Role of Organic Fertilizers in Improving Soil Fertility

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1 Introduction

Fertilizer Fertilizer is a chemical mixture of various macro- and micronutrients (in a proper ratio) required for sustainable growth and development of the plants. Organic fertilizer is used to maintain soil fertility. Organic fertilizers are biodegradable material, which makes better nutrient sources. Organic carbon content of organic fertilizers has equivalent or higher value of nitrogen and phosphorus contents. An organic fertilizer enhances potential growth of heterotrophic bacteria in soil of root zone and stimulates primary and secondary productivity in plants (Anderson 1987; Qin et al. 1995; Bokhtiar and Sakurai 2005). Quality and health of the soil could be improved by the application of organic manures at an optimum level (Yanan et al. 1997). A diagrammatic picture of different types of organic fertilizer is presented in Fig. 1.

Soil Fertility The inherent capacity of the soil to supply all essential macro- and micronutrients for the survival of plants in available forms and in a suitable proportion is known as soil fertility (Boulaine 1989). The soil fertility mainly depends on the mineralogical composition of the parent material, topography, and biological activities in the soil and local climatic conditions as temperature, solar radiation and rainfall required for pedogenesis. It is the outcome of the interactions between the

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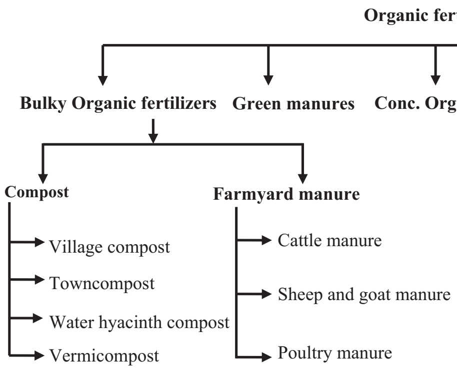

Fig. 1 Types of organic fertilizers

biological, chemical and physical properties of soil due to soil nature and the effects of climate (Liu et al. 2010).

Maintenance of Soil Fertility Soil fertility maintenance is the retaining, cycling and supplying of mineral nutrients required for the growth of plant over several years. It can be maintained by organic amendments (plant material, animal residues and sewage sludge) to soil, which are rapidly decomposed by enzymatic actions of rhizospheric microbes such as cellulase, pectinase and protease, releasing mineral nutrients such as nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) (Gianfreda and Bollag 1996; Zhang et al. 2012; Dong et al. 2012; Patil et al. 2014; Liu et al. 2014). Soil microbial biomass carbon (C) and nitrogen (N) represent the microbial size and soil fertility status and maintain nutrient pool in soil (Nair and Ngouajio 2012). There is an immense role of microbial flora to increase soil fertility, which is stimulated by many physical and chemical parameters of soil such as soil organic matter (SOM), acidity, alkalinity, and clay content (Nautiyal et al. 2010; Xun et al. 2015).

The activity of soil organisms (macroorganism and microorganisms), mineral types, soil–air exchange rates and other biological, chemical or physical processes are related to soil fertility (Das and Mukherjee 1990; Diacono and Montemurro 2010). Soil microorganisms play an important role in agro-ecosystem by degrading soil organic matter, nutrient cycling and bioremediation of pollutant of soil (Shaheen et al. 2007; Dong et al. 2014; Luo et al. 2015; Matulich and Martiny 2015). The microbial population of soil is influenced by soil organic matter that helps in improving soil fertility (Ge et al. 2010). Soil organic matter (SOM) plays a very important role in soil fertility. SOM is a very important factor that can improve soil structure stability, resistance to rainfall impact, rate of infiltration and faunal activities (Roose and Barthes 2001).

2 Types of Soil Fertility

(a) **Permanent Soil Fertility:** This type of fertility depends on the inherent nature of the soil itself. It can be improved and sustained by soil management practices.
(b) **Temporary Soil Fertility:** This type of soil fertility is acquired by appropriate soil management. This soil fertility is extremely dependent on the permanent fertility that is already available.

Organic Fertilizer Organic fertilizers are naturally occurring fertilizers produced by both plants and animals.

