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COMPARATIVE STUDY ON THE USE OF TRADITIONAL, CONVENTIONAL AND ADVANCED METHODOLOGIES FOR SUSTAINABLE AGRICULTURE – A REVIEW

Minal Patel*, Hitesh Kumarkhaniya, Bharat B. Maitreya

Department of Botany, Bioinformatics and Climate Change Impacts Management,
University School of Sciences, Gujarat University, Ahmedabad-380009, Gujarat, India.
Corresponding Email Id: minu4960@gmail.com

ABSTRACT

Environmental friendly techniques for elevating soil health includes the use of various organic amendments such as in the form of organic manures, green manures, organic matter in form of leftover straws, bio-fertilizers, composts, and many more. Traditionally the farmers usually preferred to make use of organic manures as they received a by-product from cattle farming. This helped them to maintain soil health sufficiently. However, now with the increase in population and decrease in crop yield, it has been the time to make some efforts to produce as much as sufficient as the food demand. Therefore, the conventional trend developed towards the use of artificial amendments in the form of chemical fertilizers. This improved the crop yield and proved effective to nourish demand. However, this also turned a curse with time by lowering bio geological cycles of soil and so lowering the fertility which indeed made overuse of chemical fertilizers. This has been continued for decades. Momentarily focusing more on crop productivity by supplying nutrients without harming the rhizosphere has been made possible with the help of nano fertilizers. Nanotechnology is the most advanced technology in current research trends. The current review focuses on how effective these methodologies are.

Keywords: Manures, Fertilizer, Nano-biofertilizer, Soil health

1. INTRODUCTION

Same as other fundamental resources, Soil, being a natural resource supports various goods in the ecosystem and benefits mankind (Maikhuri and Rao, 2012). The hidden principle of the term “soil health” explains that the soil not only serves as the medium for growing, instead it is living and dynamic changes the environment so subtly (Das and Verma, 2011). Soil = Solid + Mineral + Organic phase + Liquid phase + Gas phase (Pansu and Gautheyrou, 2006). Along with its productive efficiency, according to (Maikhuri and Rao, 2012) soil also plays a major role in: a) Sequestration of carbon, b) Purification of water, c) Ground water recharging, d) Controlling pathogenic populations, e) Biologically fixing Nitrogen) Conservation of Biodiversity.

Along with the management of physicochemical properties of soil for the production of plants, interaction among the communities of microbes present surrounding the roots in the soil is also considered a part of soil health which may act as promoters or inhibitors to respective plants (Lehmann et al., 2020). This way soil may be used to indicate the health of the plant (Nielsen et al., 2002). The balance in all the three properties like chemical, physical as well as biological including micro biomass performing enzyme activities (Das and Verma, 2011).

Organic manures generally develop the soil's physical, chemical, and biological properties along with conserving the moisture-holding capacity of soil and thus resulting in improved crop productivity. Although organic manures contain plant nutrients in lesser quantities as compared to fertilizers, the presence of growth-promoting principles such as enzymes and hormones, besides plant nutrients, make them essential for the improvement of soil fertility and productivity (Premshekhar and Rajshree, 2009).

Green manuring, the term itself suggests that it has nothing to do with animal waste and expresses only about plants. Large numbers of farmers incorporate green manuring into their practices as a result of the growing issues facing agriculture (Iderawumi and Kamal,2022).

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Socioeconomic factors such as the cost of land, labor, and mineral N fertilizer are seen to determine the cost-effectiveness and thereby farmers' adoption of sustainable green manure technology (Sanjana et al., 2022). Growing green manure is a beneficial and affordable way to ensure the long-term productivity of agricultural fertile soils (Iderawumi and Kamal, 2022). Because of their benifits on the physical, chemical, and biological quality along with the proper justification of soil fertility, green manures can play a significant role. Because of the agricultural use of green admixture crops and their integration, organic matter is provided to the soil, making green manures requirement in achieving assembly sustainability. Then, in cropping systems, green manure legumes supply nutrients to crops based on their capacity to fix biological nitrogen. One of the best methods to enhance soil structure, stop soil erosion, maintain soil moisture, and increase the amount of organic matter in the soil is to use “green manure” (Iderawumi and Kamal, 2022).

Since green manuring is cost-effective, eco-friendly, nourishes the soil, and enhances plant growth and improve yield apart from improvements in soil organic matter content and microbial population, it will pave a possible way to achieve sustainability in agriculture which is an urgent need of the hour. In addition to it research is needed to determine the role of green manuring in nitrogen fertilizer savings in rainfed and irrigated dry crops, as well as to explore low-cost non-chemical pest and disease management approaches in green manure crops (Sanjana et al., 2022).

