KIRKUK UNIVERSITY JOURNAL
FOR AGRICULTURAL SCIENCES

Biofertilizers, types, Benefits and their role in improving the growth of fruit trees and vegetative plants (Review)

Salah Hassan Jabbar Al-Hchami[1] — salah.h@coagri.uobaghdad.edu.iq

Yasamen Fadhil Salloom[2] — yasamen.f@coagri.uobaghdad.edu.iq

[1,2] Department of Horticulture and Landscape Design, College of Agricultural Engineering Sciences, University of Bagdad, Iraq.

- Received date 05/06/2023 and accepted 16/07/2023.

Abstract

Plant development, kinds, and benefits of bio-fertilizer inoculation will be discussed in this paper, Studies have shown that using bio-fertilizers increases the growth of the host plant, as well as improving the root growth and increasing the root system area, which leads to an increase in water and nutrient absorption. Also, the use of biological fertilizers helps reduce the toxicity in plant products as a result of a decrease in chemical fertilizers, In addition to increasing plant resistance to stress conditions like salt, drought, and temperature, bio-fertilizers can also increase soil fertility by contributing to soil aggregation and increasing the activity of soil enzymes like dehydrogenase, phosphatase, and urease, for example. These enzymes help plants be stronger against stress conditions like salt, drought, and temperature.

Key words: Bio-fertilizers, phosphatase, Plant nutrients, fruit trees and vegetative plants.

Citation: Al-Hchami, S., & Salloom, Y. (2023). Biofertilizers, types, Benefits and their role in improving the growth of fruit trees and vegetative plants.(Review) *Kirkuk University Journal For Agricultural Sciences*, 14(3), 47-56. doi: 10.58928/ku23.14305

Correspondence Author: Salah Hassan Jabbar Al-Hchami - salah.h@coagri.uobaghdad.edu.iq

Introduction

Biofertilizers

Chemical fertilizers, pesticides and manufactured chemical compounds have been used by many countries and industrial companies in an effort to provide food for everyone, which has led to an imbalance of natural and environmental balance, as well as the appearance of a number of harmful effects on humans, animals, and soil due to the build-up of toxins and minerals in the body as well as soil degradation and tainted water. This is why researchers want to utilize fertilizers that are both safe for human consumption and non-polluting to the environment, Organic and inorganic materials or live organisms are employed to fulfill a specific function in the biofertilizers, which are one of the forms of fertilizers [1], [2], [3]. Scientists' latest discoveries of biofertilizers have made it possible for them to be developed and employed in agriculture for the regulation of enhanced output, environmental protection, and the creation of crops and healthful food, as vaccines loaded with special tripods, biofertilizers contain one or more types of beneficial microorganisms that can supply plants with nutrition and improve soil fertility while reducing the use of chemical fertilizers by about 25%. This results in lower production costs and less environmental pollution,[1] Additionally, biofertilizers can be defined as microbial inoculants that contain sufficient numbers of effective strains of microorganisms capable of pollinating seeds or soil with microorganisms capable of causing useful effects to the plant host, as well as a source for different types of microorganisms that are highly effective in biological control of soil-borne pathogens [5], [6], [7], [8], [9]. Pollination of plants with biological fertilizers, particularly those that fix nitrogen in the root system, and little mineral nitrogen fertilization have been shown to promote plant growth and production, according to several scientists [10], [11]. To ensure that the plants get the nutrients they need from the biofertilizers and that they are able to produce hormones and acids that regulate plant growth and secrete antibiotics that can help them resist some of the endemic diseases in the soil that are prevalent, researchers found that the organisms used in biological fertilization must be stable [4], [12], [13], [14].

Biofertilizers, types and divisions

They may be categorized based on their activity, the nutrients they supply to a plant, and their intended usage. Biofertilizers Some of them are diseases, while others have favorable benefits on plants. The microorganisms in the rhizosphere may be categorised according to their impact on plants and the way they interact with roots, some of which are pathogens, while others have beneficial effects. So, the helpful bacteria that live in the rhizosphere are referred to as PGPR (plant growth promoting rhizobacteria) It is usual to utilize PGPR as an inoculant to improve the productivity of agricultural crops, and it provides an appealing alternative to chemical fertilizers, herbicides, and additives [15], [[16. Different bacterial species such as Azotobacter and Klebsiella have been shown to promote plant development. Among them are Pseudomonas and Azospirillum as well as Enterobacter and Alcaligenes [17], [18].

