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REVIEW ARTICLE

THE ROLE OF BIOFERTILIZATION IN IMPROVING FRUIT PRODUCTIVITY : A REVIEW

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Abstract : Extravagance in chemical fertilizers and pesticides has become a threat to the lives of citizens and infect them with serious diseases after these fertilizers were one of the most important factors that helped in increasing and developing agricultural production, but the unfair and indiscriminate use of them by farmers, left negative effects on the environment and the health of citizens as they interact with the soil and leave traces negative to the various elements of the environment. Biofertilizers are considered environmental friendly fertilizers, which are fertilizers containing microorganisms that are able to supply plants with the necessary nutrients from natural sources, which reduce dependence on fertilizers. Different chemicals which lead to reducing environmental pollution and production costs and increasing the yield in terms of quality and quantity, bacteria and fungi and blue green algae are among the most important sources of biological fertilizers, as these organisms play an important role in serving plants by providing nutrients that it contributes to improving growth, increasing yield, disease resistance or resilience in the face of bad conditions surrounding plant growth, such as environmental stress in the soil or climate changes and a large number of these organisms are associated with plants with what is called mutual benefit.

Key words : Biofertilizers, Growth, Fruit yield, Biological fertilization.

1. A Review : The Importance of Biological Fertilization

Due to the steady increase of the population in the world and as a result of the severe shortage of food resources, especially in the countries of the third world, with an increase in the costs of chemical fertilizers, especially nitrogenous ones and the pollution caused by soil and the environment and the harm to human health when excessive use is made, many countries of the world have recently moved towards searching for Natural alternatives to chemical fertilizers in order to reduce environmental pollution and reduce costs of agricultural production [Alalaf (2019)]. Among these alternatives is the use of so-called biofertilizers, which mainly depend on the use of natural biological systems to facilitate Nasser food important plant without resorting to harmful chemical fertilizers in order to maintain the productivity of these plants the lowest possible cost level if compared to other fertilizers and at the same time free of contaminants to produce healthy food safe and exportable. Biofertilizers are considered to be environmental friendly types of fertilizers, the scope of their use is linked in most countries of the world. These organisms play an important role in the service of plants by providing nutrients, fighting diseases, or withstanding bad conditions surrounding plant growth, such as environmental stress in the soil or climate changes. Also, a large number of these organisms are associated with plants with what are called Mutual benefit [Singh *et al*. (2016), Bhat *et al*. (2019)].

Biofertilizers are defined as a microbe or a group of microbes that work to provide one or more nutrients necessary for plant growth in a soft form for it by converting it from the elements that are not ready to its ready-to-absorb forms, especially important nutrients such as nitrogen, phosphorus and potassium, or it can be defined. As these are microbial inoculants that contain sufficient numbers of effective strains of microorganisms and that play an important role in the

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area surrounding the roots of the plant Rhizosphere by pollinating the seeds or soil weep. Microorganisms are able to have beneficial moral effects on the suitable plant host as well as being a source of specific types of microorganisms that are highly effective in biological control of soilborne pathogens [Yusef (2011)] and the role of biological fertilizers will increase in solution. Major plant growth problems, such as protecting plants from pathogens, secrete antibiotics that inhibit the growth of some pathogenic microbes [Raimi *et al.* (2017)]. Bio-fertilizers contain a number of microorganisms that differ according to the purpose for which this fertilizer is used. Bio-fertilizers can be divided in terms of their nature and behavior in the soil into symbiotic biofertilizers, which are produced from the activity of the microorganisms that live cooperatively with plant roots, and these Microbes supply plants with some nutrients while taking their nutritional needs, especially the carbon source from the plant, meaning that there is a mutual benefit exchange between two different Mutualism organisms that live with each other, i.e. ensuring each other, such as Mycorrhizea, and the other type is biological fertilizers that are not Asymbiotic Biofertilizers . This type of biofertilizer is characterized by the fact that the microorganisms used in its production live free lives in the soil and obtain their nutritional needs from the soil, such as Azotobacter and Azospirillum [Win *et al.* (2018)].