3 Types of Organic Fertilizer

1. Bulky organic fertilizer
   (A) Compost
   (B) Farm yard manure
2. Green manures.
3. Concentrated organic fertilizers*:*
   (A) Oil cakes: richest sources of plant nutrient of all organic manures
   (B) Other concentrated organic fertilizers
4. Guano
5. Biofertilizers
   (A) Algal biofertilizer
   (B) Fungal biofertilizer
   (C) Bacterial biofertilizer

1. Bulky Organic Fertilizers**:** These Types of Fertilizers Contain Low Amount of Plant Nutrient
   (A) Compost

Compost is the rotten organic matter that has been decomposed by the process of composting. The process of composting can be enhanced by providing controlled optimum conditions for the detritus eating microorganisms. Microorganisms play a vital role in converting heterogeneous organic matters into humus substance by the composting process. The main decomposers of organic matter are bacteria (including actinomycetes), fungi and protozoa. Protozoa, mites, nematodes and springtails feed on microbes that are involved in decomposing of organic matter (Neher 1999). Compost can be prepared from a range of waste materials like crop stubbles, straw, crop residue such as sugar cane trash and rice husks, litter, weeds, leaves, and kitchen waste. This type of compost contains 0.7–1.0% K_2O, 0.3–0.6% P_2O_5 and 0.4

0.8% N (Verma and Verma 2012). Degradation of organic matter is dominantly by fungi in early stages due to the high ratio of lignin and nitrogen and later bacteria are the secondary colonizers (Beare et al. 1992). The microbial populations in soil affects the rate of decomposition of organic matter and the successive release of available plant nutrients in the soil (Mukherjee et al. 1991; Debnath et al. 1994).

(i) **Village Compost:** The compost made from farm refuses such as crop residue, weeds, stubble and leaves of tree and vegetable plants. The farm refuses are collected and stored in the pit and mixed with cow dung slurry and water or soil and water. Microorganism inoculants are used to decompose this residue. After turning and storage for about 6 months it is suitable for application in fields. The average nutrient content of village compost is 0.4–0.8% N, 0.3–0.6%P_2O_5 and 0.7–1.0% K_2O (Verma and Verma 2012).

(ii) **Town Compost:** The compost made from town refuses like night soil, street sweepings, and dustbin refuse are called town compost. It contains 1–2% N, 1% P_2O_5 and 1.5% K_2O (Verma and Verma 2012). The biodegradable organic material is transformed into humic substances collected from various sources of the urban area (Golueke 1977; Wiles 1978; Bewick 1980). The chemical composition of solid urban waste is heterogeneous as organic (biodegradable) volatile matter, protein, lipids, sugar, cellulose, starch, lignin, phosphorus, potassium, crude fibre, etc. Mineralization and partial humification of these substances are carried out through composting (de Bertoldi et al. 1983).

(iii) **Water Hyacinth Compost:** Water hyacinth–derived manures are called water hyacinth compost. For preparing water hyacinth compost, the plants are chopped into small pieces of about 5–10 cm in length to increase the surface area for microbial action, dried in sunlight for 3 days and filled in composting boxes. Water hyacinth decomposes in only 30 days as compared to other crop plants that require up to 2–3 months. This compost could be used as surface mulch or as compost. The crude powder obtained from roots of water hyacinth has successfully been used to support vegetable crop production. As a fertilizer, water hyacinth compost contains 2% nitrogen or the equivalent to 10.5 kg of ammonium sulphate; 1.1% P_2O_5 equivalent to 6.9 kg single superphosphate; 2.5% K_20 equivalent to 5.0 kg muriate of potash (Sharma 1971). Water hyacinth has high concentrations of nutrients and faster growth rate, so it has a great potential as fertilizer for the nutrient-deficient soil. Compost of water hyacinth is a potential source of available form of phosphorus and exchangeable potassium for higher crop production. Higher application of hyacinth compost increases the soil pH, which is favourable for better growth of soil microorganisms. Hyacinth compost can act as a soil stabilizer and hence increase soil productivity.