1. **Biological nitrogen fixation**: Azospirillum, Acinetobacter, Burkholderia, Enterobacter and Erwinia are only few of the bacterial genera that are found in the plant rhizosphere and have been shown to have favorable effects on the development of plants. [19], [20]. An essential part in plant selection and enrichment of bacteria is

performed by the components of their root exudates. Due to their capacity to use exudates as sources of energy for their own growth, bacterial communities in the rhizosphere are shaped by these organic elements and their concentrations in the soil [21]. The soil rhizosphere, rhizoplane, and plant tissues all have bacterial communities [22]. Bacteria belonging to the Azospirillum, Alcaligenes and Alcaligenes genera are found in the plant rhizosphere and have the ability to have a positive influence on plant development [19], [20]. The root exudates of plants play an essential role in choosing and enhancing the kinds of bacteria. Since bacteria in exudates may use organic compounds in exudates as sources of energy, their presence and concentration in the rhizosphere influences the bacterial community's growth [21]. Bacteria may be found throughout the soil rhizosphere, rhizoplane, and even into the tissues of plants [22]. Organic chemicals found in root exudates may be efficiently taken up and catabolized by the bacterial populations that inhabit the rhizosphere [23]. It is possible to minimize the amount of chemical fertilizer used by using bio-fertilizers and bioenhancers such as bacteria that fix N2 (nitrogen) and helpful microorganisms. While organic fertilizers assist to reduce pollution and preserve the environment, using PGPR to boost production may be an environmentally friendly option [24]. Because of this, rhizospheric bacteria are often employed as inoculants in agriculture to enhance plant growth and productivity [25], [26].

1.1. **Symbiotic nitrogen fixers**

Rhizobia and Frankia are two families of nitrogen-fixing bacteria that have been investigated extensively. However, its symbiotic connection with Frankia, which develops root nodules on more than 280 species of woody plants from eight distinct families [27], is unclear. Alnus and Casuarina are reported to be efficient symbiosis partners for Frankia [28], [29]. Plant growth regulators, siderophores, and hydrogen cyanide are just a few of the compounds that certain species may release to aid plant nutrition, as may species that boost the availability of the mineral phosphate. Using the polyphasic taxonomic technique of [30], they identified 36 rhizobial species, which were grouped into seven genera (Azorhizobium, Bradyrhizobium, Methylobacterium, Rhizobium and Sinorhizobium). Different climatic and agronomic circumstances. Rhizobium and Bradyrhizobium are two examples of symbiotic nitrogen fixers.

1.2 **Non-symbiotic nitrogen fixers**

The agronomic importance of non-symbiotic nitrogen fixation cannot be overstated. Its energy-intensive nitrogen fixation mechanism is hampered by a lack of carbon and energy sources. However, migrating closer to or within plants, i.e. diazotrophs present in the rhizosphere, rhizoplane, or those developing endophytically, may compensate for this constraint. The nitrogen-fixing bacteria Azoarcus sp., Gluconacetobacter diazotrophicus, Herbaspirillium sp., and Azotobacter sp. [31], [32] are just a few examples. Other important nitrogen-fixing bacteria include Achromobacter, Acetobacter, Al.cal.igenes, Arthrobacter, Azomonas, Bacillus, Beijerinck [33]. Azotobacter, Azospirillum, Acetobacter, and Azoarcus are non-symbiotic nitrogen fixers.

1.3 **Bacillus**

A variety of metabolites are generated by Bacillus strains, making nutrients more readily available to plants in the rhizosphere [34]. Bacillus is the most prevalent species in this region [30]. B. subtilis is able to keep constant contact with higher plants and encourage their development because it is naturally present in the close proximity of plant roots. One way to see how quickly the soil microbiota colonizes in a micropropagated plant system is to look at bacterial inoculation early in acclimatization [35]. Researchers from [36] found that a rhizobacterium consortium of Bacillus spp. may be characterized as a potential strategy to improve plant health and survival rates in commercial nurseries by increasing the number of viable plants. It has also been discovered that Bacillus has the ability to boost raspberry plant output, growth, and nutrient content when grown organically [37].

1.4 **Pseudomonas**

Many characteristics of Pseudomonas sp. make them ideal for use as PGPR in agricultural soils. These fluorescent Pseudomonas species are among the most efficient strains of the bacterium. Fluorescent pseudomonads, a type of bacteria, are the subject of much study across the world (FLPs). To help keep soil healthy, FLPs perform a wide range of metabolic and functional functions [38], [39] .

