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Bio- fertilizer and dill plant (*Anethum graveolens* L.) characteristics. A Review Article

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ANNOTATION
The utilization of bio fertilizers is a promising choice for economical horticulture, and bio fertilizer applications are the most ideal choice, as they fundamentally expanded medicinal ointment content and complete creation of umbellate family plants and dill particularly contrasted with other compost applications. The instruments through which bio fertilizers can decidedly affect dill plant development could be through the union of plant chemicals, nitrogen obsession, decrease of root film potential, and the combination of certain compounds that tweak the degree of plant chemicals like the disintegration of inorganic phosphate. Also, mineralization of organophosphates, which makes phosphorus more accessible to plants, we infer that cultivating designs treated with bio fertilizers are incredible choices for cultivators searching for cleaner, all the more harmless to the ecosystem systems to expand their pay by working on medicinal balm and quality.
KEYWORDS: Bio-fertilizer; *Anethum graveolens*; traits.

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السماد الحيوي - ونبات الشبت *Anethum graveolens* L. الخصائص. مقالة مرجعية

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تعليق توضيحي
يُعد استخدام الأسمدة الحيوية خيارًا واعدًا للزراعة الاقتصادية، وتعد استخدامات الأسمدة الحيوية الخيار الأمثل، ان استخدام الأسمدة الحيوية على النباتات الطبية والعطرية زاد من انبات البذور وانتاج الزيت العطري وقدمت منتجات عالية الجودة خالية من الكيماويات الزراعية الضارة، من خلال تأثيره على التنوع البيولوجي للتربة والأنشطة الحيوية ومساعدة جذور النباتات في الوصول إلى العناصر الغذائية المهمة ، وتحويلها من الأشكال غير المتوفرة إلى الأشكال المتاحة ، وزيادة قابليتها للذوبان وتعزيز السلامة البيئية ، وتحسين توسع الجذور .حيث أصبح إنتاج النباتات الطبية والعطرية من الزيت العطري باستخدام الأسمدة الحيوية عملية أساسية لضمان محصول البذور وتحسين محتوى NPK وإحداث تأثير إيجابي على نمو النبات من خلال تخليق الهرمونات النباتية ، وتثبيت N2 ، وأيضًا إطلاق بعض الهرمونات النباتية من طبيعة GA3 و IAA والتي يمكن أن تحفز نمو النبات وامتصاص العناصر الغذائية وعملية التمثيل الضوئي.
الكلمات المفتاحية: السماد الحيوي، نبات الشبنت، الصفات.

INTRODUCTION

An annual plant in the Apiaceae family, dill (*Anethum graveolens* L.) is a significant medicinal herb used throughout the world. Dill seeds have diuretic, stomachic, and carminative properties. It can also be used to increase the production of milk for nursing mothers, prevent colic, foul breath, hacking, colds, influenza, and feminine health issues. The growth of the potato spouts was then inhibited by treating potato tubers with the carvone of the natural balm extracted from dill seeds (Sanli and Kardogan, 2019). In the food industry, dill spices and seeds are used as seasoning experts for sauces, mixed greens, and fish (Pinoet et al., 1995; Kaur and Arora, 2010). Carvone (20–60%) is a major component of the rejuvenating oil derived from dill seeds (Radulescu et al., 2010,