(iv) **Vermicompost:** The use of earthworms to convert biodegradable organic waste materials into compost is known as vermicomposting. Vermicompost is prepared by a variety of organic solid wastes of domestic animals, agro-industries, human wastes, etc. The nutrient content of vermicompost is 2–3% N, 1.55–2.25% P_2O_5 and 1.85–2.25% K_2O (Sinha et al. 2009). Vermicomposting differs from other composting, as this process is active between 10 °C and 32 °C, and is faster in comparison to composting and involve earthworms rather than fungi or bacteria. Several species of earthworms such as *Eiseniafoetida*, *Perionyx excavatus*, *Eudrilus eugeniae* and *Lumbricus rubellus* are used to convert the organic wastes into high-quality compost. The gut of earthworms produces humic acid, which helps in stabilizing pore space distribution of soil. The soil cast of earthworms has the available form of plant nutrients (nitrogen as nitrate, exchangeable Ca, Mg, K and P) and organic matter. Microbial growth is enhanced due to the nutrient-enriched casting in the gut of earthworm (Lee 1985). The microbial community in the gut of earthworms helps in the decomposition of organic waste (Fischer et al. 1995; Karsten and Drake 1997). Edward (1998) reported that vermicompost is rich in microbial populations and diversity, particularly actinomycetes bacteria and fungi. In the vermiculture (culture of earthworms), young earthworms grow and reproduce in the pit having organic waste. The faecal waste and dead tissues from a large number of earthworms could be used as manure. The use of vermicompost for higher crop production is increasing due to awareness of the adverse effects of agrochemicals (Follet et al. 1981).

Impacts of Various Composts on Soil Fertility

Compost has the same effect on soil fertility as other organic fertilizers. The physical, chemical and biological properties of soil improve by the application of compost. The application of compost makes compacted to sandy soils and clay soils loose. Compost improves the permeability of soils by increasing in the water-holding and heat-absorbing capacity. Plant growth improves in alkaline and saline soils to which compost has been added and also makes this soil less deleterious. Compost is made of plant residues having all the nutrients that are needed by the plants. Mineral nutrients are released slowly from organic matter by the activity of microbes, which improves soil fertility, resulting in higher crop yield production (Stelly 1977; Loehr et al. 1979). Utilization of organic manure as compost has many advantages such as recycling of farm waste, improved soil fertility and reduced loss of nutrients through runoff (Gandolfi et al. 2010).

(B) **Farm Yard Manure (FYM)**

Farmyard manure is the traditional and most common manure used by farmers to maintain fertility of the soil. It is easily available and has all the essential nutrients that are required by the plants. This is a heterogeneous organic material consisting of dung and urine of farm animals, crop residue that left part of fodder fed to the cattle, and household waste sweeping at various stages of decomposition. It is an important component of sustainable agricultural production. Application of FYM improves the chemical, physical and biological properties of the soil (Lee and Wani 1989). It maintains soil fertility by recycling of the plant nutrients by applying FYM to the field (Parker 1990). FYM can reduce the dependency on costly chemical fertilizer (King 1990). FYM amendments to the soil improve soil quality and crop yield (Nambiar and Abrol 1989). FYM is the most important component of integrating nutrient management. Insoluble and undigested residues of fodder are passed out in the excreta that have nitrogen and potassium, mostly in liquid form in urine, while phosphorus is present in the solid dung (Thorneby et al. 1999).

(i) **Cattle Manures:** The farm yard manure is a heterogeneous mixture of solid and liquid excreta of farm animals along with the crops residue that are left after cattle feeding. The farm yard manure is the most popular and oldest bulky organic manure that is utilized by farmers. This type of manure has about 0.5–1.5% of N, 0.4–0.8% of P_2O_5 and 0.5–1.9% K_2O (Verma and Verma 2012).

(ii) **Sheep and Goat Manure:** Sheep and goat's droppings are a good source of organic manure. It has higher nutrients as compared to the farmyard manure and are easily available to crop plants. This type of manure has about 3.0% of N, 1% of P_2O_5 and 2% K_2O (Verma and Verma 2012).

(iii) **Poultry Manures**: Poultry manure is an extremely rich source of nitrogen and organic matter. This type of manure has 1–1.8% of N, 1.4–1.8% of P_2O_5 and 0.8–0.9% of K_2O (Verma and Verma 2012). Poultry manure is a suitable manure for all crops and soils. The production of poultry manure is increasing due to the rapid growth in the poultry industry. Poultry litter has all essential plant nutrients (N, P, K, S, Ca, Mg, B, Cu, Fe, Mn, Mo and Zn) and is an outstanding fertilizer (Subramanian and Gupta 2006). Poultry manure has the ability to modify the soil environment and enhance plant growth (Chalker-Scott 2007).

Impacts of Farm Yard Manures on Soil Fertility

FYM is the traditional organic manure used by the farmer. It releases nutrients slowly as it decomposes and enhances organic matter of the soil. The nutrients of FYM are not entirely available to the crop in the year of application. Generally, 30% of N, 60–70% of P_2O_5 and 75% of K_2O become available to the first crop and rest of nutrients become available to the subsequent crops. This phenomenon of availability of plant nutrients to the subsequent crop is known as the residual effect (Gaur and Singh 1995). FYM is very effective in increasing the organic and nitrogen content of the soils.