Biofertilizers and their importance for soil and plants

A variety of publications discuss the necessity of using biological fertilizers as a complement or alternative to chemical fertilizers, since many studies have shown that their usage improves the root development of the plant by promoting hair creation, which in turn improves soil health. Root and expand the root system, which improves the plant's ability to absorb water and nutrients, resulting in an increase in vegetative development, quicker growth, and a better quality harvest, as a result. Because chemical fertilizers aren't used as much when biological fertilizers are used, they aid to minimize plant toxicity and provide healthier food. As a result, the physical, chemical and biological properties of soil are improved, especially in areas where organic matter is depleted, due to the production of enzymes that are capable of analyzing complex organic materials and converting the elements contained therein from the organic image to the mineral image suitable for plant use. As a consequence of quick melting of certain readily soluble nitrogenous chemicals, it serves a significant role in compensating for the rapid loss of nitrogen, which implies retaining soil fertility" [40], [41], [42]. Beneficial microorganisms are also added to the soil to compete with pathogenic microbes and prevent their activity and infestation of plants, while antibiotics are secreted to protect plants from pathogens present in the soil by inhibiting the growth of some pathogenic microbes. Fertilizers are also used to improve soil structure by aggregating soil grains and linking them together with org [43], [44], [13], [14].

Biofertilizers and their role on fruit trees

Toxic impacts on human health and the environment have been caused by excessive use of fertilizers and chemical pesticides, which have become a danger to the lives of residents and may cause them to become gravely sick [5], [45]. It has been shown that the fruits of fruit trees contain significant levels of residues of pesticides and chemical fertilizers that are harmful to human health and the natural environment, thus it is necessary to develop alternatives to lessen the use of fertilizers in fruit trees. Pesticides and chemicals Biofertilizers are regarded as a significant tool for enhancing fruit seedling development, speeding up the stage of fruit formation, boosting yield in terms of quality and quantity, and saving soil and water resources [46], [47], [48]. A research by [49]of apricot trees' responses to chemical, organic, and biofertilizer fertilizers shows As compared to chemical fertilizer treatment (NPK), the addition of Candida tropicalis and Azospirillum lipoferum led to an increase in the number of branches, the number of leaves, their foliar area, and their dry weight of leaves. The study by [50] reveals that the majority of the vegetative development parameters of pears may be improved. With the use of humic acid and biological fertilizers (Phosphorein and Biogein) compared to chemical fertilizer, Le-Conte had a better yield. Pollination of orange seedlings with mutant bacterial strains Azotobacter chrocoocum and Bacillus megatherium resulted in an increase in leaf count, dry leaf weight, plant height, and chlorophyll content in the leaves, according to [51]. Biofertilizers including Azotobacter and Aspergillus spp. as well as mineral nitrogen were shown to significantly improve most vegetative growth parameters in pairedV-1 berries in a research by [52]. Plant height and stem diameter rose considerably in lemon trees when Azotobacter, a bio fertilizer, was added, as reported by [53]. Chemical fertilizer NPK and 2.5 g. Seedlings-1 of biological fertilizers both increased the number of branches, stem diameter, and dry leaf weight in seedlings of the Toffahi seed type, according to [54]. (Nitrobein, Microbein and Biogein). Other experiments, such as those conducted by [55], found that pollination with Trichoderma spp. and organic fertilization with Humic Acid and Algex marine extract had a significant impact on the growth of three citrus origins (for Nicki cleopatra, Swingl stromelo, and lemon volka marina). Pomegranate trees Manfalouty had a considerable rise in the length of branches, the area of the leaf, and the number of leaves after the addition of biological fertilizers that feed the plant with nitrogen and biological fertilizers that dissolve mineral phosphate. When apricot trees aged seven were treated with fertilizer (Phosphorene and Nitrobeine), [56] found that the leaf area and dry weight of leaves, the main stem diameter, and the branch diameter all increased significantly in comparison to when apricot trees aged six were treated with fertilizer. It was shown that while treating lemon trees with three kinds of fertilizers (organic, biological, and NPK), the biological fertilizers had a good impact in lowering mineral fertilizers by 50% since they contributed to the vegetative development and quality of the fruits and soil fertility. Improved nutritional condition for trees was reflected in increased tree growth and yield as a direct result of increased soil availability of nutrients. Biofertilizers alone at the 40 g level (Phosphorine, Potassien and Rhizobactren) were examined by [57]. Spraying plant extracts on the development of the Le-Conte pear plants inlaid with the origin Pyrus betulafolia may be done for each tree or in combination. The features, number of leaves, paper area, dry and soft weight of leaves, stem diameter, and branch length of the comparative treatment were found to vary significantly. In his study, [58] found that the growth of peach seedlings of the Peento class was increased significantly by the treatment of seedlings in Azotobacter chroococcum, Azospirillum brasilense, and Bacillus megatherium and their interactions, which were isolated from fertile soil in central Iraq. The leafy area and the chlorophyll content of the leaves also increased significantly. Using the biocompost Bacillus, Azotobacter, Azospirillum, and organic fertilizer, researchers found that treating six-month-old Sindhi seedlings increased the nitrogen and phosphorus content of their leaves, while treating the plants with Bacillus and Azospirillum fertilizer increased the potassium content of their leaves. Similarly, a study conducted by [59]to demonstrate the effect of different combinations of bio-fertilizer with different bacterial species Bacillus subtilis, Azotobacte rchroococcum, Brasilense Azospirillum, and organic fertilizer (rice straw waste) on the growth of seedlings of Sindhi Citrus grandis L. at the age of six months and grafted on two origins of Citrus fruits (Vulkamaryana and Naranj) showed a positive effect of treatment with Bacillus and Azospirillum with rice straw waste. There are 80.68 leaves on this seedling, which is the first one to emerge from the soil. Plant-1 has a leaf area of 1598.4 cm2 and weighs 89.70 g both wet and dry. 1st seedling and 42.60 grams. Using the lowest-performing comparative therapy as a starting point, Seed-1 was compared in turn to that treatment. Manfalouty and Wonderful seedlings were treated with biological fertilizers (Phosphorein + Nitrobene + Potasene) at values of 4, 8 and 16 g. Most of the vegetative development parameters tested were improved by Seed-1 in each case [60]. As a consequence of applying 30 gm.tree-1 of mineral, organic, and bio fertilizers to Le-Conte pear trees (Phosphorein + Nitrobene + Potasene), [61] observed that the number of leaves, branch growth, as well as vegetative growth dry weight were all increased compared to the comparison trees. Researchers found that pear trees (Kala Amritsari) that were 19 years old were significantly increased in height, branch length, leaf area, and chlorophyll content by adding Azotobacter chroococcum and phosphate-dissolving bacteria. Adding Azotobacter chroococcum and Glomus macrocarbium to olive seedlings (Picual) significantly affected the height of seedlings, the diameter of their stems, the number of branches and leaves, the area and dry weight and wet weight of the branches, as well as a significant increase in the leaf content of nitrogen, phosphorus, and potassium, according to [62].