By using chemical fertilizers the yield can be maximized by the inputs of nutrients essential for plant health chemically for various agriculture management systems (Kibblewhiteet al., 2008). Recently there is an excessive amount of input of chemical fertilizers having nitrogen, phosphorus, and potassium in the farming practice to provide plants with all the required needs for increasing productivity in agriculture (Kumar et al., 2022). Around 53 billion tons of NPK fertilizers are used yearly to supplement the number of nutrients needed for plant growth and yield performance (Kibblewhiteet al., 2008). Unfortunately, only a small percentage of these nutrients are used by plants, while a greater percentage is precipitated by metal cations present in the soil (Fasusiet al., 2021). These practices and inputs supplement or even ‘substitute’ for biological functions that are seen as inadequate or insufficient for achieving required levels of production (Kibblewhiteet al., 2008).

Soil biota is a term that refers to the complete community of microbes within the soil system, although biodiversity can vary from soil to soil (i.e., grassland, arable, forest) and also among different plant species (Balestrini et al., 2015). The most dominant group in soil biota, both in terms of number and biomass, is represented by microorganisms (i.e., bacteria, archaea, and fungi), which show different nutrient strategies and lifestyles (saprotrophs, pathogens, symbionts) (Balestrini et al., 2015).

soil quality, availability of nutrients, environmental conditions as well as the biological health of the soil are other important criteria for improving crop yield per unit area for achieving the targeted goal of food security. Plant-associated microbes with their plant growth-promoting traits have enormous potential to solve these challenges and play a crucial role in enhancing plant biomass and crop yield (Kumar et al., 2022). Rhizosphere management can be defined as the process of improving the nutrient efficiency in the soil to enhance the nutrient needed for plant growth and improve plant yield (Fasusiet al., 2021).

Beneficial soil microorganisms enhance the management of the rhizosphere through different mechanisms that are multi-dimensional. These include the following: production of siderophore, nitrogen fixation, lytic acid production, production of hydrogen cyanide, phosphate solubilization, and production of indole acetic acid. The mechanisms of action of these beneficial microorganisms play a crucial role in improving soil fertility, plant growth, and yield (Fasusiet al., 2021). Enzymes are vital activators in life processes, likewise in the soil they are known to play a substantial role in maintaining soil health and its environment. The enzymatic activity in the soil is mainly of microbial origin, being derived from intracellular, cell-associated, or free enzyme. The biological activity in soil is largely concentrated in the topsoil, the depth of which may vary from a few to 30 cm. In the topsoil, the biological components occupy a tiny fraction (<0.5%) of the total soil volume and make up less than 10% of the total organic matter in the soil. These biological compounds consist mainly of soil organisms, especially microorganisms. Despite their small volume in soil, microorganisms are key players in the cycling of nitrogen, sulfur, and phosphorus, and the decomposition of organic residues (Das and Verma, 2011). The energy input into the soil ecosystems is derived from the microbial decomposition of dead plant and animal organic matter (Nielson et al., 2002).

Biologically and biochemically mediated processes in soils are fundamental to terrestrial ecosystem function (Kandeler, 2007). In addition to the effect on nutrient cycling, microorganisms also affect the physical properties of soil. Production of extracellular polysaccharides and other cellular debris by microorganisms helps in maintaining soil structure, as these materials function as cementing agents that stabilize soil aggregates. Thereby, they also affect water holding capacity, infiltration rate, crusting, erodibility, and susceptibility to compaction (Nielson et al., 2002).

Practically, nanotechnology permits broad advantages in agricultural research, such as disease prevention and treatment in plants using various nanocides and nutrient management of the agriculture field using nano fertilizers (Thul and Sarangi, 2015). Nanotechnology using nanodevices and nanomaterials provides new avenues for potential novel applications in agriculture such as efficient delivery of pesticides and fertilizer using nanomaterial-based formulations such as nano-fertilizers, nano-pesticides, and nano-herbicides (Kaushik and Djiwanti, 2017). To improve crop yield, it is essential to utilize the most recent innovations (Choudhary etal., 2017). Nanofertilizers reduce nitrogen loss because of soil leaching/erosion (Singh, 2017). Agri-nanotechnology promises to improve current agricultural practices and is anticipated to become a driving economic force in the near future (Jha, 2016).