Delaquis et al., 2002; Leung and Encourage, 2003). In addition to carvone, the following are also present: dihydro carvone, p-cymene, limonene, α-phelandrene, α-pinene, α-terpinene, apiole, dill apiole, 1,8-cineole, and apiole (Leung and Cultivate, 2003; Pinoet et al., 1995). (Stanojević et al. 2015) and colleagues discovered in their review that dill seeds medicinal ointment from the Southeast Serbia region had a high happy of carvone (about 90%). According to Kaur and Arora (2010), the bioactive components of dill include medicinal balms, greasy oils, proteins, carbohydrates, strands, and mineral components such as potassium, calcium, magnesium, phosphorous, and sodium. Carvone (20–60%) is the main fixing in medicinal ointment made from dill seeds (Leung and Encourage 2003; Delaquis et al. 2002; Radulescu et al. 2010). The plant is essential because it is a fragrant spice that contains volatile oil components like carvone, lonone, umbelliferone, anethole, B-camphene, and α-pinene (Sharma, 2004 and Dhalwal et al., 2008). When organic matter breaks down and naturally occurring acids fracture, B. megaterium microorganisms are used to solubilize (break up) insoluble phosphate (Aziz et al. 2012). N2 fixers and P-dissolvers were used for biofertilization, which was successful when applied to sunflower (Abdel-Salam et al. 2015), faba beans (Abdel-Salam et al. 2014), and maize (Abdel-Salam et al. 2012). By releasing natural acids to break down potassium and additionally chelating silicon particles to deliver potassium into soil arrangement, the B. circulans microorganisms are used to solubilize potassium in soils containing K-bearing minerals ((Priyanka and Sindhu (2013), Megadi et al. (2010), and Basak and Biswas 2009 and 2010). According to Malusa et al. (2012), they colonise the rhizosphere by moving inside the plant and stimulate growth by increasing the host plant's openness to and uptake of mineral supplements. These are microorganism cell configurations that can be N fixers, P solubilizers, S oxidizers, or natural matter decomposers. Through their routine metabolic activities, they are "eco-accommodating" agro-contribution of natural beginning and working on transformation of inaccessible fundamental components to accessible structure. Vesey (2003). Plant only consumes 10% - 40% of applied supplements; the remaining 60-90% is lost due to immobilization, filtration, volatilization, and other processes. Biofertilizer, as a fundamental part of natural cultivating, plays a Bio job in keeping up with the drawn-out richness and manageability of soil (Mishra, N. 2013). Since synthetic treatment procedures could cause this issue, it was important to foster elective techniques to supply supplements to the developing plant, to create substance free restorative and fragrant plants. That pattern has been the fundamental objective of numerous analysts and makers to guarantee the excellent and wellbeing item, for people as well as for the climate. Consequently, using natural and biofertilizers has become essential (Glala et al. 2013; Saleh et al. 2010; Glala et al. 2012; Ezzo et al. 2012; and Glala et al. 2010.(

LITERATURE REVIEW

The use of biofertilizers including various microbial strains has resulted in a reduction in the use of manure and good products free of harmful Agrochemicals for human safety. Using bio-composts to create fragrant and healing plants became an essential cycle to ensure seed yield and increase *Anethum graveolens*' NPK content (Kewalanand et al., 2001;Randhawa et al., 1996; Singh, 1991). Biofertilizers can have a positive effect on plant development through a variety of mechanisms, including the interaction of phytohormones, N2 obsession, a reduction in the root's film capability, or a combination of specific chemicals (ACC deaminase, for example) that balance the degree of plant chemicals. Additionally, the solubilization of inorganic phosphate and the mineralization of natural phosphate allow plants to access phosphorus (Rodriguez and Fraga, 1999). In addition to fixing nitrogen, free-living nitrogen-fixing microorganisms like Azotobacter and Azospirillum can also supply specific phytohormones of the GA3 and IAA types that can stimulate plant growth, supplement retention, and photosynthesis (Abdel-Latif et al., 2001; Fayez et al., 1985). The commercial biofertilizers Biogene, Netrobene, and Serialene were used to boost the vegetative development, seed output, and unstable oil yield of the dill plant (Kandeel et al., 2004). Al-Qadasi (2004) discovered that immunising Ocimum basilicum spice with Azotobacter, Azospirillum, and Bacillus increased the amount of total starch, carotenoids, NPK items, and chlorophyll (a, b). When a combined application of 60 kg N/cared for with biofertilizer was performed, dill plants had the maximum new and dry load of various plant parts, oil rate, chlorophyll, total flavonoids, and NPK items (Said Al Ahl, 2005). In comparison to the control, Hassan (2009) discovered that microorganisms injected separately or in combination with compound manures significantly enhanced the roselle plant's development characteristics and increased its sepal yield. Furthermore, the application of biofertilizers, either alone or in combination with substance composts, increased all-out sugars, chlorophyll content, and NPK rates. The development and yield of the Foeniculum vulgare plant were impacted by seed Azotobacter and Azospirillum vaccination in the presence of material manures. Additionally, the starch content and NPK components in the dried spice were further enhanced (Mahfouz and Sharaf-Eldin, 2007). Kandeel et al. (2002) discovered that the expansion of plant level, number of branches per plant, and new and dry loads of leaves and roots was facilitated by double immunisation with harmonious N2 fixers (Azospirillum and Azotobacter) with half or full dosages of inorganic N compost. Fennel is a biofertilizer, according to research by El-Ghadban et al. (2006), Badran and Safwat (2004), because it increases development and oil yield while altering the creation of substances. Since many of them can fix nitrogen, they can function as bio fertilizers. When soils were recently treated or heat sanitized to obtain a control without soil biota, supplements could be supplied, causing soil microbial community disruption and vaccination success to be jeopardised (Read and Smith, 2008a). The development and yield of the Foeniculum vulgare plant were impacted by seed immunisation with Azotobacter and Azospirillum in the presence of

