivering through nanotechnological approach to meet out crop demand and fertilizers encapsulated in nanoparticles will enhance the uptake of nutrients [25].

4. Nutrient use efficiency and nanofertilizer:

Enhancing nutrient use efficiency is a commendable goal and ultimate trial handled by agriculture fertilizer industry in worldwide. Presently nanofertilizer have involved with the experimental fields to increasing use efficiency of applied fertilizer. The nanofertilizer consist of higher surface area because lesser in size of the nanoparticle and have high reactivity, solubility in water. The nano encapsulation techniques considered as three ways: (a) nutrient can be encapsulation inside nanoporous particle, (b) A thin polymer can be used for outer coating (c) Can be released nanosize level fertilizer. Zeolite based nano encapsulated fertilizer is ability to release nutrient in slowly in to the crops and increase nutrient use efficiency [26]. In the conventional fertilizer the 50–70% of low in nitrogen uses efficiency. New smart delivery systems of nano technological approach is enhance nitrogen availability and use efficiency. The fertilizer use effectivity in 10–25% for phosphorus. With nano-fertilizers rising as substitutes to traditional fertilizers, buildup of nutrient in soils and thereby eutrophication and drinking water impurity may additionally be eliminated. In fact, nanotechnology has opened up new opportunities to enhance nutrient use efficiency and limit charges of environmental protection. The encapsulation techniques such as manganese core shell will help to uptake and slow release of nutrient need based (5). Maximum number of agricultural soils in India has low native fertility and effective and continuous crop production on these soils needs regular nutrient efforts. The considerable available of nutrients for recycling through animal manures and crop residues is significantly insufficient to reimburse for the quantities uptake in crop production. However, the use of conventional fertilizers in worldwide improved progressively over a period of time the use efficiency of nutrients applied as fertilizers continues to remain terribly low in phosphorous (15–20%) and micronutrients (2–5%) like zinc, iron, copper. When nutrient inputs are used incompetently then both cost of farming and threat of biosphere pollution rise. Thus, the economy and ecology highlights the obsessive need for more effective use of nutrients in crop production. Since, fertilizer nutrients are exclusive and used in huge quantities at national level, any rise in use efficiency will lead to a considerable cut in nutrient necessity and huge economic advantage at national level [27]. The slow-release properties of Zn to plants may be closely associated with higher yields. Nanotechnology has great potential in agriculture as it can enhance the quality of life through its application in fields like sustainable and quality agriculture, and improved and rich food for the community [28, 29].

5. Environmental and health situation of nanofertilizers:

The utility of nanostructures or nanoparticles as agrochemicals (fertilizers or pesticides) is systematically being explored, before nanofertilizers may want to be used in agriculture or farming for a general farm practice. The homes of many nanoparticles are viewed to be of attainable hazard to human health, viz., size, shape, solubility and crystal phase, type of material, and exposure and dosage concentrations. However, specialist opinions indicate that food products containing nanoparticles available in the market are probably protected to eat, but this is an area that needs to be more actively investigated. To address the protection challenge element research are required to know the effect of nanoparticles within the human body once exposed through nanofood. Researchers have to assess and improve suited evaluation techniques to investigate the impact of nanoparticles and nanofertilizers on biotic and abiotic factors of ecosystem. Among the various issues, the accumulation of nanomaterials in environment, edible part of plants would possibly be the necessary issues earlier than use in agriculture.

6. Conclusion:

World population is increases geometrically its agricultural challenge for feed and developing population with nutritious food. The biotic and abiotic scope which limits the agricultural production has an effect on human health and use of exclusive nanofertilizers to improving crop production in agriculture. It is required to attentively study the association of nanoparticle and crop micro biome. Supplementary, in order to recognize the interface of nanoparticlewith soil and environment ecosystem.Investigational confirmation of the allowable use of nanofertilizer quantity within safety limits need to be described. The interface of nonmaterial's with soil and plants varies with the type of nanofertilizer the applied attention of nanoparticle the time of treatment, plant genotype and the stage of growth. Regardless of these possible benefits, the recommendation of nanofertilizer in crop enhancement could come with hazards for the environment non-target plants, useful soil organism affected if nano-materials are misrepresented.

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