Synthesis of nano-fertilizers has been done for regulating the nutrients released depending on the requirements of the crops (Goel, 2016). The application of nano fertilizers substituted for traditional fertilizers is an innovative way to release nutrients gradually into the soil in a controlled way, thus preventing negative effects caused by the excessive consumption of commercially available fertilizers (Jha, 2016). The use of nano fertilizer may lead to an increase in production along with a reduction in the frequency of fertilizer application and soil toxicity (Jha, 2016). If nano fertilizers are composed of particles having sizes lesser than the sizes of cell wall pores (5–20 nm), then they may enter in plant cells straight through the cell wall structures which are like a sieve (Goel, 2016). It is necessary to address the environmental fate, uptake, and potential phytotoxicity of NPs (Jha, 2016).

2. FERTILIZERS: ITS EFFECT AND USES

The decreasing soil nutrients cannot feed the increasing population and also leads to an increase in health issues (Akhtar et al., 2022). The elevation in food insecurity is the reason for disputes, uncertainty in the economy, and transition in the environment (Sharma et al., 2022). for the same i.e. food security throughout globally, there must be increased crop production to a sustainable level, and that too with minimal inputs (Kaushik and Djiwanti, 2017). The population of human beings is increasing along with the decrease in resources and being unstable socially with a degrading environment is a severe threat to all the natural processes sustaining the global ecosphere and lives on earth (Doran, 2022). As per recent data, the trend of elevation in the population of human beings shows that by the year 2050, all overpopulation could rise to around nine and a half billion which will demand a high amount of food (Kumar etal., 2022).

Climate change because of changes in the seasonal cycle is the disturbing life cycle of crops (Akhtar et al., 2022). Some of the challenges that the agriculture sector is facing are: (Kaushik and Djiwanti, 2017) a) The yield of crops at the stagnant phase, b) Deficiency of various nutrition, c) Availability of proper water source, d) Undesired changes in climatic conditions, e) Less efficient nutrient use

There has always been Potential use of fertilizers to improve the production and food quality, especially after the introduction of high-yielding ad varieties responsive to fertilizers (Goel, 2016). Furthermore, overusing and using chemical fertilizers not appropriately leads to some side effects on the environment that affect farmers majorly which demand the introduction of environment-friendly practices (Fasusiet al., 2021).

To feed the increasing population day by day, the population worldwide is demanding agricultural products at affordable prices (Choudhary etal., 2017). The application of beneficial microbes as biofertilizers in sustainable agriculture practices has emerged as innovative and environment-friendly technology for improving soil fertility and plant growth (Kumar et al., 2022). The study of microbial communities inhabiting diverse habitats and their collective contribution to plant growth development and protection has received intense interest over the last two decades (Kumar et al., 2022). Continuous innovation is strongly needed to meet the challenges of increasing global food security and climate change (Kumar et al., 2017).

3. EFFECTS OF FERTILIZER ON SOIL AND CROPS:

Soil consists of a solid phase having a variety of particle sizes surrounded by gaseous phases and fluids, whose composition fluctuates quantitatively and qualitatively with space and time. Generally, the water remains discontinuous when the water is not saturated exceptionally. The soil is a porous space filled with water and in absence of it gets filled by air and other volatile compounds. There are always interchanging molecules and ions among all phases of solids, liquids, and gases which represent a great balance among all the three properties like chemical, physical and biological. This balance is of great significance and needs to be maintained (Nielsen et al., 2002).
Soil plays a major role as either source or sink or both for pollutants during the movement of rainwater and snowmelt. These pollutants are as shown below: (Lehman et al., 2002).

- Herbicide
- Pesticide
- Antibiotics
- Heavy metals
- Microplastics
- Pathogens
- Perfluoroalkyl
- poly-fluoroalkyl
- Effluents
- Commercial waste
- Polycyclic aromatic hydrocarbon

In addition to these, the imbalance in soil nutrients by fertilizers used in agriculture also causes problems globally which is the reason for eutrophication and has a negative impact on the quality of drinking water. Previously assessment of soil generally aimed for the health of soil, however momentarily it involved all other roles such as quality of water, changes in climate, and health of human populations (Lehman et al., 2002).
Although artificial indicators i.e. chemicals, still dominate over promoting biodiversity of soil to improve soil health due to lack of awareness and ineffective methods (Lehman et al., 2002).
Quality of soil can be expressed as the suitability of a specific type of soil, its functional capacity, either within its artificially maintained or natural ecosystem boundaries for sustainability of productivity of animals and plants, improve and maintain quality of air and water and provide support for habitation and health of human beings (Maikhuri and Rao, 2012).
There are various parameters of soil that need to be calculated for determining the quality of soil. These are such as soil moisture, water holding capacity, soil pH, electrical conductivity, presence of various macronutrients and micronutrients.