substance manures. Additionally, the starch content and NPK components in the dried spice were further enhanced (Mahfouz and Sharaf-Eldin, 2007). Kandeel et al. (2002) discovered that the expansion of plant level, number of branches per plant, and new and dry loads of leaves and roots was facilitated by double immunisation with harmonious N2 fixers (Azotobacter and Azospirillum) with half or full dosages of inorganic N compost. Fennel is a biofertilizer, according to research by El-Ghadban et al. (2006), Badran and Safwat (2004), because it increases development and oil yield while altering the creation of substances. Since many of them can fix nitrogen, they can function as biofertilizers. Different live microorganisms are present in biofertilizers (BFS), such as beneficial microscopic organisms and growths that can convert significant supplements from inaccessible to accessible structures, thereby promoting seed germination and root extension (Zhaoxiang, W., et al., 2020). A successful BFS in crop creation will increase harvest and restorative plant yields and strengthen the growth of the plant's underground roots (Rezaei-Chiyaneh, E. et al. 2020). Among its many benefits are increased soil biodiversity and Bio exercises; additionally, BFS promotes natural wellbeing and increases the dissolvability of supplements, especially large-scale ones, which helps establish roots to reach them (Saghir Khan, M., Saif, S., Ahmad, E., Zaidi, Z., and Rizvi, A. 2015).

CONCLUSION

The utilization of biofertilizers on restorative and fragrant plants expanded seed germination and rejuvenated balm creation and gave great items liberated from harmful farming synthetic compounds through its effect on soil biodiversity and Bio exercises and aiding plant roots to get to fundamental supplements, changing over them from inaccessible structures into accessible structures, expanding their solvency and upgrading natural wellbeing, and further developing root extension. The development of restorative and fragrant plants from rejuvenating oil utilizing biofertilizers has turned into a fundamental interaction to guarantee seed yield, further develop NPK content, and decidedly affect plant development through the amalgamation of phytohormones, N2 obsession, and delivery of a few plant chemicals of GA3 and IAA nature, which can invigorate plant development, supplement retention, and the photosynthesis process.

REFERENCES

Al-Hadidi, Khalil Hathal. 2007. Effect of planting dates and distance between rows on yield and its components of two cultivars of yellow corn, Master Thesis, College of Agriculture and Forestry - University of Mosul.

Abd-El Latif, M.R.; A.A. El-Bana and A.A. Galal (2001). Effect of biofertilizers Microbein and Phosphorine on bacterial pod blight of guar and black cumin damping off root rot and with diseases. Proc. Of the fifth Arabian Horticulture Conference, Ismailia, Egypt, March 24-28: 133 – 140.

Abdel-Fattah, D.A.; W.E. Ewedab; M.S. Zayed and M.K. Hassaneina (2013): Effect of carrier materials, sterilization method, and storage temperature on survival and biological activities of Azotobacter chro

ococcum inoculants. Ann Agric. Sci., 58:111-118.

Abdel-Salam, A.A.; E.H. Noufal; K. A. Shaban and M.A. Ahmed (2012). Bio-fertilization and efficient productivity of maize grown on a newly reclaimed saline sandy clay soil. 1st International Conference Biotechnology Applications in Agriculture, Benha University, Moshtohor and Hurghada, 18-22 Feb. 2012, Egypt .