Biofertilizers and their role on vegetative plant

Many crops, including tomato, lettuce, corn, beans, cabbage, sugarcane, and many more, have been shown to benefit from the use of biofertilizers, which have been examined extensively and proved to play a significant role in agricultural productivity. When [63] conducted an experiment to determine the impact of bio-fertilizer on the growth and productivity of soybean varieties, the results show that the use of biofertilizers and their interaction had a significant impact on plant height, branch count and leaf count at various DAS, pods plant-1, pod size, seeds pod-1, 100 seed weight, grain yield, straw yield, biological yield, and harvest index (percent). Cucumber plant growth and biochemical parameters were studied in a separate research comparing the effects of chemical fertilizers and bio-fertilizers. When it came to cucumber growth qualities, the findings showed that bio-fertilizer application had a large influence, whereas chemical fertilizer application had a negligible effect on cucumber production [64]. Biofertilizers, such as Rhizobium phaseoli, Azotobacter chroococcum, and Azospirillum brasilense, had an impact on the growth and yield of green beans in an experiment conducted by [65]. The results showed that biofertilizers had a significant effect on increasing plant growth.

Conclusion:

It can be concluded that fertilization of fruit trees and vegetative crops with bio fertilizer has an important role in improving vegetative growth, increasing tree productivity and reducing toxicity in plant products as a result of reducing chemical residues, and this helps in obtaining high-quality production (clean planting), in addition to the use of bio fertilizers had a role important in reducing environmental pollution due to the reduction of chemical fertilizers, which lose the soil its biological diversity, as well as its positive role in restoring the microbial balance of the soil, stimulating its biological processes and providing a large part of the nutrients important to the plant.