3.1 Effects of Organic manures:

Animal wastes play a significant role in supplying organic matter and act as soil conditioners. On average cattle produce around 5 tons per annum of fresh dung. In countries like India and some other developing countries, most of the fraction of cattle dung produced is used as a source of fuel in cooking and heating by making bricks from it (Yadav et al., 2013).
Most significant use of cattle dung is that it easily gets converted into compost and can be used in agricultural fields as Manure. For the same the cattle dung is allowed to dry on heaps in open space naturally without any kind of amendments. This degradation process may consume some time and if still not stabilized could attract termites and flies in the field after its application. Hence, this becomes the major problem regarding flies and bad odour in rural areas (Yadav et al., 2013).

The biologically active life forms present in soil are capable of converting organic pollutants like hydrocarbon toluene into less or no harmful compounds. That is why both organic contents in the form of manure and activity of soil microorganisms determine the health of soil (Lehman et al., 2002).

Decomposition of plant litter can be measured by placing the litter in so-called litterbags in the field. Litterbags are made of inert nylon with a defined mesh size allowing a free exchange of air, water and nutrients and access for organisms. The mesh size defines the groups of organisms that can contribute to the decomposition within the litterbag. The decomposition rate of the litter is determined as weight loss per time interval (Nielson et al., 2002). The soil surface and litter layer also contain numerous macro fauna species (mainly arthropods: beetles, spiders, diplopods, chilopods, snails). Because soil functionality depends on the activity of soil biota, measures of their activity, biomass, and diversity (including the presence and health of root symbionts) have often been proposed as indicators of soil quality (Balestrini et al., 2015). The level of Organic matter in soils directly contributed to plant growth by supplying essential nutrients such as N, P, and S. The chemical structure of Organic matter has an approximate stoichiometry of C/N/P/S of 100/10/1/1 and is the primary available source of these nutrients in soil and sediments (Horwath and Paul, 2015).

3.2 Effects of Green manure:

Crop rotation and green manure/ cover crops constitute a technology that is appropriate and essential to achieve sustainable agricultural production (Donald, 2011). Utilizing green manure as an Alternative to artificial fertilizers is crucial to sustainable agriculture (Iderawumi and Kamal, 2022). Green manure/cover crops are plants that are grown in order to provide soil cover and to improve the physical, chemical, and biological characteristics of soil (Donald, 2011).

Utilizing green manure, soil microorganisms convert nitrogenous and carbon molecules into nutrients that plants may receive. When compared to controlled fields, the allowed use of green manuring produced significant levels of organic matter reserves that improved the physical and chemical qualities of the soil. Additionally, the ability to recycle nutrients was increased through the use of green manures between crop cycles. Higher agricultural yields are a result of the improved soil characteristics of the available land (Iderawumi and Kamal, 2022). Legumes are usually utilized as green manure crops as they fix atmospheric nitrogen in the root nodules through symbiotic fixation with a bacterium (Rhizobium) and leave part of it for utilization of the companion or succeeding crop. Salinized soils have also been effectively treated using green manures. Farmers are currently promoting these and other organic methods. Recently, it has been assumed that green manures' primary effects on soil quality improvement are related to an increase in soil organic matter (SOM) levels, nutrient availability and cation exchange capacity (CEC), organic acid formation, a decrease in Al^{3+} levels, and the recycling and mobilization of nutrients from deeper soil layers. The addition and balancing of SOM are crucial for the recovery of damaged soils in tropical contexts because biological activity, such as root action, macro- and microbiological activity, and organic material decomposition, is the only way to restore and sustain soil physical conditions. Dhiancha (Sesbania aculeate), sun hemp, guar, and other widelyused crops (Iderawumi and Kamal, 2022).

3.3 Effects of Chemical fertilizer:

The use of conventional mineral fertilizers is increasing at an alarming rate due to the large and rapid growth of the world's population and the ever-increasing demand for food (Pajuraet al., 2023). Complex situation between N, P and K fertilizers leads to imbalances in their use around the world (Penuelas et al., 2023).

Nitrogen fertilization has increased by an order of magnitude in the last six decades. The average increase in yield during 1930–2000 attributable to inputs of N fertilizers generally ranged from about 40–64% in temperate climates (USA and England) and tended to be much higher in the tropics. The response of agricultural systems to increased N fertilization has evolved differently in countries during the last five decades. Some countries have improved their agro-environmental performances, but increased fertilization in other countries has produced low agronomic benefits and higher environmental losses. Agronomic benefits and higher environmental losses, such as accelerated emissions of nitrous oxide leading to global