Various sources indicate the role and importance of the fertilizers and the features that it adds to the soil and as a result it contains beneficial microorganisms such as bacteria, fungi, etc. [Yadav and Sarkar (2019), Kumar and Kumar (2019)] and that its use brings many benefits to plants and soil, including :

1. Providing nutrients important for plant growth by stabilizing atmospheric nitrogen, dissolving triple and five calcium phosphates, converting them into mono calcium phosphate, which is suitable for absorption by the plant, and converting potassium from the insoluble form to the soluble and suitable for absorption by the plant.
2. Reducing dependence on agricultural chemical compounds, especially fertilizers and pesticides, chemical compounds - Agro, which means reducing production costs and reducing the level of environmental pollution as a result of using such chemicals. Rather, it can be said by excluding one of the most important forms of pollution resulting from traditional agricultural transactions.
3. Increasing the organic matter in the soil, which leads to improving its physical, chemical and biological properties, especially in lands that suffer from a lack of organic matter.
4. Compensating the rapid loss of nitrogen as a result of the rapid melting of some easily soluble nitrogenous compounds, which means preserving soil fertility.
5. Improving the root growth of the plant by encouraging the formation of root capillaries and increasing the surface of the root system, which leads to increased absorption of water and nutrients.
6. Improving the vegetative growth of the plant, as pollinated plants are faster to grow and are given a high quality crop.
7. The secretion of some hormones such as indole acetic acid (IAA) and gibberelic acid (GA_3) important for plant growth.
8. Preserving the fertility of the soil and its biological diversity, and even supplying it with abundant quantities of beneficial microorganisms that may compete with pathogenic microbes and prevent their activity and infestation with plants. It also works to improve the properties of loosened sandy soil by the gel and sludge that these pollen produce in granules soil and increase its cohesion.
9. Speeding up the germination of seeds and seedlings, which reduces the chance of disease.
10. Excretion of antibiotics that protect the plant from pathogens present in the soil by inhibiting the growth of some pathogenic microbes.
11. Reducing environmental pollution and reducing production costs, as biofertilizers are clean food sources for plants and are inexpensive when compared to mineral fertilizers.
12. Production of enzymes capable of analyzing complex organic materials and converting the elements contained in them from the organic image to the mineral image suitable for plant use.

2. Nitrogen-fixing Bacteria

In order to nitrogen to be available for use with microorganisms, it must switch from the gaseous image to the stabilized image, which is often in the form of ammonia ions NH_4 or nitrate NO_3 and atmospheric nitrogen can be fixed by microorganisms in two ways that are either symbiotic by coexistence with plants, including many species such as *Rhizobium* sp. or not symbiotic, as the bacteria install nitrogen in the atmosphere and are in a free state in the soil as they depend on themselves to obtain the energy source, has been isolated, up to 100 bacterial strains installed for nitrogen from the area surrounding the rhizosphere. The genera of *Azosperillium* and *Azotobacter* are free living bacteria that are more efficient at fixing atmospheric nitrogen as well as their ability to secrete some hormones, enzymes and vitamins. They have been widely used as a biological fertilizer with a large number of plants, as atmospheric nitrogen is installed by some bacteria converting nitrogen invasive N_2 to ammonia or by other bacteria convert nitrogen from the ammonia image to nitrate so that it becomes available to the plant and all of these organisms possess the nitrogenase enzyme that fixes the nitrogen [Sharma *et al*. (2019)].

Azospirillum brasilense is one of the free living bacterial species fixing to atmospheric nitrogen and one of the most important neighbourhoods that encourage plant growth in the rhizosphere through its production of hormones and the expansion and spread of roots and absorption of water and nutrients as it fixes nitrogen at a rate of 48 kg N / ha / year [Contreras-Angulo *et al*. (2019)].

As for the bacterium *Azotobacter chroococcum*, which is one of the isolated types of soil and the most common being living in different types of soils and all over the world and has the ability to install 10 mg nitrogen per gram of carbohydrates and these types of bacteria in addition to fixing them to nitrogen produce some amino acids and vitamins such as thiamine B_1 and riboflavin B_2 and some growth regulators like indole IAA and gibberelin GA_3 [Sharma *et al*. (2019)].