Reference

[1] Mahdi, SS, Hassan, GI, Samoon, S A, Rather, HA, Dar, SA and Zehra, B (2010). Bio-fertilizers in organic agriculture. Journal of Phytology. 2(10): 42-54.

[2] Arun, KS (2007). Bio-fertilizers for sustainable agriculture. Mechanism of P-solubilization. Sixth edition, Agribios publishers, Jodhpur, India, pp.196-197.

[3] Hussein, HA (2021). Biological fertilizers and their role in plant growth. Review. International Research Journal of Advanced Science Vol. 2(1): 17–20.

[4] Mishra, BK and Dadlich, SK (2010). Methodology of nitrogen biofertilizer production. J. Adv. Dev. Res.1(1):3-6.

[5] AL-Hadad, MAM (1988). The role of biofertilizers in reducing agricultural costs, reducing environmental pollution and increasing crop productivity. National training course on the production of biological fertilizers. Arab Organization for Agricultural Development AOAD. Jordan. 16-21p.

[6] Silk, R, Hoflich, G and Remus, R (2000). Role of diastrophic bacteria in Plant nutrition. Edited N. Neeru in Azotobacter in Sustainable Agriculture CBS Publishers and Distributors. New Delhi, India.p:124-135.

[7] AL-Hadad, ZA (2003). The Proceedings of the Arab Conference on Organic Agriculture to clean the environment and boost the economy. Tunisia. 261-270 p.

[8] Havlin, JL, Beaton, JD, Tisdale, SL and Nelson, WL (2005). Soil fertility and fertilizers, An Introduction to Nutrient Management, 7th ed, Upper Saddle River New Jersey. USA. pp.515.

[9] AL-Badawe, MA (2008). Use of mycorrhizal fungi in biological fertilization. UAE Magazine Murshid. Abu Dhabi Agriculture Administration. 38:221-230.

[10] Angus, J.F. (2001). Nitrogen supply and demand in australian agriculture. Australian Journal of Experimental Agriculture 41,277-288.

[11] Kennedy, IR, Choudhury, ATMAm Kecskés, ML and Mihaly, L (2004). Non-symbiotic bacterial diazotrophs in crop-farming systems: can their potential for plant growth promotion be better explo- ited? Soil Biology& Biochemistry 36, 1229-1244.

[12] Ali, NAS (2012). Fertilizer Technologies and Uses. Bookstore for Printing, Publishing and Translating. University of Baghdad. Ministry of Higher Education and Scientific Research. Iraq.

[13] Assefat, LS (2012). Biofertilizer and its role in reducing water pollution problems with chemical fertilizers. Libyan Agriculture Research Center Journal international. 3(S2): 1457-1466.

[14] Mir, M, Hassan, GI, Mir, A, Hassan, A and Solaimani, M (2014). Effects of bio-organics and chemical fertilizers on nutrient availability and biological properties of pomegranate orchard soil. International Journal of Fruit and Vegetable Sciences. 1(2): 24-27.

[15] Kloepper, JW, Leong, J, Teintze, M, Schroth, MN (1980). Enhanced plant growth by siderophores produced by plant growthpromoting rhizobacteria. Nature, 286: 885–886.

[16] Ashrafuzzaman, M, Hossen, FA, Ismail, MR, Hoque, MA, Islam, MZ, Shahidullah, SM and Meon, S (2009). Efficiency of plant growthpromoting Rhizobacteria (PGPR) for the enhancement of rice growth. African Journal of Biotechnology, 8 (Suppl 7): 1247-1252.

[17] Kloepper, JW, Lifshitz, R, Zablotowicz, RM (1989). Free-living bacterial inocula for enhancing crop productivity. Trends in Biotechnology, 7 (Suppl 2): 39–43.

[18] Joseph, B, Patra, RR, Lawrence, R (2007). Characterization of plant growth promoting Rhizobacteria associated with chickpea (*Cicer arietinum* L). International Journal of Plant Production, 1 (Suppl 2): 141-152.

[19] Tilak, KVBR, Ranganayaki, N, Pal, KK, De, R, Saxena, AK, Nautiyal, CS, Mittal S, Tripathi, AK, Johri, BN (2005). Diversity of plant growth and soil health supporting bacteria. Current Science, 89 (Suppl 1): 136-150.

