Development of plant-volatile-based remote sensing for early detection of insect pest presence and crop protection

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Currently, global agriculture is challenged to provide food for an increasing human population while facing climate change and a negative environmental footprint due to chemical pollution. Early identification of plant stress enables fast intervention to limit crop losses, and optimized application of pesticides and fertilizer to reduce environmental impacts. Current image-based remote sensing technologies identify plant stress responses days or weeks after the stress event, usually only after substantial damage has occurred and visual cues become evident. In contrast, plant volatiles are released seconds to hours after stress events, and can quickly indicate both the type and severity of stress. An automated and non-disruptive sampling method is needed to enable the use of plant volatiles for monitoring plant stress in precision agriculture. Here, we present the development of a sampling pump that can be deployed and collected with an uncrewed aerial vehicle. We observed comparable volatile recovery from a blend of 6 to 7 analytical standards between our sampler and a commercial portable pump at low air flows (i.e, 150-200ml/min). Furthermore, our sampler was capable of sampling at the higher flow rates 300, 400, and 500ml/min, which depending on the chemical class of the volatiles -as in the case of the green leaf volatiles (GLVs)-, could be advantageous in outdoor sampling conditions (yet to be tested). Moreover, under indoor sampling conditions of still air, we found that our sampler is capable of recovering volatiles when the distance between the volatile emission point and the sampler is at 1m, 2m, and 4m distance without significant reduction of the volatiles collected. On the other hand, the air downwash of a drone hovering at 1m, 2m, and 4m above the sampler and the volatile emission point significantly reduced the quantity of volatiles recovered. The possibility of robotic collection of plant volatiles is a first and important step towards the use of chemical signals for early stress detection and opens up new avenues for precision agriculture beyond visual remote sensing.