Abdel-Salam, A.A.; T.A. El-Maghraby; I.M. Farid; M.A. AbdelSalam and S.A. El-Shahid (2014). Biofertilization of faba beans (Vicia faba) grown on a clay loam Typic Torrifluvent soil, using inocula of N2-fixing Rhizobium leguminosarum and Pdissolving Bacillus megaterium under field conditions. Proc. 2nd Int. Conf. Biotech. Appl. Agric. Vol. 1, Benha Univ., Moshtohor & Hurghada, Egypt, 8-11 Apr. 2014.

Abdel-Salam, A. A. ; S. M. Soliman ; Y. G. M. Galal ; W. R. Zahra ; A. A. Moursy and M. A. Hekal (2015). Response of sunflower (Helianthus annuus L.) to N-application and biofertilization with assessment of fertilizer N recovery by 15N versus subtraction methods. J. Nucl. Tech. Appl. Sci., 3(3):157-169.

Al-Qadasi, A.S.S. (2004). Effect of bio fertilization on Ocimum basilicum L. plants. M.Sc. Thesis, Fac. of Agric., Cairo Univ.

Arora, N. K. (2013). "Plant microbe symbiosis: fundamentals and advances," in Plant Microbe Symbiosis: Fundamentals and Advances, ed N. K. Arora (Dordrecht: Springer Science +Business Media).

Aziz, G. ; N. Bajsa ; T. Haghjou ; C. Taule ; A. Valverde ; J. Mariano and A. Arias (2012): Abundance, diversity and prospecting of culturable phosphate solubilizing bacteria on soils under crop–pasture rotations in a no-tillage regime in Uruguay. Appl. Soil Ecol., 61:320-326.

Basak, B. and D.R. Biswas (2009). Influence of potassium solubilizing micro-organism (Bacillus mucilaginosus) and waste mica on potassium uptake dynamics by Sudan grass (Sorghum vulgare Pers.)grown under two Alfisols. Plant and Soil., 317(1):235-255.

Bashan, Y. ; G. Holguin and L.E. Bashan (2004): Azospirillum-plant relationships: agricultural, physiological, molecular and environmental advances (1997–2003). Can J. Microbiol., 50:521-577.

Bhardwaj, D. ; M.W. Ansari ; R.K. Sahoo and N. Tuteja (2014). Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. Microb. Cell Factory. 13: 66-72.

Bhattacharyya, P.N. and D.K. Jha (2012) : Plant growth-promoting rhizobacteria (PGPR) : emergence in agriculture. World J. Microbiol. Biotechnol., 28:1327-1350.

Chi, F. ; P. Yang ; F. Han ; Y. Jing and S. Shen (2010): Proteomic analysis of rice seedlings infected by Sinorhizobium meliloti 1021. Proteomics., 10:1861-1874.

Delaquis, P. J., K. Stanich, B. Girard, and G. Mazza. 2002. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. Int. J. Food Microbiol. 74: 101-9.

Dhalwal, K., V.M. Shinde and K.R. Mahadik (2008): Efficient and sensitive method for quantitative determination and validation of umbelliferone, carvone and myristicin in (*Anethum graveolens* L.) and (Carum carvi L.) seed. India J. Chromatograaphia 67(1-2): 163-167.

El-Ghadban, E.A.E., M.N. Shalan and T.A.T. Abdel-Latif, 2006. Influence of biofertilizers on growth, volatile oil yield and constituents of fennel (Foeniculum vulgare Mill.). Egyptian J. Agric. Res., 84: 977–992.

Fayez, M.; N.F. Eman and H.E. Makbol (1985). The possible use of nitrogen fixing Azospirillum as biofertilizer for wheat plants. Egypt. J. Microbiol., 20 (2): 199-206.

Gholami, A. ; S. Shahsavani and S. Nezarat (2009) . The Effect of Plant Growth Promoting Rhizobacteria (PGPR) on Germination seedling Growth and Yield of Maize. Int J Biol Life Sci., 5:1-8.

Glala AA, Abd El-Samad EEH, El-Abd SO, Obiadalla-Ali HA (2012) Increasing organic production of summer squash by modulating plant sex ratio. Acta Hort (ISHS) 933:137–143.