2. Green Manures

Green manure is the un-decomposed green plant material that could be obtained in two ways: (i) by collecting green leaves and twigs of trees, shrubs and herbs that grow up in field forest and wastelands and (ii) by cultivating some legume crops and subsequently ploughing or turning them into the soil to enhance physical structure as well as soil fertility.

The important plant species useful for green-leaf manure are neem (*Azadirachta indica*, mahua (*Madhuca longifolia*), wild indigo (*Baptisia australis*), Mexican *Lilac* (*Gliricidia sepium*), Karanji (*Pongamia glabra*), Mudar (*Calotropis procera*), Agati (*Sesbania grandiflora*), subabul (*Leucaena leucocephala*) and other shrubs. The most important green manure crops are sunn hemp (*Crotalaria juncea*), dhaincha (*Sesbania bispinosa*), Ranmoong (*Phaseolus trilobus*), Guar (*Cyamopsis tetragonoloba)* and Sesbania *(Sesbania rostrata)*.

Characteristics of Green Manure Crops

- Green manure crops should be fast growing, non-woody and of shorter duration so that they could be fitted in a cropping system.
- Green manure crops should produce high biomass and should be succulent for rapid decomposition.
- Green manure crops should have the ability to grow on low fertility soils.
- Green manure crops should be mixed in the soil after attaining vegetative growth because they are grown for their green leafy materials that are high in nutrients. The main purpose of practice of ploughing and mixing into the soil of un-decomposed green plant tissue is to increase soil organic carbon that helps in maintaining soil fertility.
- The green manure of legumes crop adds mainly nitrogen to the soil.
- There are improvements in physical, chemical and biological properties of the soil by using green manuring and it also enhances mobilization of minerals, leaching and percolation. The effect of green manure on soils is similar to that of farmyard manures. It is cheap and is the best method to increase soil fertility, as it can supplement farmyard and other organic manures without involving much cost. The legumes crops used as green manuring crops provide nitrogen, phosphorus, potassium as well as soil organic matter, while non-leguminous crops provide only organic matter to the soil.
- Impacts of Green Manures on Soil Fertility

Green manuring adds organic matter and nutrients to the soil macro (N, P, K), secondary and micronutrients that help in the maintenance of soil fertility needed for optimum plant growth and higher yield. Humus formed from green manures enhances water-holding capacity of soil, promotes aeration and drainage, decreases soil loss by erosion, conserves moisture and prevents nutrient leaching and granulation, which help the plant growth. Deep-rooted green-manure crops help in the turning of nutrient from deep soil layer to topsoil layer. The organic matter of soil increases through green manuring that stimulates the activity of soil microorganism. These microorganisms enhance the rate of decomposition of un-decomposed green plant material and change the biochemical properties of soil. All legume crops have the ability to fix free nitrogen from the atmosphere due to root nodule bacteria (*Rhizobium* sp.) and improve the nitrogen status of the soil that can minimize the use of nitrogenous fertilizers. Weed proliferation and weed growth can be reduced by cultivating green manure crops in the off-season. The alkaline problem of soil could be improved through application of green manure.

3. Concentrated Organic Manures

(A) **Oil Cakes:** Oil cakes are by-products of oilseed crops and are known as concentrated organic manures. These are a good source of organic nitrogen and also have a small amount of phosphorus and potassium. In organic farming, oil cakes are used as manure for increasing crop production. This manure adds organic carbon to the soil and enhances growth of beneficial microbes of soil. Oil cakes are divided into two groups.

(i) **Edible Oil Cakes**: These oil cakes are safely fed to livestock as concentrates, for example, coconut cake, linseed cake, groundnut cake, mustard oil cakes, til cake, etc.
(ii) **Non-Edible Oilcakes**: Oil cakes that are not suitable for feeding livestock and hence mainly used for manuring crops, for example, castor cake, cotton seed cake, mahua cake, neem cake, etc.

Both these types of oil cakes can be used as manure; however, non-edible oil cakes are used as manures principally for horticultural crops. After application of oil cake in the agriculture fields, the nutrient is available for crop plant in 7–10 days. Oil cakes should be ground very fine before application for even distribution in the soil (Daji 1955).

