Review of: "The Role of Plant Growth-Promoting Bacteria (PGPB) in Soil Fertility Restoration in Chemical-Contaminated Areas"

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Potential competing interests: No potential competing interests to declare.

The review article entitled “The Role of Plant Growth-Promoting Bacteria (PGPB) in Soil Fertility Restoration in Chemical-Contaminated Areas” intends to analyze the current investigations in the field of Bioremediation related to the multifaceted activity of plant growth-promoting rhizobacteria. It is now evident that the human activities, including a wide number of industrial productions and the excessive use of chemical-based fertilizers and biocontrol agents in plant-soil systems disturbed the normal functioning of soils. As a result, inorganic and organic pollutants changed the soil properties thus decreasing biodiversity and biogeochemical equilibrium. A short analysis of the industrial and agronomic activities defining the type of the related hazardous pollutants could be important point of the Introduction of the review paper by Dr. CT Swamy.

Another important point is to define the term biofertilizers. There are many definitions of biofertilizers including some proposal to change this term with probiotics. Following this suggestion, the author could mention the main group of plant beneficial microorganisms.

The review paper deals exclusively with bacteria. This fact limits to great extent the bioremediation properties of another part of the soil microorganisms – soil fungi, which play role in all soil processes, in many cases collaborating with bacteria. Explaining the metabolic response of soil microorganisms in toxic conditions caused by high metal concentrations and/or organic pollutants to identify microbial detoxification mechanisms and their implication in bioremediation strategies would clarify the importance of microbial consortiums in contaminated soil. Here, these mechanisms could be interrelated with the plant beneficial traits of soil microorganisms to show the multifunctionality of the soil microorganisms.

The statement that “… long-term research …. on the organization of the current microbial population in and around plants is lacking” is a bit exaggerated. There are many studies on the effect of introduced plant beneficial microorganisms on soil microbiome. In fact, this kind of research is now the key of understanding the role and the exit of different laboratory and/or commercial formulated microbial inoculants particularly in field conditions. In this sense, the part of the review dedicated on ·Field specific formulations” could be presented better showing the art of the formulation and the type of formulated products with their advantages and disadvantages. This part of the development of a formulated commercial microbial plant beneficial product is probably the most decisive and determines its behavior in soil-plant systems.

Risk assessment and Scaling up Chapter could be extended. The author could include the safety criteria applied in

general in the production of biofertilizers as well as the schemes of production of microbial inoculants starting from selection and fermentation details and ending with the selection of the formulation method of single strains or microbial consortium.

The work could finish with presenting tendencies in the field of bioremediation (alone or combined with phytoremediation) underlying the role of plant beneficial microorganisms in soils with different characteristics and different plants.

References which could be used to improve the review paper:

Ancona V, Rascio I, Aimola G, Caracciol AB, Grenni, P Uricchio VF, Borello D, Chapter 2 - Plant-assisted bioremediation: Soil recovery and energy from biomass, Editor(s): Vimal Pandey, Assisted Phytoremediation, Elsevier, 2022,

pp. 25-48, https://doi.org/10.1016/B978-0-12-822893-7.00012-4.

Ceci, A., Pinzari, F., Russo, F. *et al.* Roles of saprotrophic fungi in biodegradation or transformation of organic and inorganic pollutants in co-contaminated sites. *Appl Microbiol Biotechnol* **103**, 53–68 (2019). https://doi.org/10.1007/s00253-018-9451-1

Zhang M, Pereira e silva Mde C, Chaib De Mares M, van Elsas JD (2014) The mycosphere constitutes an arena for horizontal gene transfer with strong evolutionary implications for bacterial–fungal interactions. FEMS Microbiol Ecol 89:516–526. https://doi.org/10.1111/1574-6941.12350

Ye S, Zeng G, Wu H, Zhang C, Liang J, Dai J, Liu Z, Xiong W, Wan J, Xu P, Cheng M (2017) Co-occurrence and interactions of pollutants, and their impacts on soil remediation—a review. Crit Rev Environ Sci Technol 47:1528–1553. https://doi.org/10.1080/10643389.2017.1386951

Rani R, Kumar V, Gupta P, Chapter 16 - Plant growth-promoting rhizobacteria-assisted bioremediation of toxic contaminant: recent advancements and applications, Editor(s): Surajit Das, Hirak Ranjan Dash, Microbial Biodegradation and Bioremediation (Second Edition), Elsevier, 2022, pp. 327-341, https://doi.org/10.1016/B978-0-323-85455-9.00003-5.

Vassileva, M.; Mendes, G.d.O.; Deriu, M.A.; Benedetto, G.d.; Flor-Peregrin, E.; Mocali, S.; Martos, V.; Vassilev, N. Fungi, P-Solubilization, and Plant Nutrition. *Microorganisms* **2022**, *10*, 1716. https://doi.org/10.3390/microorganisms10091716

Vassileva M, Flor-Peregrin E, Malusá E and Vassilev N (2020) Towards Better Understanding of the Interactions and Efficient Application of Plant Beneficial Prebiotics, Probiotics, Postbiotics and Synbiotics. *Front. Plant Sci.* 11:1068. http://doi:10.3389/fpls.2020.01068

Vassilev, N., Nikolaeva, I. & Vassileva, M. Polymer-based Preparation of Soil Inoculants: Applications to Arbuscular Mycorrhizal Fungi. *Rev Environ Sci Biotechnol***4**, 235–243 (2005). https://doi.org/10.1007/s11157-005-2098-2

Vassilev N, Malusà E, Neri D and Xu X (2021) Editorial: Plant Root Interaction With Associated Microbiomes to Improve Plant Resiliency and Crop Biodiversity. *Front. Plant Sci.* 12:715676. http://doi:10.3389/fpls.2021.715676