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Editorial: The use of volatile organic compounds in sustainable management of pests and diseases

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Editorial on the Research Topic
The use of volatile organic compounds in sustainable management of pests and diseases

Global pesticide use has increased by 20% globally over the last decade (Shattuck et al., 2023), while yields of many major crops have stagnated or are close to stagnation (Tian et al., 2021). This discrepancy suggests a mismatch between pesticide applications and actual needs in time and space. Together, pests and diseases, are estimated to account for 10-40% of global crop losses, depending on the crop and production region (Savary et al., 2019). Currently, pest and disease management rely heavily on pesticides that are applied broadly across an agricultural area, often according to pre-determined schedules and fixed time intervals, as they need to be applied preventively, before symptoms develop. This approach has probably led to redundant use of pesticides, when and where the risk for pests and diseases was actually low. Repeated use of pesticides also increases the risk of developing pesticide resistance, which in turn often leads to an increased use of pesticides, as growers try to counteract declining efficacy with repeated applications or higher pesticide dosages.

Innovation in the agricultural sector, particularly in insect pest management, has led to new approaches to reducing yield losses from pests through odour-based confusion techniques, that are integrated into sustainable pest management strategies. Odours are volatile chemical signals, which are emitted by living organisms either actively to communicate information or passively. Sensing volatile organic compounds (VOCs) emitted directly by pests and pathogens, or by plants in response to changes in their physiochemical state due to attack by these pests, could allow us to map plant pests and diseases in a non-destructive manner. In recent years, research into VOC-based pest detection and management has been developing rapid and field-portable sensor technologies in the past few years. Pest biology is now merging with new tools for detection, prevention, mapping and targeted pest management.

The objective of this Research Topic is to highlight the current research areas involving VOC-based approaches for sustainable pest and pathogen management and potential future development.

Our Research Topic included five submitted manuscripts, and four accepted papers that were viewed over 3500 times and downloaded over 1000 times during the year. Contributions included applied field research, method development, and literature reviews.

The use of VOCs for direct pest management in the field was demonstrated in the research paper by Thöming. Herbivore induced plant volatiles (HIPVs) are VOCs emitted by the plant after insect attack to attract natural enemies of the pest insect. However, the arrival of the natural enemies at this stage may be too late to keep the pest population below the level of economic damage. Thöming showed that the use of a synthetic odor paste, containing specific HIPVs, which can be applied to the crop in order to attract lace wings, natural enemies of aphids, in a timely manner to prevent pest populations to increase beyond the damage level. This successful approach, combined with the manipulation of edge vegetation near the crop to maintain biological control populations, has begun to be implemented by farmers in Norway.

The review on analytical methods used to analyze VOCs in pulse crops presented and addressed the challenges posed by capturing, detecting, identifying, and analyzing volatile compounds at low levels and with high specificity (Makhlouf et al.). The paper discussed static versus dynamic VOC sampling, gas chromatography-mass spectrometry (GC-MS), solid phase microextraction (SPME), proton transfer reaction-mass spectrometry (PTR-MS) and the use of electronic noses. As always, the choice of method depends on the purpose of the study, the specificity and sensitivity required, but also on the ease of use, collection time and the resources available for the experiments in question. Capturing, identifying, and quantifying VOCs that are specific to pests and pathogens remains challenging, but the development of a new headspace collection device has shown that it is possible to collect VOCs from different developmental stages of the Brown marmorated stinkbug (*Halymorpha halys*), both in the laboratory and in the field. This device can be used to compare VOC signatures between different samples under the same environmental conditions and in parallel at the same time (Karimi and Gross).

The challenges in identifying VOCs that are robustly emitted by pests and pathogens or attacked host plants were also highlighted in the review of how VOCs can be used to detect invasive plant pests and pathogens by (Favaro et al.). In this article, the authors reviewed the current literature on VOCs released by the brown marmorated stink bug (*Halymorpha halys*), the fall armyworm (*Spodoptera frugiperda*), the cotton bollworm (*Helicoverpa armigera*), the pinewood nematode (*Bursaphelenchus xylophilus*) and *Phytophthora ramorum* and their respective host plants. While there were many studies on the insect pests, few studies identified VOCs that were robustly emitted under different environmental conditions and specific enough to identify the target pest based on these VOCs. Reliable results on VOCs emitted from trees attacked by the pinewood nematode and the literature on *Phytophthora* species were very limited and requires more comprehensive studies using highly specific and sensitive analytical methods.

This Research Topic brings together some of the key areas, where VOCs can be used for sustainable plant pest and pathogen management, including the development and use of analytical methods, pest detection, and effective biological control in the field. These innovative approaches are increasingly important to meet the growing challenges of preventing the invasion, establishment and spread of plant pests in agricultural production areas and forests.

Author contributions

AF: Conceptualization, Writing – original draft, Writing – review & editing. JS: Writing – original draft, Writing – review & editing. QW: Writing – original draft, Writing – review & editing.

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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