Current Research in Microbial Sciences 2 (2021) 100016

Contents lists available at ScienceDirect

Current Research in Microbial Sciences

journal homepage: www.elsevier.com/locate/crmicr

Current trends in plant growth-promoting microorganisms research for sustainable food security[☆]

Sergio de los Santos-Villalobos[a,*], Fannie Isela Parra-Cota[b]

[a] Instituto Tecnológico de Sonora, 5 de Febrero 818 Sur, Col. Centro, C.P. 85000 Ciudad Obregón, Sonora, Mexico
[b] Campo Experimental Norman E. Borlaug, Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. Norman E. Borlaug Km. 12, C.P. 85000 Ciudad Obregón, Sonora, Mexico

ARTICLE INFO

Keywords:
Microbial inoculants
Biofertilizers
Bio-pesticides
Microbiome
Next-generation sequencing
Omics sciences

ABSTRACT

The use of intensive non-sustainable agricultural practices for satisfying global food demand is degrading the agro-ecosystems, leading to their inability to produce efficient and equitable sources of calories. Microbial communities play an important role in the improvement of soil fertility and plant development; thus, the genetic and metabolic diversity of microbiota in agro-ecosystems is a promising alternative for designing microbial inoculants to not only produce enough food but also mitigates the economic, health, social, and environmental issues caused by conventional agriculture. This Special Issue has been launched to compile and inspire high-impact recent advancements on bioprospecting beneficial microorganisms as a sustainable strategy to warranty global food security.

The global human population – estimated to reach 10 billion people in 2050 – projects to increase the current food production by 70–100% (FAO, 2018). At present, to meet these future needs of food, farmers are implementing intensive agricultural practices, *i.e.* planting densities, tillage methods, irrigation schedules, synthetic agro-inputs for plant growth and phytosanitary control (Diaz-Rodriguez et al., 2019). Intensive agriculture has led to high pressure in land use, leading to soil salinization, desertification, erosive events, greenhouse gas emissions, eutrophication, and loss of microbial diversity (Ibarra-Villarreal et al., 2020). This pressure induces unfavorable biotic and abiotic conditions in agro-ecosystems, causing 50% losses in crop yield worldwide (Kumar and Verma, 2018). For example, approximately 2 million tons of synthetic pesticides are utilized annually worldwide (Sharma et al., 2019), with only about 0.1% reaching the desired target (Vega-Vásquez et al., 2020). Similarly, the use of nitrogen (N) fertilizers has increased by 7.4 times; however, the yield has increased only 2.4 times in the same period, suggesting that crops have reduced their ability to use N efficiently (Hirel et al., 2011). The use of intensive non-sustainable practices increases the economic, health, social, and environmental costs of agriculture. Thus, in recent years, global society has faced new challenges related to the development of sustainable alternatives for satisfying high food demand.

Currently, microbial inoculants are gaining importance, which are eco-friendly and sustainable bio-products containing live microorganisms that, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or plant tissues for promoting growth by increasing the supply or availability of primary nutrients to the host plant or controlling the colonization of phytopathogens (Villarreal-Delgado et al., 2018; de los Santos-Villalobos et al., 2018). The global interest in this type of bio-products is noted since their international market has been valued at over US $ 1.72 billion in 2014, which is expected to reach US $ 4.17 billion by 2023, with an annual growth rate of 9.9% (Timmusk et al., 2017).

Microbial inoculants, and their interaction with the native microbiota and crops, are involved in several vital ecosystem processes, such as organic matter decomposition, soil structure and fertility, nutrient cycling, plant growth regulation, and biocontrol of pest and diseases (Chavez-Diaz et al., 2020). However, the success of these microbial inoculants in agro-ecosystems can be increased by studying the genetic and metabolic diversity of their microbial strains, and the interaction with i) plant genotypes, ii) crop phenological stages, iii) exposure to disease-suppressive soils, iv) root exudate compositions, v) plant hormone signaling, vi) native microbiota, vi) agricultural practices, vi) soil and climatic conditions, among others (Valenzuela-Aragon et al., 2019).

Since microorganisms contained in microbial inoculants interact and increase the crops yield, more precise bioprospecting and integrative studied – based on recent scientific advancements – of promising

☆ **This article belongs to the Special Issue:** Current trends in plant growth-promoting microorganisms research for sustainable food security. https://www.journals.elsevier.com/current-research-in-microbial-sciences/call-for-papers/current-trends-in-plant-growth-promoting-microorganisms

* Corresponding author.
E-mail address: sergio.delossantos@itson.edu.mx (S. de los Santos-Villalobos).

https://doi.org/10.1016/j.crmicr.2020.100016
Received 29 October 2020; Accepted 3 November 2020

microbial strains will lead to the design of innovative and more efficient microbial inoculants for contributing to food security worldwide.