climate change and high N loadings leading to contaminated drinking water and toxic algal blooms in downstream ecosystems (Penuelas et al., 2023).
Phosphorus fertilization has increased much less than N-fertilization in the last decades. The demand for P fertilizers, however, is expected to increase in the next decades; the global peak in P production has been predicted to occur around 2030 (Penuelas et al., 2023).
Potassium fertilizer with industrial fertilizers containing the third key nutrient, K, from mineable reserves has continuously increased since the Industrial Revolution. As with P, we are currently in a scenario, where rich countries tend to over fertilize with K, implying environmental problems and even potential threats to human health, whereas poor countries frequently have problems with access to K fertilizers, limiting their crop production. Very low rates of application of potash fertilizer in agricultural production in India and other developing countries lead to the rapid depletion of K in the soil. The depletion of plant-available K in soils has a variety of negative impacts, including preventing optimal uses of N and P fertilizers, threatening the yields of the cropping systems and decreasing farmer income. (Penuelas et al., 2023).
A significant portion of fertilizers are lost, increasing agricultural cost, wasting energy and polluting the environment, which are challenges for the sustainability of modern agriculture (Chen et al., 2017).

3.4 Effects of Bio-fertilizer:

Organic manure in soils and sediments represents residual compounds and the organic structures remaining following the decomposition of plant, fauna, and microbial inputs. The formation and decay of Organic manure is an essential ecosystem process contributing to the regulation of atmospheric trace gases, particularly CO_2, N_2O, and CH_4. (Horwath and Paul, 2015).
Methane (CH_4) is found extensively in Nature and is a greenhouse gas in the atmosphere. Methane is produced in anoxic environments by methanogenic Archaea and consumed by aerobic methane oxidizing bacteria, the methanotrophs. Important terrestrial sites for methane oxidation are wetland areas receiving a high input of organic material. Furthermore, landfills containing high amounts of organic wastes are a source of methane and the habitat of many methanotrophs (Nielson et al., 2002).
The mineralization of soil organic nitrogen (N) through nitrate to gaseous N_2 by soil microorganisms is a very important process in global N-cycling. This cycle includes N-mineralization, nitrification, denitrification and N_2-fixation. Gaseous nitrogen (N_2) is a product of the anaerobic denitrification of nitrate. N_2 is lost to the atmosphere or consumed by N_2-fixing Rhizobium or cyanobacteria due to their nitrogenase enzyme (Nielson et al., 2002).
Nanotechnology refers to the engineering and restructuring of functional systems on the scale of molecules and atoms (Sangeetha, et al., 2017).
Nowadays, the field of agricultural science is diversifying worldwide (Choudhary etal., 2017). In the present scenario, agriculture sector development is only possible by increasing resource use efficiency through effective use of modern technologies, which will damage the production bed minimally because of limited arable lands and water resources (Goel, 2016). Bio nanotechnology and nanobiotechnology are important disciplines that discuss the intersection of biology and nanotechnology (Gholami-Shabaniet al., 2017). A number of plants have been used for the synthesis of gold and silver nanoparticles, for example, Solanum indicum, Allium cepa, and pomegranat (Kumar et al., 2017). The utilization of phosphorus (P) and nitrogen (N) fertilizers has turned into a prime issue globally leading to eutrophication in coastal ecosystems as well as freshwater bodies.Therefore, there are major thrusts to develop bio-fertilization by involvement of nanomaterials (NMs). The main perspective of sustainable agriculture and implication of present nanotechnology in agricultureare regarded as important factors to feed and nourish the world's quickly developing population (Choudhary etal., 2017). Earlier nanoparticles or nanostructured materials were often synthesized by chemical methods, but these days, these materials are synthesized by plant parts or microbial strains, i.e., green synthesis (Kumar et al., 2017).. In nano-fertilizers, nutrients can be encapsulated by nanomaterials, coated with a thin protective film, or delivered as emulsions (Jha, 2016). Like farming where plants are used for producing food, nanoparticle farming is also done where plants are grown in defined soil for

production of nanoparticles. Simplicity, low cost, and eco-friendliness are hallmarks of green synthesis of nanoparticles (Kumar et al., 2017).
To meet the demands of improving yields without compromising the environment, environmentally friendly fertilizers (EFFs) have been developed (Chen et al., 2017).