3. Bacteria Dissolving Phosphorous

The use of phosphorous-dissolving bacteria in improving soil properties and increasing their fertility is one of the most recent methods used to increase the efficiency of phosphorous fertilizers by dissolving non-soluble and non-absorbable phosphorous to an absorbable and dissolved form in the soil, and increasing the solubility of the phosphorous element in the basic soil leads to improve soil properties, which leads to increased agricultural production [Abu Saud *et al*. (2013)]. Mineral phosphorous is usually found in the form of triple calcium phosphate, which is an unavailable and non-absorbable form for plants, especially in neutral soils or slightly inclined to alkaline. When mineral phosphate fertilizers are added to this type of agricultural soils, a small portion of which the plant benefits from and the rest soon turn to an insoluble or non-soft form of the plant, and the soil is rich in phosphorous, but the plant cannot benefit from it [Al-Bashbishi and Sharif (1998)], micro-soil neighbourhoods (microbes) have played an important role in preparing phosphorus from the soil for the plant, especially the dissolved bacteria. The *Bacillus subtilis* phosphate, which has increased interest in it, is considered one of the vital fertilizers because of its role in converting the insoluble image (triple calcium phosphate) into a soluble image again (mono calcium phosphate) as it grows and activates as a result of root secretions and their organic matter and produces outputs. Nutritional transformations (organic acids such as formic acid, fumaric, acetic and succinic as well as carbon dioxide) outside their cells thus leading to the conversion of insoluble triple phosphates into soft, soluble phosphate. Among the organisms that increase the readiness of inorganic phosphorus and which have been proven to have the ability to dissolve calcium phosphate is the genus Pseudomonas, which is part of the group of bacteria that stimulate plant growth and is one of the efficient species in dissolving insoluble phosphate and the secretion of growth regulators, especially oxyene, and thus encourages the growth of the plant. It has a great ability to concentrate on the roots of cultivated plants and its production of metabolites stimulating the growth of plants as well as inhibiting the activity of microbes that attack the plant at the same time, and some studies have indicated that Pseudomonas have an indirect role in the life of plants by reducing The impact of growth inhibitors and the development of biological control agents and this positively affects plant growth process, and the most important types of this genus are the *P. fluorescens* and *P. putida* [Kumar *et al*. (2015)].

4. Potassium Solute Bacteria

The plant needs potassium in large quantities because it is one of the major and important nutrients in plant nutrition. A large part of potassium is linked to the mineral part of the soil in an inapplicable form called silicate Bacteria such as *Bacillus*, *Pseudomonas*, *Penicillium* and *Streptomyces* on microbes that have the ability to convert Potassium from the insoluble form to the soluble image suitable for absorption by the plant, and interest has increased in recent years to pollinate the soil with these bacteria, especially *Bacillus circulans*, which analyze the organic materials present in the soil and interact with potash silicate compounds

An insoluble day such as orthoclase and biotite makes it dissolve [Bhat *et al*. (2019)].

4.1 The effect of adding biofertilizers on the characteristics of vegetative growth and the leaf content of nutrients

El-Salhy *et al*. (2010) recommended the possibility of reducing the amount of chemical fertilizers added to *Citrus reticulate* trees inlaid with bitter orange by adding a biogen-enriched container containing Azotobacter at a concentration of 100 g. Tree, which caused a significant increase in the characteristics of vegetative growth, leaf area and carbohydrate ratio to Nitrogen in branches compared to chemical fertilizers.

Fawzi *et al*. (2010) found that all treatments including bio-fertilizers used significantly increased percentage of N, P, K and Mg in the leaves of Le-Conte pear trees as compared to the control.

Boshra *et al*. (2011) found when fertilizing *mangifera indica* L. 12 year-old Ewaise with biofertilizers using (nitropin at a concentration of 200g. tree), (phosphorous at a concentration of 20g. tree) and (potassin at a concentration of 10g. tree) that all of these fertilizers were effective very improved in the nutritional and chemical status of trees compared to untreated trees.

El-Sabagh *et al*. (2011) indicated in a study on two types of grapes; Thompson seedless and Flame seedless, to know the effect of four types of biofertilizers (Biogen, Nitrobeine, Rhizobacterine, Dry Yeast) and they were added separately or interfering with mineral nitrogen to the biofertilizers resulted in a significant increase in nitrogen, phosphorous and potassium in the leaves.

El-Khawaga and Maklad (2013) in their experiment to improve the growth of orange trees classified Valencia class using a combination of the bio-fertilizer containing *Bacillus smegatherium*, *Bacillus cireulans* and *Azotobacter chroococcum* that this combination resulted in a significant increase in all characteristics of vegetative growth compared to untreated trees.

Khamis *et al*. (2014) confirmed, through the results obtained in their study, that all treatments using biofertilization (phosphorine at a concentration of 40 g. Plant^{-1} + Rhizobacterin at a concentration of 40 g. Plant^{-1}) improved all measurements of vegetative growth (stem height, diameter and number of growths). The side of each seedling, the number of leaves per seedling and the leaf area, also improved the leaf content of photosynthetic pigments such as chlorophyll A and B, carotenoids and nutrients (nitrogen, phosphorous, potassium, calcium, magnesium, iron, manganese, and zinc) for guava seedlings *Psidium guajava* at one year of age.

