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EDITED AND REVIEWED BY
Maryke T. Labuschagne,
University of the Free State, South Africa

*CORRESPONDENCE
Surendra K. Dara
✉ surendra.dara@oregonstate.edu

†These authors have contributed equally to this work

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Editorial: Integrated pest management strategies for sustainable food production

Surendra K. Dara [1*†], Cesar Rodriguez-Saona [2†] and William R. Morrison III [3†]

[1]North Willamette Research and Extension Center, Oregon State University, Aurora, OR, United States, [2]Philip E. Marucci Blueberry and Cranberry Research Center, Rutgers University, Chatsworth, NJ, United States, [3]United States Department of Agriculture, Agricultural Research Service, Center for Grain and Animal Health Research, Manhattan, KS, United States

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Editorial on the Research Topic
Integrated pest management strategies for sustainable food production

Introduction

Numerous species of endemic and invasive pests threaten productivity of food crops and negatively impact food security and affordability around the world. Synthetic pesticide application is the most common practice for addressing various pests, which frequently leads to pesticide resistance, endangerment of beneficial organisms, residue buildup that harms environmental and human health, and increased yield losses and crop production costs. Integrated pest management (IPM) strategies offer a comprehensive solution to address all kinds of pests in an economically viable, environmentally sustainable, and socially acceptable manner contributing to safe and effective pest suppression. As Dara (2019) noted, the paradigm of IPM has been changing and expanding. Whereas earlier models were based on ecological and economic aspects, newer models of IPM include management, business, and sustainability, while emphasizing the importance of research and outreach as well as various social factors that influence food access and affordability. Indeed, Deguine et al. (2021) suggested a key shortcoming of IPM is that integration of practices has proceeded haphazardly, proven ineffective, and yielded unacceptable outcomes. Thus, although numerous scientific publications present the efficacy of various pest control options and their role in an IPM program, there is a dearth of peer-reviewed publications that offer comprehensive solutions for various pests of a crop or a particular pest that attacks multiple crops before or after harvest.

Coverage

In this Research Topic, we invited reviews or original research that provide system, pest- or crop-specific comprehensive IPM solutions that can help researchers, educators, students, and agriculture. In the end, we have curated multiple important articles that will help move the state of the art forward in different ways for IPM and specific systems. For example, Buitrago et al. put together a comprehensive look at spittlebugs in tropical and subtropical America by combining information on Cercopidae taxonomy, geographical distribution, biology, and control strategies to contribute to the development of IPM in grasses and sugarcane. In Mexico, Piña-Dominguez et al. put together a comprehensive evaluation of the ecological effects of harvesting wild, edible insects, including *Atta mexicana* (Hymenoptera: Formicidae), Pyrgomorphidae, *Comadia redtenbacheri* (Lepidoptera: Cossidae), and *Aegiale hespriaris* (Lepidoptera: Hesperiidae), which are seasonally collected from agricultural land for food and medicine. Their article aims to provide an updated assessment of the potential use of agricultural insects as part of a sustainable diet, considering current international legislative and ethical concerns about harvesting and consuming wild edible insects. Together, these two articles contribute important perspectives from Latin America on IPM in traditional and novel systems.

Impressively, Ben-Zvi and Rodriguez-Saona synthesize three decades of literature on cranberry IPM, including analyzing 139 peer-reviewed publications. Their results show that the top three most studied insect pests of cranberries have been *Sparganothis fruitworm*, *Rhopobota naevana*, and *Acrobasis vaccinii*, while the main regions with the most published entomological papers on cranberry IPM research have been New Jersey, Massachusetts, and Wisconsin in the United States, followed by British Columbia in Canada. Among IPM tactics for cranberry, published research on chemical control, as well as on host-plant resistance has increased. The authors' work is an important foundational advance for cranberry IPM moving forward over the next several years.

After harvest, Gerken and Morrison focus on covering community ecology concepts (e.g., competition, niche partitioning, behavioral ecology, physiology, development, and succession) for IPM in the post-harvest supply chain and how they can improve the management of stored product insects. The authors note that current knowledge of stored product ecosystems lags behind what is known for field pest ecosystems, and hinders our ability to design effective control strategies for the whole system. Here, they present a review of work on stored product insect pests through a community ecology lens by analyzing how the current state of the knowledge can be used to better develop and implement more effective post-harvest IPM. This contribution helps round out the coverage in this Research Topic to include the management of food systems after harvest.

Finally, Filho et al. discuss how the digital transformation of agriculture is affecting the implementation of IPM. In particular, the authors note that while the traditional IPM approach is generally carried out with control solutions delivered throughout the whole field, new approaches involving digital technologies will need to consider adaptations in the concepts of economic thresholds, sampling, population forecast, injury identification, and ultimately the localized use of control tactics. In their contribution, the authors reviewed how the traditional IPM concepts could be adapted, considering this ongoing digital transformation in agriculture, including the ongoing use of drones, automated traps, and satellites, and potential near-future use of autonomous robots. This work helps move the conversation forward on this topic significantly.

Overall, the literature will benefit going forward from taking a more synthetic and systems-based approach to integrating IPM practices among different pests. This will provide additional insight into patterns and solutions that may not be apparent when each tactic or pest in a system is viewed individually. Emergent properties are common traits of complex systems in biology when dealing with weeds, arthropod pests, and pathogens of our food production system. However, we may overlook that the food production itself has emergent properties influenced by social, economic, and regulatory factors, which are only apparent when we view the comprehensive picture.

Author contributions

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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.

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