3.5 Effects of Nano-fertilizers:
Environmentally friendly fertilizers are fertilizers that can reduce environmental pollution from nutrient loss by retarding, or even controlling, the release of nutrients into soil. Most of EFFs are employed in the form of coated fertilizers. The application of degradable natural materials as a coating when amended into soils is the focus of EFF research (Chen et al., 2017).
Nanoparticles interact with plants causing many morphological and physiological changes, depending on the properties of NPs (Siddiqui et al., 2015). Nano-fertilizers have unique features such as ultrahigh light absorption and photo energy transmission, causing significant expansion in the leaf surface area and rise in photosynthesis. Nanocomposites consisting of nitrogen, phosphorus, potassium, and other micronutrients have shown to enhance the uptake and use of nutrients by crops (Jha, 2016). Seed is the most important input determining crop productivity (Kaushik and Djiwanti, 2017).
Plant growth and development starts from the germination of seeds followed by root elongation and shoot emergence as the earliest signs of growth and development (Siddiqui et al., 2015). There are many studies on the effects of nanomaterials on the seed germination and growth to promote its use for crop production (Kaushik and Djiwanti, 2017). Researchers from their findings suggested both positive and negative effects on plant growth and development, and the impact of engineered nanoparticles (ENPs) on plants depends on the composition, concentration, size, and physical and chemical properties of ENPs as well as plant species (Siddiqui et al., 2015). Reported that embedded single walled carbon nanotubes in the isolated chloroplast augmented three times higher photosynthetic activity than that of controls, and enhanced maximum electron transport rates, and Single walled carbon nanotubes enabled the plants to sense nitric oxide, a signaling molecule (Siddiqui et al., 2015). To reduce the harmful effects of chemicals used in chemical synthesis of nanoparticles, green synthesis is the new approach towards nano biofertilizer production.

4. GREEN SYNTHESIS
In recent term "green synthesis" has been coined for nanoparticle (NP) synthesis which has many advantages including its scalability, biocompatibility and applicability by utilizing water which acts as a reduction medium. The vitamins, proteins, organic acids, amino acids, and secondary metabolites act as capping and stabilizing agents, and playing key role to reduce metal salts of synthesized NPs. (Vittahlrajet al., 2020). Formerly, an extensive research had been done on the utilization of different plants extracts such as leaf, inflorescence, root hair, seed, peel for the synthesis of AgNPs including aloe vera, Mangifera indica, Phoenix dactylifera, Caesalpinia ferrea and Banana. Recently, it is found that onion can be used as a potential candidate for synthesis of AgNPs (Vittahlrajet al., 2020).
Biological synthesis of silver nanoparticles (AgNPs) using plants has become an alternative to the conventional chemical synthesis method (Masum et al.,2019). these physiochemical methods, although some are durable and technically viable, are highly restricted in large-scale application due to the use of hazardous chemicals, high cost, high energy and time consuming, and difficulty in waste purification. Therefore, there is a growing need to use economical and environmentally safe and green synthesis routes that use non-toxic chemicals in the synthesis protocol of various nanoparticles (Masum et al.,2019).

4.1 Silver nanoparticles
Momentarily, silver nanoparticles (AgNPs) have received a great deal of attention from many researchers working on multiple disciplines due to their unique features and a wide spectrum of applications such in food science, medical, agriculture, and agricultural technologies. Several methods have been described for the synthesis of AgNPs, such as chemical reduction, micro emulsions, radiation, hybrid methods, photochemical reduction and sonoelectrochemical, microwave-based systems and recently green synthesis route. Biological synthesis of silver nanoparticles (AgNPs) using plants has become an alternative to the conventional chemical synthesis method (Masum et al.,2019).

Onions contains various minerals viz. calcium, iron, manganese, magnesium, phosphorus, potassium, zinc, selenium, flouride and iron. Onion used as a reducing agent for synthesis of AgNPs, was obtained from the local vegetable market. First of all, onion peel was removed and washed with distilled water twice, then cut into small pieces. 10 g of onion weighted and blended with 100 ml distilled water using a high-speed mechanical blender. The obtained slurry was mixed with the 70% alcohol and stirred for 1 min to get homogenous slurry. The alcohol blended slurry was subjected to boiling with continuous stirring for 4 min. After cooling the mixture was filtered by whatman paper 1 and stored at 400C for 24h. The precipitate was dissolved in distilled water and stored it for further use (Vittahlrajet al., 2020).

In order to obtain biosynthesized AgNPs, fresh fruits of Phyllanthus emblica were procured from the supermarket and stored before use at 4°C. the fresh fruits were carefully clean with sterilized double deionized water (ddH_2O) and then chopped into small pieces and removed seeds. The sliced fruits were then finely macerated by a blender through sterile ddH_2O to obtain 10% (w/v) fruit broth. The resulting extract was passed through a muslin cloth and then filter by Whatman No. 1 filters paper and kept at 4°C until use (Masum et al.,2019).

Five ml of onion extract was mixed with 5, 10 and 20 ml of 1.0 mM AgNO3 (analytical grade, Sigma Aldrich) with constant stirring at 60–650 °C for 5 min and incubated at room temp for 5 days. The AgNPs formation was observed by the color change. The AgNPs were collected by centrifugation at 15,000g for 20 min. Dispersion of AgNPs in de-ionized water followed by centrifugation were repeated three times to confirm purification. Onion extract and AgNPs were stored as lyophilized powder (Vittahlrajet al., 2020).