(B) **Other Concentrated Organic Manures**

Blood-meal, meat-meal, fish-meal, horn and hoof meal, raw bone-meal and steamed bone meal are dried and powdered and after that can be used as manure. These concentrated organic manures are a good source of nitrogen, phosphorus and potassium.

Impacts of Concentrated Organic Manures on Soil Fertility

The non-edible oil seed cakes such as castor cake (*Ricinus communis*), jatropha cake (*Jatropha curcas*) and neem cake (*Azadirachta indica*), along with other manure as poultry and grass trimmings, are used to improve soil fertility. Addition of cellulolytic fungi enhances the decomposition and improves the soil quality (Gaur et al. 1982; Gaind and Nain 2007).

4. Guano

Guano is a natural organic fertilizer that is obtained from the excreta and dead bodies of birds. It has a high nutrient content (7–8% nitrogen, 11–14% phosphorus and 2.3–3% potassium). It has been reported that the nitrogen of organic fertilizers is water-insoluble and is gradually released with the decomposition of fertilizers (Cooke 1972). However, the rate of nitrification in guano is more rapid in comparison to other organic fertilizers (Owen et al. 1950). Guano was the most popular fertilizer before the development of fertilizer through free nitrogen of the atmosphere (Hadas and Rosenberg 1992). Guano has a higher nitrogen content and is rapidly decomposable. It is a costly fertilizer (Hadas and Kautsky 1994). Feather meal can be substituted for guano, as it is considerably cheaper and also has a high nitrogen content. It is obtained as a by-product from poultry processing plant (Hadas and Kautsky 1994).

Impacts of Guano on Soil Fertility

This type of organic fertilizer is nutrient-rich and has the ability to provide nutrient quickly. It is suitable for all crops and can apply before or at sowing time. The guano of seabirds have the highest nutrient value (10–16% nitrogen, 8–12% phosphorus and 2–3% potassium), while bats and other birds have a lower nutrient content. Guano stimulates soil microorganism activity by introducing an enzyme that enhances the process of decomposition of organic matter and improves the soil texture. Beneficial microbes are found in guano that increases soil fertility and controls fungi and nematodes. It works in similar way to compost and helps in increasing soil fertility. Guano acts as a soil binder by binding soil particles together. It does not leach out easily by natural weathering and helps to build up better aeration in the soil. Small oceanic islands are the common nesting places of seabirds where excreta of these birds alter physical, chemical and biological properties of soil and plant communities (McColl and Burger 1976; Nelson 1979). Phosphate, nitrate, and ammonium content are extremely high in ornithogenic soils that enhance growth of plants (Hutchinson 1950; Wainright et al. 1998; Anderson and Polis 1999). Soil moisture increases with deposition of guano; this may be due to increasing soil organic matter, while pH of soil decreases with its increment in the soil (Wait et al. 2005).

5. Biofertilizer

Biofertilizers are products that contain living microorganisms and enhance plant growth by increasing the availability of primary nutrient in the rhizosphere of the host plant. These are generally applied to the surface of plants and seeds. Biofertilizers increase soil fertility by adding nutrients through the natural process as nitrogen fixation, phosphorus solubilization or nutrient mobilization. Biofertilizers could reduce the dependency on chemical fertilizer. These biofertilizers are cost-effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. The organic matter of the soil can be increased by application of biofertilizers (Zaccaro et al. 1999; Maqubela et al. 2009), thus improving the soil structure (De Cano et al. 2002; Maqubela et al. 2009; Saadatnia and Riahi 2009).

Biofertilizers have been classified into three classes based on microorganisms used.

