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Editorial: Bioinoculants with nano-compounds to improve soil health: a step toward sustainable agriculture

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Editorial on the Research Topic
Bioinoculants with nano-compounds to improve soil health: a step toward sustainable agriculture

Introduction

Modern agriculture is largely concerned with the sustainable cultivation of cereals and other food-based crops to meet the food difficulties of a growing worldwide population. However, intensive agricultural methods and widespread use of agrochemicals cause soil fertility deterioration, pollution, disturbance of soil diversity, pest resistance and declines in crop yield (Singh and Singh, 2017; Chaudhary et al., 2022). As a result, researchers are changing their focus to more environmentally friendly fertilizing technologies in order to preserve agriculture sustainability (Parveen et al., 2023; Srivastava et al., 2023). The usefulness of beneficial microbes and nanoparticles have been well recognised in reducing the negative impacts of agrochemicals (Mushtaq et al., 2020; Chaudhary et al., 2021; Shah et al., 2021). Applying different nanoparticles/nano-based fertilizers to boost crop production has also resulted in a revolution in agriculture. Given their mutually advantageous qualities, bioinoculants and NPs can be utilized in conjugation to maximize benefits (Kukreti et al., 2020; Agri et al., 2021). However, combination of both or their synergistic use has improved crop-modulating effects in terms of crop production and soil fertility restoration (Kumari et al., 2020; Agri et al., 2022). Bioinoculants and Si-NPs use significantly affects sugar beet growth and yield under soil salinity stress (Alharbi et al., 2022a). Combined application of *Azotobacter, Pseudomonas* spp. along with silica NPs (Si NPs: 500 mg/L), reduce the negative effects of irrigation with saline water on the growth and productivity of barley (Alharbi et al., 2022b). Silver NPs and *Bacillus cereus* promoted maize plant development, reducing harmful fungal pathogens growth (Kumar et al., 2020). Silicon dioxide NPs (100 ppm) and *B. cereus-Amazcala* were applied together, and improved the chilli pepper growth (Ferrusquía-Jiménez et al., 2022). We accepted 11 papers on this Research Topic. The main points of the Research Topic are discussed below.

Bioinoculants and nanoparticles

According to Adeleke et al. nanomaterials derived from endophytic microorganisms can minimize the abiotic stresses on plants, increase photosynthesis, nutrient absorption and microbial diversity and improved plant and soil health parameters. Applying nano-growth enhancers derived from beneficial bacteria like nano-fertilizers, nano-herbicides and nano-pesticides is considered safe and environmentally benign in assuring sustainable agriculture.

Ayilara et al. provide a wide-ranging summary of the growing use of biopesticide, phyto-pesticides, nano-pesticides and nano-biopesticides to combat plant diseases, enhance plant nutrition and provides crop protection. These are good substitutes for chemical pesticides because they are affordable, have a specific mode of action, are environmentally beneficial and do not create greenhouse gases. As a result, their addition to the currently used synthetic pesticides will be a more effective way to protect crops from pests and ensure sustainable agriculture.

Upadhayay et al. emphasize on the combined effect of different microbes and nanomaterials to maximize the crop production for the growing people, amelioration of biotic and abiotic stress, maintain soil health and lessen the massive dependence on chemical-based fertilizers.

Mishra et al. developed and utilized the urea nanoparticles as nano-biofertilizers. The foliar spray of calcium phosphate urea NPs (CaP-U NPs) on finger millet seeds showed improvement in plant growth parameters such as shoot length, chlorophyll content and enzymatic activities like guaiacol peroxidase and superoxide dismutase under drought circumstances. They reported that CaP-U NPs (0.5%–1%) were effective for growth indices and defence activation.

Kashyap et al. concentrated on the benefits of microbial inoculants and their potential and mechanism of action for increasing agricultural productivity. They also highlighted the screening, characteristics, and importance of bioinoculants as biocontrol agent for controlling plant disease against different pests and insects.

Ayilara et al. examined the role of microorganisms and nanotechnology in cleanup process of harmful pollutants. They discussed about the natural attenuation method of remediation, which encourage and improved the ability of microbes in degradation of pollutants. They also studied nano bioremediation's role in deleting harmful contaminants from the environment.

Ayilara and Babalola talked about several remediation techniques. They discussed the use of microbial enzymes for cleanup and function of various microorganisms, including bacteria, fungi and algae. They also discussed how various microbial consortiums might be a more effective approach to bioremediation.

Ahamad et al. evaluated the efficacy of beneficial microorganism such as arbuscular mycorrhizal fungi (AMF) and vermicompost, both separately and together in reducing the detrimental effects of *Meloidogyne incognita* on carrot growth. Applying AMF in carrot plants repressed root galls and nematode inhabitants and improved plant growth, carotenoid, chlorophyll and phenol content, respectively. AFM and vermicompost may be useful alternatives to plant development under biotic stress conditions.

Zhang et al. reported that application of different microbial inoculants, such as *Bacillus velezensis* and *Brevundimonas faecalis*, inhibit the growth of pathogenic fungus. These microbial inoculants also improved the plant length and seedling biomass while controlling oat root rot.

Naitam et al. demonstrated the capacity of the halophilic archaea *Halolamina pelagica* CDK2 to promote wheat growth and to diminish the negative effects of salinity. This strain possesses the potential to produce indole acetic acid and solubilize the essential nutrient such a potassium, phosphorus and zinc, which involved in promoting plant growth. The inoculated treatments showed significantly higher amounts of total protein, chlorophyll and sugar content in presence of haloarchaea. Additionally, the inoculation caused a significant decrease in the antioxidant activity.

Bhandari et al. offers a thorough understanding on nano-biochar applications in different fields. Nano-biochar modulates the transport and absorption of essential micro and macronutrients and harmful pollutants. Nano-biochar is a detoxicant for managing waste, reducing soil erosion and preserving soil nutrients. Additionally, nano-biochar serves as a biosensor for the detection and monitoring of harmful pollutants.

Author contributions

PC: Conceptualization, Visualization, Writing–original draft, Writing–review and editing. SC: Writing–review and editing. VR: Writing–review and editing. DJ: Writing–review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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