As guest editors, we are confident that this Special Issue (through original research papers, reviews, genome announcements, or draft genomes) will compile and also inspire high-impact research activities with novel insights of broad interest and great importance on the role of often untapped microbiota in agro-ecosystems for providing sustainable alternatives to warranty global food security.

Funding

This research received no external funding.

Declaration of Competing Interest

The authors declare no conflict of interest.

Acknowledgments

The authors wish to thank the staff members at the ELSEVIER editorial office and Current Research in Microbial Sciences, in particular, David Ojcius, Bilge San, Mark C. Gannon, and Gowri Vasanthkumar for all their support.

References

Chavez-Diaz, I.F., Zelaya Molina, L.X., Cruz Cárdenas, C.I., Rojas Anaya, E., Ruíz Ramírez, S., de los Santos Villalobos, S., 2020. Considerations on the use of biofertilizers as a sustainable agro-biotechnological alternative to food security in Mexico. Rev. Mex. Cienc. Agríc. 11 (6), 1423–1436. doi:10.29312/remexca.v11i6.2492.

De los Santos Villalobos, S., Parra-Cota, F.I., Herrera Sepúlveda, A., Valenzuela-Aragon, B., Estrada Mora, J.C., 2018. Collection of edaphic microorganisms and native endophytes to contribute to national food security. Rev. Mex. Cienc. Agríc. 9 (1), 191–202. doi:10.29312/remexca.v9i1.858.

Diaz-Rodríguez, A., Parra-Cota, F.I., Santoyo, G., de los Santos-Villalobos, S., 2019. Chlorothalonil tolerance of indole producing bacteria associated to wheat (Triticum turgidum L.) rhizosphere in the Yaqui Valley, Mexico. Ecotoxicology 28, 569–577. doi:10.1007/s10646-019-02053-x.

FAO. 2018. The future of food and agriculture – Alternative pathways to 2050. Summary version. Rome. 60 pp. Licence: CC BY-NC-SA 3.0 IGO. http://www.fao.org/3/CA1553EN/ca1553en.pdf.

Hirel, B., Tétu, T., Lea, P.J., Dubois, F., 2011. Improving nitrogen use efficiency in crops for sustainable agriculture. Sustainability 3 (9), 1452–1485. doi:10.3390/su3091452.

Ibarra-Villarreal, A.L., Parra-Cota, F.I, Yepez, E.A., Gutiérrez-Coronado, M.A., Valdez-Torres, L.C., de los Santos-Villalobos, S., 2020. Impact of a shift from conventional to organic wheat farming on soil cultivable fungal communities in the Yaqui Valley, Mexico. Agrociencia 54, 643–659.

Kumar, A., Verma, J.P., 2018. Does plant—microbe interaction confer stress tolerance in plants: a review? Microbiol. Res. 207, 41–52. doi:10.1016/j.micres.2017.11.004.

Sharma, A., Kumar, V., Shahzad, B., Tanveer, M., Sidhu, G.P.S., Handa, N., Kohli, S.K., Yadav, P., Bali, A.S., Parihar, R.D., Dar, O.I., Singh, K., Jasrotia, S., Bakshi, P., Ramakrishnan, M., Kumar, S., Bhardwaj, R., Thukral, A.K., 2019. Worldwide pesticide usage and its impacts on ecosystem. SN Appl. Sci. 1, 1446. doi:10.1007/s42452-019-1485-1.

Timmusk, S., Behers, L., Muthoni, J., Muraya, A., Aronsson, A.C., 2017. Perspectives and challenges of microbial application for crop improvement. Front. Plant Sci. 8 (49), 1–10. doi:10.3389/fpls.2017.00049.

Valenzuela-Aragón, B., Parra-Cota, F.I., Santoyo, G., Arellano-Wattenbarger, G.L., de los Santos-Villalobos, S., 2019. Plant-assisted selection: a promising alternative for *in vivo* identification of wheat (*Triticum turgidum* L. subsp. *durum*) growth promoting bacteria. Plant Soil 435, 367–384. doi:10.1007/s11104-018-03901-1.

Vega-Vásquez, P., Mosier, N.S., Irudayaraj, J., 2020. Nanoscale drug delivery systems: from medicine to agriculture. Front. Bioeng. Biotechnol. 8 (79), 1–10. doi:10.3389/fbioe.2020.00079.

Villarreal-Delgado, M.F., Villa-Rodríguez, E.D., Cira-Chávez, L.A., Estrada-Alvarado, M.I., Parra-Cota, F.I., De los Santos-Villalobos, S., 2018. The genus Bacillus as a biological control agent and its implications in agricultural biosecurity. Mex. J. Phytopathol. 36 (1), 95–130. doi:10.18781/R.MEX.FIT.1706-5.