Glala AAA, Marzouk NM, Al-Bassyuni MSS, Nagwa MKH (2013) Influence of organic nitrogen fertilizers replacement rates associated with Azosprillum spp, enrichment on tomato. J Appl Sci Res. 9(3):1952–1959.

Hassan, F. (2009). Response of Hibiscus sabdariffa L. plant to some biofertilization treatments. Annals Agric. Sci. Ain Shams Univ. Cairo. 54: 2, 437 – 446.

Kandeel, A.M., S.A.T. Naglaa and A.A. Sadek, 2002. Effect of biofertilizers on the growth, volatile oil yield and chemical composition of Ocimum basilicum L. plant. Annals Agric. Sci. Ain Shams Univ. Cairo, 47: 351–371.

Kandeel, Y.M; F.A. Menesy; M.M. Khalafalla and W.M. Gad (2004). Effect of some commercial biofertilizers on growth, seed, volatile oil yield and chemical composition of *Anethum graveolens* L. J. Agric. Res. Tanta Univ., 30 (3): 721-737.

Kaur, G.J., Arora, D.S. (2010): Bioactive potential of *Anethum graveolens*, Foeniculum vulgare and Trachyspermum ammi belonging to the familiy Umbelliferae - Current status. Journal of Medicinal Plants Research, 4, 2: 087–94.

Kewalanand.; C.S. Pandy; L.D. Bisht and S. Singh (2001). Influence of stage of umbel harvesting and nitrogen levels on European dill (*Anethum graveolens*). J. of Medicinal and Aromatic Plants Sci., 23: 3, 361-364.

Leung, A.Y and, Foster , S., (2003). Encyclopedia of common natural ingredients (used in food , drugs , and cosmetic s) , Second edition . A john wiley & Sons Inc , Hoboken . New Jersey.

Mahfouz, S.A. and M.A. Sharaf-Eldin (2007). Effect of mineral vs. biofertilizer on growth, yield and essential oil content of fennel (Foeniculum vulgare Mill.). International Agrophysics, 21: 361-366 .

Mali, G.V. and M.G. Bodhankar (2009). Antifungal and phytohormone production potential of Azotobacter chroococcum isolates from groundnut (Arachis hypogea L.) rhizosphere. Asian J. Exp. Sci., 23:293-297.

Malusa E, Sas-paszt L, Ciesielska J. Technologies for beneficial micro-organisms inoculation used as biofertilizers. The Scientific World, 2012. doi:10.1100/2012/491206.

Megadi, V.B. ; P.N. Tallur ; R.S. Hoskeri ; S.I. Mulla and Z. Minnekar (2010). Biodegradation of Pendimethalin (herbicide) by Bacillus circulans . Ind. J. Biotech., 9:173-177.

Mishra, N. Haematological and hypoglycemic potential *Anethum graveolens* seeds extract in normal and diabetic Swiss albino mice. Vet. World 2013, 6, 202–507.

Perrig, D. ; M.L. Boiero ; Masciarelli, O.A., Penna, C., Ruiz O.A., Cassan, F.D. and Luna, M.V. 2007: Plant-growth promoting compounds produced by two agronomically important strains of Azospirillum brasilense, and implications for inoculant formulation. Appl. Microbiol. Biotechnol., 75:1143-1150.

Pino, J. A. Roncal, E., Rosado, A. & Goire, I. 1995. Herb oil of dill (*Anethum graveolens* L.) grown in Cuba. J. Essent. Oil Res., 7, 219–220.

Priyanka, P. and. S.S. Sindhu (2013). Potassium solubilization by rhizosphere bacteria: Influence of nutritional and environmental conditions. J. Microbiol. Res., 3(1): 25-31.

Radulescu, V., Popescu, M.I. and llies, D.-C., (2010). Chemical composition of the volatile oil from different plant parts of Anthum graveolens L.(Umbelliferae) cultivated in Romania . Farmacia 58, 594- 600.

Randhawa, G.S.; B.S. Gill; S.S. Saini and J. Singh (1996). Effect of plant spacing and nitrogen levels on the seed yield of dill seed (*Anethum graveolens* L.). Acta Hort., No. 426, 623-628.