(A) **Algal Biofertilizer**

Algae are a natural organic source of biofertilizers that can be thought as one of the best substitutes to the chemical fertilizers. Algal biofertilizer is formed by algae as azolla and blue-green algae (BGA). Azolla (*Azolla pinnata*) is a water fern (Pteridophyte). It is also known as the aquatic weed that is commonly found floating in pond, lakes, shallow trenches and channels. Azolla is commonly found in the rice fields. Blue-green algae (BGA), also known as cyanobacteria, are commonly found in the rice fields and are capable of photosynthesis. BGA also produce plant growth regulators, stimulate the transport of nutrients from soil to plants, cause cluster of soil and improve the physical and chemical properties of the soil (Singh et al. 2016; Naser et al. 2017). These BGA are also able to fix free nitrogen and enhance the level of phosphorus by converting insoluble phosphorus into a soluble form (Irisarri et al. 2001). Some BGA live in symbiotic association as *Anabaena Azolla* live in the epidermal cavity of the leaf of *Azolla pinnata* where it fixes atmospheric nitrogen. This association is termed as *Azolla Anabaena* complex. Fresh *Azolla* has about 90–95% water. Decomposed *Azolla* contains 4–6% nitrogen, 0.5–0.9% phosphorus, 2–6% potassium, 0.4–1.0% calcium, 0.5% magnesium, 0.11–0.16% manganese, 0.06–0.16% iron and 9–10% total ash. BGA biofertilizer enriches nitrogen and decreases the stress affecting growth and yield of plants (Alam et al. 2014; Singh et al. 2014). Some microalgae as *Tetraselmis* sp. are used in the production of biofertilizers that are eco-friendly and good for maintaining soil quality.

Algal biofertilizer plays a significant role in conservation and build-up of soil fertility, therefore increasing the growth and yield of plant as a natural biofertilizer (Song et al. 2005). It can be cultivated in barren areas (Saadaoui et al. 2016) and is a good source of majority of micro- and macronutrients that are necessary for plant growth. It enhances nutrient transport from soil to the plant and helps in the reduction of soil salinity (Saadatnia and Riahi 2009). Algal biofertilizers enhance the level of phosphorus in the soil by the production of organic acids (Wilson 2006). Application of algae biofertilizer increases the population of beneficial microorganisms in the soil (Mishra et al. 2013). It secretes some growth-promoting substance like hormones (auxin, cytokinins gibberellin and abscisic acids), vitamins, amino acids (Roger and Reynaud 1982; Rodriguez et al. 2006). Algae biofertilizer can fix CO_2 through photosynthesis that decreases the level of CO_2 in the atmosphere and finally reduces the effect of global warming. It increases the pore size of the soil through the filamentous structure and production of adhesive substances, enhances the water-holding capacity of the soil through production of viscous substance (Roger and Reynaud 1982) and enhances the soil organic matter after death and decomposition (Saadatnia and Riahi 2009).

(B) **Fungal Biofertilizer**

Fungal biofertilizers include plant growth stimulating fungi e.g. *Aspergillus, Fusarium, Penicillium*, *Piriformospora, Phoma* and *Trichoderma,* mycorrhizal fungi (ectomycorrhiza, e.g., *Pisolithus tinctonus* and arbuscular mycorrhizae, for example, *Glomus mosseae* or *Glomus intraradices,* which form mutualistic relationship with plants, enzymatic producing fungi as *Myriococcumthermophilum*, *Thermoascus aurantiacus*, and *Thermomyces lanuginosus* for compost production and P-solubilizing fungi (*Penicillium spp.* and *Fusarium spp*.) and K-solubilizing fungi (*Aspergillus niger, Aspergillus terreus*) Fungal biofertilizers play a significant role in stimulating plant growth, productivity and improving soil fertility. Mycorrhizae are fungi which form mutualistic relationships with roots of 90% of plants (Das et al. 2007; Rinaldi et al. 2008). Mycorrhizae promote absorption of nutrients and water, control plant diseases, and improve soil structure (Chandanie et al. 2006; Rinaldi et al. 2008). The use of bioinoculants of phosphorus solubilizing fungi (*Penicillium* and *Aspergillus*) to soil for improving phosphorus uptake is becoming popular.

(C) **Bacterial Biofertilizer**

Plant growth promoting rhizobacteria (PGPR) are used in the production of biofertilizer. Bacteria that colonize roots of plant are known as PGPR (Kloepper and Schroth 1978). PGPR are mostly free-living and soil-born bacteria that are isolated from soil for the production of biofertilizers. Biofertilizers are applied to the seeds and crops to enhance growth of the plant. PGPRs are used in the production of biofertilizer and have at least one characteristics as suppression of plant disease, improved nutrient acquirement and phytohormone production (Kloepper et al. 1980). The direct mode of action involves phosphorus solubilization and its uptake by roots of plants, free nitrogen fixation, production of siderophores, production of phytohormones like auxins, cytokinins and gibberellins, and depressing level ethylene in plants. In last few decades, a large array of bacteria including species of *Azospirillum, Azotobacter, Alcaligenes, Arthrobacter, Burkholderia, Bacillus, Enterobacter, Klebsiella, Pseudomonas* and *Serratia* have been reported to enhance the plant growth (Kloepper et al. 1989; Glick 1995). Presently several biofertilizers are available in the market for increasing the uptake of nitrogen through nitrogen-fixing bacteria associated with the root (*Azotobacter* and *Azospirillum*), iron uptake from siderophores-producing bacteria (*Pseudomonas, Bacillus*), sulphur uptake from sulphur-oxidizing bacteria (*Thiobacillus*) and phosphorus uptake from phosphate mineral-solubilizing bacteria (*Bacillus*, *Pseudomonas* and *Azotobacter*). *Rhizobium* are gram-negative soil bacteria that fix free nitrogen from atmosphere in the root nodules of legumes crop plant, and these bacteria were the first biofertilizer identified and applied in legumes crops for over 100 years ago (Kannaiyan 2002).