[20] Egamberdiyeva D (2005). Plant-growth-promoting rhizobacteria isolated from a Calcisol in a semi-arid region of Uzbekistan: biochemical characterization and effectiveness. Journal of Plant Nutrition and Soil Science, 168 (Suppl 1): 94–99.

[21] Curl, EA and Truelove, B (1986). The Rhizosphere. Springer Verlag, Berlin-Heidelberg, 288.

[22] Hallmann, J, Quandt-Hallmann, A, Mahaffee, WF, Kloepper, JW (1997). Bacterial endophytes in agricultural crops. Canadian Journal of Microbiology, 43 (Suppl 10): 895–914.

[23] Barraquio, WL, Segubre, EM, Gonzalez, MS, Verma, SC, James, EK, Ladha, JK, Tripathi, AK (2000). Diazotrophic

enterobacteria: What is their role in the rhizosphere? In The Quest for Nitrogen Fixation in Rice. IRRI, Manila. Edited by Ladha JK, Reddy PM, 93-118.

[24] Ştefan, M, Mihasan, M and Dunca, S 2008. Plant growth promoting Rhizobacteria can inhibit the in vitro germination of Glycine Max L seeds. Scientific Annals of University "Alexandru Ioan Cuza" Iasi, Section Genetics and Molecular Biology, T. IX, 3: 105-110.

[25] Chaiharn, M, Chunhaleuchanon, S, Kozo, A and Lumyong, S (2008). Screening of Rhizobacteria for their plant growth promoting activities. KMITL Science and Technology Journal, 8 (Suppl 1): 18-23.

[26] Adesemoye, A, Torbert, H and Kloepper, J (2009). Plant growth-promoting Rhizobacteria allow reduced application rates of chemical fertilizers. Microbial Ecology, 58 (Suppl 4): 921-929.

[27] Schwintzer, R and Tjepkema, JD (1990). The Biology of Frankia and Actinorrhizal Plants. Academic Press Inc. San Diego, USA, 99.

[28] Wheeler, CT and Miller, JM (1990). Current and potential uses of actinorrhizal plants in Europe. In The Biology of Frankia and Actinorrhizal Plants. Academic Press, San Diego, USA. Edited by Schwintzer CR, Tjepkema JD, 365–389.

[29] Dommergues, YR and Marco-Bosco (1998). The contribution of N2- fixing trees to soil productivity and rehabilitation in tropical, subtropical and Mediterranean regions. In Microbial Interactions in Agriculture and Forestry Oxford & IBH, New Delhi. Edited by Subba Rao NS, Dommergues YR, 65–96.

[30] Sahgal, M and Johri, BN (2003). The changing face of rhizobial systematics. Current Science, 84 (Suppl 1): 43–48.

[31] Vessey, JK (2003). Plant growth promoting rhizobacteria as biofertilizers. Plant and Soil, 255 (Suppl 2): 571–586.

[32] Barriuso, J and Solano, BR (2008). Ecology, Genetic Diversity and Screening Strategies of Plant Growth Promoting Rhizobacteria (PGPR). Journal of Plant nutrition: 1-17.

[33] Saxena, AK and Tilak, KVBR (1998). Free-living nitrogen fixers: Its role in crop production. In Microbes for Health, Wealth and Sustainable Environment, Malhotra Publ Co, New Delhi. Edited by Verma AK, 25–64.

[34] Charest, MH, Beauchamp, CJ, Antoun, H (2005). Effects of the humic substances of de-inking paper sludge on the antagonism between two compost bacteria and Pythium ultimum. FEMS Microbiology Ecology, 52(Suppl 2): 219–227.

[35] García, JAL, Probanza, A, Ramos, B, Palomino, MR and Mañero, FJG (2004). Effect of inoculation of Bacillus licheniformis on tomato and pepper. Agronomie for Sustainable Development, 24 (Suppl 4): 169-176.

[36] Jaizme-Vega, MDC, Rodríguez-Romero, AS and Guerra, MSP (2004). Potential use of rhizobacteria from the Bacillus genus to stimulate the plant growth of micropropagated bananas. Fruits, 59 (Suppl 2): 83-90.

[37] Orhan, E, Esitken, A, Ercisli, S, Turan, M and Sahin, F (2006). Effects of plant growth promoting rhizobacteria (PGPR) on yield, growth and nutrient contents in organically growing raspberry. Scientia Horticulturae, 111 (suppl 1): 38-43.

