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# Editorial: Advances of novel bioproducts for sustainable agriculture

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## Editorial on the Research Topic

### Advances of novel bioproducts for sustainable agriculture

Protection against pests, pathogens, and weeds is crucial for agroecosystem management to prevent significant crop losses (Oerke, 2006). Chemical pesticides, widely used since the 1960s, have led to numerous negative impacts, including harm to human health and changes to biodiversity (Deguine et al., 2023). Around the world, sustainable agriculture efforts are underway to find a balance between preserving the environment and ensuring food security. To address this, a shift towards environmentally friendly methods is underway in sustainable agriculture, using innovative strategies that reduce exposure to pesticides and their negative impacts (Deguine et al., 2023). A new generation of bioproducts is being developed, using volatile compounds from plants and microorganisms. In this sense, the latest advancements in agriculture include bioproducts derived from bacteria and fungi, products utilizing monoterpenes and other volatile compounds to safeguard crops from pests and diseases, and bioproducts to boost crop yield along with carrier materials that offer stability, protection, and control.

Consequently, this Research Topic focuses on developing new formulations of eco-friendly biopesticides, studying soil microorganisms and plant-derived bioactive compounds, and exploring new techniques for bioproduct development.

A publication titled “*Effect of Neo-Boost Pesticide on Mortality and Development of Tetranychus urticae*” is presented by Bruinsma et al. The authors show the need for additional pesticides with different modes of action. The study recommends field doses depending on the developmental stages of *T. urticae*. Neo-Boost has high efficiency against larvae, moderate efficiency against adults, and no effect on eggs of *T. urticae*. The study also shows that Neo-Boost could enhance plant defenses against mites and has the potential to be used as a novel acaricide or combined with other ingredients for more potent mite control. They demonstrate the efficacy of Neo-Boost, which could be used in its current formulation or combined with other active ingredients.

On the other hand, López et al. review the use of essential oils and derivatives as biopesticides in “*New insights into biopesticides: solid and liquid formulations of essential*

*oils and derivatives.*” Both solid and liquid formulations of essential oils have been developed, with solid formulations showing benefits over liquid in terms of biological protection and storage. There are several commercial products available on the market, mostly in the form of liquid formulations. Spray-dried solid formulations, such as complex or micro/nanospheres, vary in terms of encapsulation efficiency, particle size, and controlled release, primarily based on the type of wall material or surfactant used. Spray-dried essential oils have several noteworthy advantages. However, liquid formulations are easier to scale and apply. Therefore, this review focuses on the advances of essential oils in both solid and liquid formulations and derivatives for use in agriculture.

The study by Escudero-Leyva et al. titled “*Tolerance and Biological removal of fungicides by Trichoderma species isolated from the endosphere of wild Rubiaceae plants*” is presented. The authors studied the tolerance and biological removal of fungicides by *Trichoderma* species isolated from the endosphere of wild Rubiaceae plants since the demand for agrochemical-free products has increased and sustainable and environmentally friendly disease management strategies, such as biological control, are needed. The quality of coffee is closely tied to effective management against plant pathogens, and environmentally safe practices can lead to an improvement in coffee flavor (Feria-Morales, 2002). Consumers are seeking food safety and chemical-free products, leading to a significant rise in demand for organic coffee (Lee et al., 2015). Thus, there is a pressing need for sustainable and eco-friendly disease management approaches, like biological control (Rice, 2018).

One of the challenges in transitioning from conventional to organic agriculture is the adaptation of introduced beneficial microorganisms to fields with residual agrochemicals (Gharieb et al., 2004; Shen et al., 2019) or in regions where agrochemicals and antagonistic microorganisms are used simultaneously (Mishra et al., 2014; Nongmaithem, 2015; Palazzini et al., 2018). Endophytic fungi, which inhabit plant interiors, can act as antagonists against phytopathogens and can be used as biological control and bioremediation agents. Therefore, in this study, endophytic *Trichoderma* isolates were able to tolerate and prevail under fungicides, suggesting the possibility of combined use with low-toxicity fungicides for transitioning to organic agriculture. These *Trichoderma* isolates were notable for tolerating cyproconazole and chlorothalonil, but other related fungicides should be avoided when transitioning to organic or pesticide-free agriculture. Therefore, in developing sustainable agriculture strategies, it is important to consider the combination of pesticide tolerance, removal, and ecotoxicity tests with biocontrol or bioremediation microorganisms, and the interactions between agrochemicals.

One last review by Garrido-Miranda et al. titled “*Essential oils and their formulations for the control of Curculionidae pests*”

highlights the great potential of essential oils as natural insecticides against weevils and related species. They can play a significant role in managing pests and promoting organic farming as they do not leave behind toxic residues and are environmentally safe.

The primary disadvantages of essential oils, i.e., their high volatility and degradation, can be mitigated through the use of encapsulation techniques. Future research should concentrate on finding ways to improve the efficacy of essential oils or mixtures of essential oils in controlling various life stages of pests in varying environmental conditions through encapsulation.

Although there are companies producing this kind of product, more studies are needed on species specificity, persistence in the environment, toxicity, etc. Therefore, the use of essential oils and their formulations for pest control will remain a strategy for sustainable agriculture. The authors of several recent articles have reviewed the benefits and drawbacks of using formulations of essential oils as natural insecticides and biopesticides and how they can be used effectively in controlling pests and diseases. Encapsulation methods are seen as a solution to the challenges posed by the high volatility and degradation of essential oils, and future research should focus on developing effective encapsulation methods. A multidisciplinary approach is needed to find new bioproducts and to overcome the challenges in pest control and crop loss.

## Author contributions

ML wrote the article; ML, MP-V, MS, NZ, and AP revised the manuscript. All authors contributed to the article and approved the submitted version.

## 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.

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