EDITORIAL
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Editorial: Research Advances on *Drosophila suzukii*

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Editorial on the Research Topic

Research Advances on *Drosophila suzukii*

In this Research Topic, we present research advances on the chemical ecology of the spotted-wing drosophila, *Drosophila suzukii* (Matsumura), an insect pest from Southeast Asia (Kanzawa, 1939; Calabria et al., 2010; Walsh et al., 2011) that causes significant economic damage to soft, thin-skinned small fruits and stone fruits (Goodhue et al., 2011; Farnsworth et al., 2017; Knapp and Mazzi, 2021). It became an invasive pest almost concurrently in 2008 in Europe (Calabria et al., 2010) and North America (Hauser, 2011), and has now spread to South America (Deprá et al., 2014) and sub-Saharan Africa (Boughdad et al., 2021; Kwadha et al., 2021). Recent records suggest that plants from 13 families are hosts to *D. suzukii* (Cloonan et al., 2018).

The fast rate at which *D. suzukii* caused damage to multiple crops, including blueberry, cherry, strawberry and raspberry, necessitated intensification of surveillance, resulting in its detection in new areas (Asplen et al., 2015; Lavrinienko et al., 2017). Along with monitoring its presence, on-going research has aimed at understanding its behavior (e.g., Abraham et al., 2015; Revadi et al., 2015a,b; Rice et al., 2016; Wallingford et al., 2016; Belenioti and Chaniotakis, 2020). In this Research Topic, Kraft et al. provide further advances in research on *D. suzukii* feeding behavior by way of molecular gut content analysis, showing that adults' use of food resources is species- and substrate-specific within fruit types, and that freshly eclosed adults feed on pupal meconium probably to obtain symbiotic bacteria. Indeed, this symbiotic association has been suggested in an earlier review (Broderick and Lemaitre, 2012). Kraft et al. have also demonstrated that *D. suzukii* adults utilize resources within crop fields and surroundings non-crop habitats. In another paper, Stockton and Loeb demonstrated that the oviposition choice by gravid *D. suzukii* females is fixed and guided by a hierarchical system—females utilize other potential hosts as oviposition site only when their preferred choice is not available. This is in line with the finding by Kraft et al. showing that *D. suzukii* utilize both crop and non-crop habitats for resources. Of course, they utilize non-crop resources only when their preferred resources are unavailable in crop fields.

The ability of *D. suzukii* to utilize both crop and non-crop plants and spread to new territories requires the development of new traps and attractants for its monitoring and management (e.g., Lee et al., 2013; Cha et al., 2014; Renkema et al., 2014; Kirkpatrick et al., 2018; Lasa et al., 2019). However, many traps and attractants in use are not selective, capturing many non-targets. This could be problematic for early detection during surveillance if identification is not accurate, especially because male *D. suzukii* share their characteristic black spot with their sister species *Drosophila biarmipes* Malloch and *Drosophila subpulchrella* Takamori and Watabe (Cini et al., 2012). To improve early detection of *D. suzukii* to kick-start intervention, the paper by Piper et al. demonstrated that a non-destructive high-throughput DNA metabarcoding could be used

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to detect *D. suzukii* and discriminate it from its closest relatives and other non-target arthropods in large, unsorted trap catches by an accuracy of 96%. This technique identified *D. biarmipes* and *D. subpulchrella* by an accuracy of 100% and could identify 57 other arthropods that are not targeted in insect surveillance. This is a major advancement in surveillance and early detection.

Field trapping and surveillance rely heavily on attractants. Earlier studies have demonstrated that odors from the fruit puree (Abraham et al., 2015) and intact fruits (Revadi et al., 2015b) of host plants, including raspberry, strawberry, blueberry, and cherry, are highly attractive to both female and male *D. suzukii*, and that females use these odors as oviposition cues (Karageorgi et al., 2017; Cloonan et al., 2018). Based on this knowledge, the article by Piñero et al. demonstrated that diluted concord grape juice is as attractive, and in some cases more attractive, than commercial attractants. It is interesting to note that, in cage experiments, diluted concord grape juice attracted more females and males than AlphaScents® SWD lure and Scentry® SWD lure, which are commercial attractants. Moreover, diluted concord grape juice attracted more females than other commercial lures, i.e., Suzukii Trap® Max Captures, Trécé broad spectrum PEEL-PAK® multi-component lure, and Trécé high selectivity 3-component lure. A similar trend was observed in field captures. Addition of NaCl to diluted concord grape juice increased *D. suzukii* captures by four-fold, while reducing the capture of non-target drosophilids. This demonstrates a potential inexpensive bait formulation that could be used for large scale surveillance.

In a related laboratory study, the article by Bolton et al. demonstrated that synthetic blends of fruit volatile compounds are attractive to both female and male *D. suzukii*. In an earlier study (Abraham et al., 2015), we showed that female *D. suzukii* were significantly attracted to both fruit extracts and an 11-component synthetic blend from electrophysiologically-active volatile compounds from raspberry extract. However, when given a choice between the raspberry extract and the synthetic blend, females were more attracted to the fruit extract (Abraham et al., 2015). Clearly, there was a need to optimize the 11-component synthetic blend. Using a similar technique, Bolton et al. optimized synthetic fruit volatiles by combining them with isoamyl acetate and β-cyclocitral, a strawberry leaf volatile compound known to be attractive to *D. suzukii* (Keesey et al., 2015). In the end, Bolton et al. have succeeded in formulating a 3-component synthetic blend consisting of isoamyl acetate, β-cyclocitral, and methyl butyrate, which is very attractive to female *D. suzukii* but not attractive to the non-target *D. melanogaster* under laboratory conditions. This blend could be a promising candidate attractant for monitoring *D. suzukii* populations in crop fields if it works in field trials. This research contributes to current efforts to identify attractive blends for *D. suzukii* (Larson et al., 2021).

Attractants can be combined with killing agents (i.e., insecticides) to develop attract-and-kill strategies to manage *D. suzukii*; however, the type of insecticide can influence their efficacy. In a paper by Babu et al., the authors tested a novel product (ACTTRA SWD®) that can be mixed with an insecticide as an attract-and-kill strategy for managing *D. suzukii*. In a series of no-choice and choice bioassays, they identified fenpropathrin, cyantraniliprole, malathion, zeta-cypermethrin, and spinosad as insecticides that could be added to ACTTRA SWD® formulations for an effective attract-and-kill technique to manage *D. suzukii*.

Overall, the contributions to this Research Topic add to current knowledge on how chemical ecology can be applied to improve monitoring and management tools for *D. suzukii* that can complement, and thereby reduce, the use of synthetic insecticides.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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