[38] Lata Saxena, AK, Tilak, KVBR (2002). Biofertilizers to augment soil fertility and crop production. In Soil Fertility and Crop Production Science Publishers, USA. Edited by Krishna KR, 279–312.

[39] Lugtenberg, BJJ and Dekkers, LC (1999). What makes Pseudomonas bacteria rhizosphere competent? Environmental Microbiology, 1 (Suppl 1): 9–13.

[40] Osip, CA, Ballescas, SS, Osip, LP, Besaino, NL, Bagayna, AD and Jumalon, CB (2000). Philippine council for Agr. Forestry and Natural Resources Research and Technology .143:17 -18.

[41] Hunter, M and Keith, B (2002). File: IIA: lmycra. htm. Beneficial Microbes in Soil Less Potting Media . 4(2) 151-159.

[42] Koele, N, Kuyper, TW and Bindraban, PS (2014). Beneficial organisms for nutrient uptake. 63 p.

[43] Altomare, C, Norvell, W A, Bjorkman, T and Harman, G. E. (1999). “Solubilisation of phosphates & micronutrients by the plant growth promoting & biocontrol fungus Trichoderma harzianum Rifai”, Vol. 65. Applied Environmental Microbiology, pp. 2926-2933.

[44] Harman, GE (2000). Myths and dogmas of biocontrol change in perceptions derived from research on Trichoderma harzinum T.22. Plant Dis Rep.84 (4): 377- 393.

[45] AL-Ansary, NMA (2006). Environmental pollution modern risks and a scientific response. Arab Publishing Bookstore. Jordan.

[46] Al-Shahat, TMR (2007). Biofertilizers and organic farming are healthy food and clean environment. Faculty of Agriculture. Ain Shams Universi-ty. First Edition. Egypt.200p.

[47] Sharaf, MM, Bakry, KHA and EL-Gioushy, SF (2011). The Influence of some Bio and Organic Nutritive addenda on Growth, Productivity, Fruit Quality and Nutritional status of Washington Navel Orange trees. Egypt. J. of AppL.Sci, 26 (9):253-269.

[48] Ennab, HA (2016). Effect of Organic Manures, Biofertilizers and NPK on Vegetative Growth, Yield, Fruit Quality and Soil Fertility of Eureka Lemon Trees (Citrus limon (L.) Burm). J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 7(10): 767- 774.

[49] Stino, RG, Mohsen, AT and Maksoud, MA (2009). Bio-Organic fertilization and its impact on apricot young trees in newly reclaimed soil. American–Eurasian J. Agric. And Environ. Sci., 6(1): 62-69.

[50] Mohammed, SM, Fayed, TA, Esmail, AF and Abdou, NA (2010). Growth, nutrient status and yield of Le-Conte pear trees as influenced by organic and biofertilizer rates compared with chemical fertilizer. Bull. Fac .Agric .Cairo Univ. 61(1):17-32.

[51] Ismail, O M, Dakhly, OF and Ismail, MN (2011). Influence of some bacteria strains and algae as biofertilizers on growth of bitter orange seedlings. Australian Journal of Basic and Applied Sciences, 5(11): 1285-1289.

[52] Nithya, D, Poornima, SM, Murugan, RP, Gopikrishnan, V, Radhakrishnan, M, Bhivi, D and Balagurunathan, R (2011). Influence of biofertilizers and irrigation systems for the growth and yield of mulberry plants. International Journal of Plant, Animal and Environmental Sciences. 1(3):93-99.

[53] Khehra, S and Bal, JS (2014). Influence of organic and inorganic nutrient sources on growth of lemon (*Citrus limon* L. Burm.) cv. Baramasi. Journal of Experimental Biology and Agricultural Sciences. 2(1S):126-129.

[54] Haggag, LF, Merwad, MA, Shahin, MFM and Fouad, AA (2014). Effect of NPK and bio-fertilizers as soil application on promoting growth of "Toffahi" olive seedlings under greenhouse condition. Journal of Agricultural Technology. 10(6):1607-1617.

[55] Al-Haiani, AMA, Al-Samarri. AA and Al-Shammari, MFM (2014). Effect of Inocuation Trichoderma Spp and Organic Fertilizer Humic Acid and Seaweed Extract Application on Citrus Root Stock Growth. Diyala Agricultural Sciences Journal. 6 (2): 96-106.