Impacts of Biofertilizer on Soil Fertility

Biofertilizers enhance soil fertility by adding organic matter to the soil that acts as binder for the soil particles together, preventing soil erosion, eructing, and desertification. It also increases the water-holding capacity of the soil (Swathi 2010). Biofertilizers are an alternative source of chemical fertilizer to increase soil fertility. Biofertilizers play an important role in the increment of crop productivity and sustainability of the soil (Obana et al. 2007; Malamissa et al. 2007; Pandey et al. 2008; Khosro and Yousef 2012). Application of biofertilizers increases the biodiversity of beneficial microorganisms as algae, bacteria (plant growth-promoting rhizobacteria, (PGPR) and nitrogen fixers) and fungi including the arbuscular mycorrhiza fungi (AMF). Biofertilizers release the nutrients slowly. Soil fertility increases by the long-term application of biofertilizers, which leads to the buildup of nutrients in fields.

4 Advantages of Using Organic Fertilizers

1. Organic fertilizers are suitable because they supply balanced nutrients that help to keep plants healthy.
2. These fertilizers enhance soil biological activity that improves nutrient mobilization from organic and chemical sources through the process of decomposition.
3. Enhancement in root system has been found by using organic fertilizers due to better soil structure.
4. Organic fertilizers increase the organic matter content of soil and improve soil texture, water retention and resistance to erosion. Therefore, it helps in the improvement of soil physical and physiological structure.
5. Organic fertilizers have the ability to release nutrients slowly and contribute to the residual pool of organic N and P in the soil, reducing N-leaching loss and P fixation and also supply micronutrients.

5 Disadvantages of Using Organic Fertilizers

1. Organic fertilizers are comparatively low in nutrient content, so larger volumes are needed to provide enough nutrients for crop growth and yield.
2. The nutrient release rate is too slow to meet crop requirements in a short time, hence some nutrient deficiency may occur.
3. The sufficient quantity of nutrients does not exist in organic fertilizers to sustain maximum crop growth.
4. The cost of compost production is high as compared to chemical fertilizers.
5. Long-term or heavy application to agricultural soils may result in salt, nutrient or heavy metal accumulation and may adversely affect plant growth, soil organisms, water quality and animal and human health.

6 Conclusions and Future Perspectives

In agriculture, intensive use of various kinds of chemical fertilizers has reduced soil fertility and made soil unsuitable for crop plants. This huge application of chemical fertilizers has also led to severe health and environmental threats such as soil erosion, water pollution, pesticide harming, water logging and reduction of biodiversity. Crop production is increased by the intensive use of inorganic fertilizer, but it causes soil fertility depletion. To minimize this adverse effect of chemical fertilizers, a new approach has been developed, called organic agriculture. Organic agriculture includes the use of organic fertilizers. Organic fertilizers are gaining familiarity in many countries, these being eco-friendly and cost-effective. The best practice is organic farming to conserve soil fertility and the environment. In this farming system, different types of organic material are used as compost (village compost, town compost, water hyacinth compost, vermicompost), farmyard manure (cattle manures, sheep penning, poultry manures), green manures (leguminous plant and non-leguminous plant), biofertilizers (algal biofertilizers, fungal biofertilizers, bacterial biofertilizers or plant growth-promoting rhizobacteria, (PGPR)). These fertilizers are able to increase crop yields and minimize the evil effect of chemical fertilizers, pesticide and herbicides. Therefore, there is an urgent need for the involvement of governmental and international policies for the development of eco-friendly production technologies to reduce the adverse effect of intensive farming to discontinue use of various kinds of chemical fertilizers, pesticides and insecticides.

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