Revillas, J.J. ; B.Rodelas ; C. Pozo ; M.V. Martinez-Toledo and L.J. Gonzalez (2000): Production of B-Group vitamins by two Azotobacter strains with phenolic compounds as sole carbon source under diazotrophic and adiazotrophic conditions. J. Appl. Microbiol., 89:486-493.

Rezaei-Chiyaneh, E. et al. Co-inoculation of phosphate-solubilizing bacteria and mycorrhizal fungi: Effect on seed yield, physiological variables, and fixed oil and essential oil productivity of ajowan (Carum copticum L.) under water deficit. J. Soil Sci. Plant Nutr. 21, 3159–3179.(2021) .

Rodriguez, H. and R. Fraga (1999). Phosphate solubilizing bacteria and their role in plant growth promotion. Biotech. Advan., 17:319-339.

Sahoo, R.K. ; M.W. Ansari ; T.K. Dangar ; S.Mohanty and N. Tuteja (2013). Phenotypic and molecular characterization ofefficient nitrogen fixing Azotobacter strains of the rice fields. Protoplasma., 251:511-520.

Sahoo, R.K. ; M.W.Ansari ; M.Pradhan ; T.K. Dangar ; S.Mohanty and N. Tuteja (2014). Phenotypic and molecular characterization of efficient native Azospirillum strains from rice fields for crop improvement. Protoplasma., 4:943-953.

Said Al Ahl, H. A. (2005): Physiological studies on growth, yield and volatile oil of Dill (*Anethum graveolens* L.). ph.D thesis Fac. of Agric., Cairo university.

Saikia, S.P. ; D. Bora ; A.Goswami ; K.D. Mudoi and A. Gogoi (2013). A review on the role of Azospirillum in the yield improvement of non-leguminous crops. Afr. J. Microbiol. Res., 6:1085-1102 .

Saleh SA, Glala AA, Ezzo MI, Ghoname AA (2010) An attempt for reducing mineral fertilization in lettuce production by using bio-organic farming system. Acta Hort. (ISHS) 852:311–318.

Sanli, A.; Kardogan, T. Carvone containing essential oils as sprout suppressants in Potato (Solanum tuberosum L.) tubers at different storage temperatures. Potato Res. 2019, 62, 345–360.

Sharma, R. (2004). Agro-techniques of medicinal plants. Daya Publishing House, New Delhi, pp. 3-10.

Sharma, S. B. ; R. Z. Sayyed ; M. H. Trivedi and T.A. Gobi (2013). Phosphate solubilizing microbes: Sustainable approach for managing phosphorus deficiency in agricultural soils. Springerplus., 2:587-594.

Sheng, X.F. and L.Y. He (2006): Solubilization of potassium bearing minerals by a wild type strain of Bacillus edaphicus and its mutants and increased potassium uptake by wheat. Canadian J. Microbiol. 52:66-72.

Singh G, Maurya S, De-Lampasona MP and Catalan C (2005). Chemical constituents, antimicrobial investigations, and antioxidative potentials of *Anethum graveolens* L. essential oil and acetone extract: part 52. J Food Sci. 70: 208-215.

Singh, A. (1991). Uptake of nutrients by dill (*Anethum graveolens*). Indian J. Agron., 36 (suppl.), 185-8.

Smith, S. E., and Read, D. (2008a). "Mycorrhizas in agriculture, horticulture and forestry," in Mycorrhizal Symbiosis, 3rd Edn. (Oxford, UK: Elsevier Ltd.), 611–637.

Stanojević, J.S., Stanojević, Lj.P., Cvetković, D.J., Danilović B.R., 2015: Chemical composition, antioxidant and antimicrobial activity of the turmeric essential oil (Curcuma longa L.). Advanced technologies, 4(2): 19–25.

Vessey, J.K., 2003. Plant growth promoting rhizobacteria as biofertilizers. Plant Soil, 255: 571–586.

Zaidi A, Ahmad E, Khan MS, Saif S, Rizvi A (2015) Role of plant growth promoting rhizobacteria in sustainable production of vegetables: current perspective. Sci Hortic 193:231–239.

Zhaoxiang, W.; Huihu, L.; Qiaoli, L.; Changyan, Y.; Faxin, Y. Application of bio-organic fertilizer, not biochar, in degraded red soilimproves soil nutrients and plant growth. Rhizosphere 2020,16, 100264.