In the biosynthesis process of AgNPs, the effects of the quantity of fruit extract were assessed to intensify the synthesis route producing the metal nanoparticles. In a 100 ml aqueous solution $AgNO_3$ (1 mM), various concentrations of aqueous fruit extract (2.5, 5, 10, and 15 ml) were added and boiled (65°C) for 20 min and then kept at room temperature under dark condition. To confirm that the synthesis of AgNPs was mediated by phytochemicals of P. emblica fruits, control flasks containing the mixture of aqueous solution of $AgNO_3$ and sterile ddH_2O were used. The reduction of silver ions was thus observed by changing the optical color in dark brown an taking into account the complete bioreduction of Ag overnight samples of synthesized AgNPs were measured using UV-2550 Shimadzu Spectrophotometer.

The rapidly formed biosynthesized AgNPs were obtained by centrifugation at 10,000 rpm for 10 min in a centrifuge machine followed by carefully washed with sterile ddH2O and freeze-dried following the instruction of Alpha 1-2 LDplus. and then stored at -80°C. Based on the fast reduction of AgNO3 into AgNPs, only the capable AgNPs sample prepared from 15 ml of fruit extract was used for further characterization using several methods including Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), and energy dispersive X-ray (EDX) spectroscopy (Masum et al.,2019).

Seeds of two vegetative crops (tomato and brinjal) were used and plants were cultivated in net house. The 15 days old plants were sprayed with the addition of different doses (5, 10 and 15 ml/l) of nanofertilizer extracted from Onion. The control plants were sprayed with water only. The spraying was done after every 2 days. After 7 days, data of plant vigor and biomass of plant was observed and recorded (Vittahlrajet al., 2020).

In the present study, AgNPs synthesis by reducing Ag+ ions present in the aqueous solution of silver nitrate with the help of onion extract was investigated. The best reaction conditions were obtained with 5 ml onion extract and 10 ml 1.0 mM AgNO3. The synthesis was confirmed by UV-Visible analysis. The color change from colorless to dark brown indicated the formation of AgNPs. The change in the state of a matter from the molecular scale to nano scale is accompanied with color change due to excitation of surface plasmon vibrations (SPV) in NPs (Vittahlrajet al., 2020)..

In order to standardize the nanoparticles synthesis route, different quantities of P. emblica fruit extract varied from 2.5, 5, 10, 15 ml with 100 ml aqueous solution of AgNO3 (1 mM) were tested in this study. After 30 min, the dissolution of the 15 ml fruit extract caused the rapid change in color from light yellowish to dark brown, indicating the fast reduction of AgC to Ag0 in AgNO3 solution while the color in other samples was changed after incubation for 2–8 h in a dark room and the control sample remained colorless (Masum et al.,2019)..

4.2 Characterization

The synthesized AgNPs where characterized by UV- visible spectroscopy, FTIR and SEM. From all the samples prepared, the best concentration of AgNPs Were chosen for further characterization based on the data obtained from UV-visible spectroscopy (Vittahlrajet al., 2020)..

4.2.1 UV–vis spectroscopy

Synthesis of AgNPs was assured by measuring the UV–vis spectrum of the reaction mixture. The absorption spectrum was recorded over the range of 300–800 nm using UV–vis spectrophotometer [14]. The synthesis of AgNPs in the solution was confirmed by the results of UV-visible spectrophotometers, which exhibited a spectrum of surface plasmon resonance (SRP) ranging from 430 to 436 nm of absorption band. However, it could be noted that AgNPs was also synthesized with 2.5 ml of fruit extract in 100 ml AgNO3 solution. Indeed, the SPR spectra of AgNPs derived from the higher concentration of fruit extract showed a sharper and strong absorption band at 430 nm (Masum et al.,2019)..