Haggag *et al*. (2014) found in their study to add a number of biofertilizers (Nitrobein, Microbein and Biogein) in the growth of olive seedlings of an Apple cultivar, that these fertilizers recorded a significant superiority with the studied traits (height of seedlings, number of branches, leaves and leaf content of nitrogen and potassium).

Shaimaa and Massoud (2017) found that treatment of interference between (*Azotobacter* bacteria at a concentration of 10 ml. Tree^{-1} + Arbuscular mycorrhizal at a concentration of 10 ml. Tree^{-1} + NP with a concentration of 75%) caused a significant increase in the studied characteristics (tree height, chlorophyll content and dry and wet weight. For the vegetative group of Washington Navel variety trees inlaid with bitter orange origin.

In a study of Ataweia *et al*. (2018) to demonstrate the vegetative response to two-year seedlings of *Mangifera indica* L. at age of one year for levels of biofertilizers, the results showed that the intervention treatment between the addition of the biological fertilizer of Mycorrhizal at a concentration of 40 g. Bluish green at a concentration of 1 g. seedlings^{-1} resulted in a significant improvement in the characteristics of vegetative growth (height and diameter of seedlings, number of branches/seedlings, number of leaves / seedlings and leafy area).

Note: The biological fertilization factors in biogen containing bacteria (*Azotopacter chroococcum* + *Azosperillium brasilense*) and potassium-containing containers (*Bacillus circulans*) significantly out weighed the rest of the fertilizer treatments especially the treatment of comparative characteristics (number of leaves and the ratio of nitrogen and potassium leaves and phosphorus) Local oranges growing on the origin of sour orange.

The effect of biofertilizers on the characteristics of fruits and yields of fruit trees :

Patel *et al*. (2005) also noted higher yield and quality fruits with combined application of biofertilizers m Amrapali mango.

El-Sayed (2006) found in its study to add some biofertilizers (biogen, nitropin and phosphorous) in the fruiting growth of 8-year old pomegranate trees planted in sandy soil that the addition of these fertilizers gave a significant increase in the weight and number of fruits and improved the chemical properties of the quality of the fruits.

Shamseldin *et al*. (2010) mentioned that the inoculation with strain 843 of *Pseudomonas fluorescence* growth promoting rhizobacteria significantly improved fruit quality as well as increased fruit yield, fruit weight, fruit length and TSS percentage of Washington navel orange.

Abd-Alhamid *et al*. (2015) concluded in his study to show the effect of mineral fertilizers and bio-fertilization on the yield and quality of the fruits of the olive trees of the Manzanillo variety. The results indicate that B+MNF75% gave the highest values of initial and final fruit set, yield, fruit quality as well as weight, volume, length diameter of fruit, pulp weight, flesh oil content and iodine value. Bio-fertilizer with lower levels of mineral nitrogen fertilization resulted in decreasing nitrate content of fruit and peroxide value of oil. Trees treated by B+MNF75% gave the lowest oil acidity value. Total microbial count in the rhizosphere also was the best.

Morsey *et al*. (2015) found in his study on apple trees that the quality of the fruit including each of the material's fruit characteristics, *i.e.* fruit weight, size, stability, height, diameter and shape were chemical and fruit properties such as TSS%, acidity and TSS / acid ratio improved by trees subject to treatments. Various bio-stimulants compared to control.

Ennab (2016) confirmed in his study to add some biofertilizers that contain bacteria Azotobacter Azospirillum, *Bacillus circulans*, on yield, quality of fruits and soil fertility for sublime lemon trees. Eureka cultivar showed that this addition showed significant mean differences between yield and fruit quality, due to the positive effect of bio-fertilizers.

According to the results obtained by El-Alakmy *et al*. (2018), it is recommended to use nitrogen fertilization with protamine amino acid as this treatment has improved the flowering and nutritional status of olive trees with the production of a high yield with good fruit characteristics in addition to preserving the environment from emerging pollution problems about mineral fertilization as well as the use of environmental waste.

5. Conclusion

All studies whose results were presented unanimously on the importance of positive biological fertilization in improving most traits of vegetative growth and the leaf content of the nutrients of fruit plants and thus its reflection in obtaining good traits of fruiting and yielding growth. So more studies are required on the use of biofertilizers in improving the growth of fruit plants as they are environmentally safe and inexpensive and to reduce the amount of chemical fertilizers used and thus reduce production costs and reduce environmental pollution.

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