[56] Al-Hadethi, MEA and AL-Dujaili, JA (2015). Effect of Biofertilizers, Algae extract and Brassinolide on growth character of Apricot trees. Euphrates Journal of Agriculture Science. 7(3): 63-82.

[57] Mohamed, MS (2017). Response of ′Le-Contё pear trees to biofertilization and antioxidants. M.Sc. Thesis. Faculty of Agriculture. Benha University, Egypt.

[58] Al-Hadethi, MEA, AL-Dulaimi, AST and Almashhadani, BMK (2017). Influence of biofertilizers on growth and leaf mineral content in Peach transplants. IOSR Journal of Agriculture and Veterinary Science. 10(9):90-93.

[59] AL- Abbasi, GBA and AL-Zuhairi, FFA (2018). Effect of bio and organic fertilization on the growth of Pomelo seedlings Citrus grandis L. grafted on different rootstocks. Euphrates Journal of Agriculture Science. 10(2): 39-61.

[60] Ataweia, AA, Abd EL latif, FM, Bakry, KHA, Abd El- Moneim, AA, and Madian, MN (2018). A Comparative study on fertilization of pomegranate transplants. 1-Vegetative growth measurements. Middle East Journal of Agriculture Research. 7(3): 1049-1058.

[61] Eweda, OSM (2018). Response of Le-Conte pear trees to mineral and bio-organic fertilization. Ph.D. Dissertation, College of Agriculture. Benha University. Egypt.

[62] El-Shazly, MM and Ghieth, WM (2019). Effect of Some Biofertilizers and Humic Acid Application on Olive Seedlings Growth under Irrigation with Saline Water. Alexandria Science Exchange Journal. 40(2):263-279.

[63] Haque, F, Tariq HHMM, Farooque, AM, Podder, S, Abdul Karim, MD and Abu Zafur Al Munsur, MD (2021). Effect of Bio-Fertilizer on Growth and Productivity of Soybean Varieties. International Journal of Agriculture and Environmental Research Vol. 07, (01): 1-17.

[64] Saeed, KS, Ahmed, SA, Hassan, IA and Ahmed, PH (2015). Effect of Bio-fertilizer and Chemical Fertilizer on Growth and Yield in Cucumber (*Cucumis sativus*) in Green House Condition. Pakistan Journal of Biological Sciences 18 (3): 129-134.

[65] Al-Jebory, KD and AL-Rukabi, MNM (2017). Effect of bio-fertilizers and molybdenum on growth and yield of green bean. The Iraqi Journal of Agricultural Sciences 48(3):681-689.

Kirkuk University Journal for Agricultural Sciences, Vol. 14, No. 3, 2023 (47-56)

الأسمدة الحيوية، أنواعها، فوائدها ودورها في تحسين نمو أشجار الفاكهة ونباتات الخضر

صلاح حسن جبار الحجيمي[1]　　　　ياسمين فاضل سلوم [2]

salah.h@coagri.uobaghdad.edu.iq　　　　yasamen.f@coagri.uobaghdad.edu.iq

[1، 2] قسم البستنة وهندسة الحدائق، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق.

• تاريخ استلام المقالة 2023/06/05 وتاريخ قبولها 16/07/2023

المستخلص

في هذه المقالة يتم مناقشة فوائد وأنواع السماد الحيوي ودوره في تطور النبات، وقد أظهرت الدراسات أن استخدام الأسمدة الحيوية يزيد من نمو النبات المضيف، فضلاً عن تحسين نمو الجذر وزيادة مساحة النظام الجذري ، مما يؤدي إلى يؤدي إلى زيادة امتصاص الماء والعناصر الغذائية. كما أن استخدام الأسمدة البيولوجية يساعد في تقليل السمية في المنتجات النباتية نتيجة انخفاض الأسمدة الكيماوية ، بالإضافة إلى زيادة مقاومة النبات لظروف الإجهاد مثل الملح والجفاف ، ودرجة الحرارة. يمكن للأسمدة الحيوية أيضًا أن تزيد من خصوبة التربة من خلال المساهمة في تراكم التربة وزيادة نشاط إنزيمات التربة مثل dehydrogenase و phosphatase و urease ، على سبيل المثال. تساعد هذه الإنزيمات النباتات على أن تكون أقوى ضد ظروف الإجهاد مثل الملح والجفاف ودرجة الحرارة.

الكلمات المفتاحية: الأسمدة الحيوية، الفوسفتيز، العناصر الغذائية، أشجار الفاكهة، نباتات الخضر.