4.2.2 Fourier transform infrared

The FTIR spectra of biogenic AgNPs derived from P. emblica fruit extract after reaction with $AgNO_3$ and fruit extract control without $AgNO_3$. The FTIR data indicates the marginal shift in the peak position of spectra as depicted. The spectral analysis reveals the number of functional biological group responsible for stabilization of nanoparticles, which acts as capping or stabilizing agents. FTIR measurement based on AgNPs mediated by fruit extract revealed different absorption peaks at 3404, 2923, 2852, 1637, 1535, 1384, 1219, 1160, 1061, and 519 cm^{-1}. In case of AgNPs, a very strong absorption peak shifted toward a lower wave number was observed at 3404 cm^{-1}, which indicates the binding of silver ion (Ag^+) with hydroxyl and or amine groups in the P. emblica fruit extract. Other bands figured at about 2923 and 2852 cm^{-1}, are also remarkable because of the stretching vibration of hydrocarbon (C–H) bonded of alkenes, while the peak at 1637 cm^{-1} is also predominant and represents the involvement of amide-I bond (–C = O) of proteins as a capping agent and stabilization of AgNPs. Moreover, the band at 1621 cm-1 in fruit extraction was due to the presence of amide I vibrations, which was shifted to 1535 cm^{-1} in AgNPs due to the proteins that may have been linked to AgNPs by the amine groups. The peak observed around 1384 cm^{-1} in AgNPs spectra extract that could be assigned to C–H symmetric vibrations and same peak was also observed in fruit extract. The spectral peak at 1238 cm^{-1} in extract (shifted to 1219 cm^{-1} in AgNPs) was found by the C–C stretching vibration (Masum et al.,2019).

4.2.3 Scanning electron microscopy

The morphology of AgNPs was studied using SEM. Thin films of the sample were prepared on a carbon coated tape by just placing a very small amount of the sample on the grid, extra sample removed using a blotting paper and then the film on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 minutes. The SEM analysis was used to determine the structure of the reaction products that were formed (Vittahlrajet al., 2020).

5. OBSERVATION OF ALL THE TREATMENT OF FERTILIZER:

The increased fresh weight and vigor of nanobiofertilizer treated plant can be because of onion is rich in carbohydrates, proteins, sodium, potassium and phosphorus. These mineral nutrients play a very important role in plant growth and development. Potassium citrate increases leaf area, improves leaf mineral content, enhances yield, and improves fruit quality. Similarly, the application of nano silver liquid showed the highest dry and fresh weights compared to the control green onions (Vittahlrajet al., 2020). they concluded that the nanobiofertilizer synthesized from onion extract was an effective fertilizer for brinjal, tomato plants and need to test it in field condition. The use of such types of nanobiofertiizer could reduce the environmental pollution and the excessive use of chemical fertilizers in the field and helps in reduction of farm management costs. the study clearly provides an economic, environmental friendly, and straightforward reproducible approach in AgNPs synthesis employing P. Emblica fruit extracts as a reducing, stabilizing, and capping agent (Masum et al.,2019).. The FTIR results found several phytochemicals responsible for the rapid reduction of ions, leading to AgNPs formation. Especially, hydroxyl groups oxidation of hydrolysate, which likely stimulated the formation of nanoparticles. In the reaction mixture, biosynthesized AgNPs have been detected as mono-dispersed, rather stable, of comparatively smaller in shape and were adhered with an organic layer, in which proteins participated (Masum et al.,2019).

Nano-biofertilizer improves soil fertility by various strategies including: (a) restoring nutrients by nitrogen fixation and phosphorus solubilization; (b) enhancing nutrient absorption capacity of the soil; (c) siderophore production that chelates iron and sequesters heavy metals to make them unavailable for plants; (d) producing phytohormones and compatible solutes; (e) conserving soil moisture; and (f) developing resistance or tolerance in plants against biotic and abiotic stresses. They also enhance the nutrient use efficiency of plants (Akhtar et al., 2022). The application of nano-biofertilizer increases the number of grains per comb, the number of rows per comb, grain yield, and biomass yield and improves the harvest index of Z. mays in a limited water supply. Nano-biofertilizers aid in bioremediation and replenish essential nutrients in the soil. They upregulate genes responsible for producing antioxidants, osmolytes, and stress-related proteins, reduce the damaging effects of ROS on plants, and maintain the structure and function of the cell. They also preserve membrane transporters enhanced hormonal production and their activities (Akhtar et al., 2022) When the plants receive these treatments, their antioxidant systems become active, protecting the cell membrane and organelles from the adverse effects of stress. They also increase their levels of growth hormones, including indole acetic acid and cytokinin, while reducing the production of stress hormones (abscisic acid). These changes make the plant stress-tolerant and increase the chances of crop establishment under unfavorable environmental conditions (Akhtar et al., 2022).

CONCLUSION:

Nanofertilizers used as foliar application reduced the risk of soil degradation due to harmful chemical fertilizers. And moreover, the slow-release mechanism prevents the loss of nutrients by leaching. Where Green manure, organic manure, biofertilizer, etc. as fertilizer alone are not sufficient enough to produce the yield to fulfil the demand. Hence, external treatments are necessary and so nano fertilizer should be promoted. Many more researches need to be conducted on larger scale to get the best result possible.

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