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Introduction

Detection and Monitoring of Plant Pathogens and Pests

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The ability to monitor and detect pathogen movement and presence is critical to managing and mitigating losses due to plant diseases and to understanding agricultural, natural, and urban ecosystems. Managers are faced with the increasing need for decision aids that allow them to rapidly adapt to emergent or exotic pathogens and to address how climate change is affecting endemic pathogens and pests. In addition, agricultural producers must often balance the competing interests of improved product quality and longer shelf life, while meeting the market demands for reduced pesticide use and lower costs.

All of this must be accomplished in increasingly volatile weather where current disease and pest management methods and/or manager's intuitions are no longer able to meet current climatic conditions. Managers need decision aids that allow for both rapid assessment of pathogen presence and the associated risk of disease-related losses. Additionally, there is a need to improve pathogen detection in many plant-based materials to safeguard global trade.

This focus section presents some of the latest approaches to developing rapid sampling and detection methodology for monitoring pathogens and pests in agronomic systems.

Thiessen (2024) presents a practical review of the use of inoculum monitoring as a decision aid. The review discusses how some fungal pathogens are able to disperse over great distances, in some cases traveling between continents. The author describes some of the physical limitations of spore dispersal associated with different fungi, such as the size, shape, and discharge method, and presents some of the strengths and weaknesses of inoculum detection methods and how they can complement visual inspections of plants. The author describes how incorporating features of each pathosystem's biology is critical for effective placement of spore traps in a landscape and closes with some of the promises and limitations of using inoculum detection methods in decision making, especially in the context of regulatory environments and in conjunction with predictive models.

Swiecki et al. (2024) present a method for using pear-baiting to detect *Phytophthora* species from the leachate of nursery plants, allowing for more high-throughput detection of dangerous pathogens in nursery production systems. Monitoring for *Phytophthora* species is critical in nursery settings, as infested lots can rapidly transmit quarantine-level pathogens to regions that are undergoing restoration efforts. Simulation models suggested effective sampling sizes for accurate detection of *Phytophthora* at different detection thresholds, and they found that their altered sampling method outperformed random sampling. This work demonstrates that targeted sampling based on our understanding of pathogen biology in relation to microclimate can be used to improve our ability to monitor and detect pathogens.

van de Vossenberg et al. (2024a) use reverse transcriptase PCR to target messenger RNA from *Synchytrium endobioticum* propagules to assess whether viable pathogen inoculum is present in soil samples. This procedure affords the added benefit of not only detecting pathogen presence, but also determining whether the source was from living pathogen propagules. This viability testing is needed to accurately assess fields that are suitable for use in production of seed potatoes and to rapidly assess the effects of treatment on *S. endobioticum* viability. This method could prove very useful in assessing post-harvest treatments for managing diseases during storage and shipping or for developing methods to reduce pathogen transmission during plant propagation.

In a second article, van de Vossenberg et al. (2024b) present a real-time PCR procedure to detect the presence of the quarantined false codling moth (*Thaumatotibia leucotreta*). They demonstrated that this assay out-performed other PCR and LAMP assays currently in use. This work is a clear example of the use of receiver operating characteristics to compare the performance of different assays and set thresholds for detection.

Shymanovich et al. (2024) describe the development of novel LAMP/Cas12 diagnostic assays for rapid detection and discrimination of Californian strains of tomato spotted wilt virus (TSWV) that were either wild type or alternatively resistance breaking to the Sw-5b resistance gene. Assays were validated using field samples, and offer potential for in-field diagnostic use, enabling faster TSWV disease management decisions in commercial tomato crops. This study shows the utility of CRISPR-Cas12a in developing diagnostic assays and monitoring specific point mutations.

Roggenkamp et al. (2024) developed a qPCR assay diagnostic for the detection and quantification of *Phyllachora maydis*, the causal agent of corn tar spot. Assay validation of field samples was conducted by several different labs to demonstrate the transferability of the technology. This work demonstrates the variability in assay performance among labs and the need to carefully tune assays for the specific conditions in each lab, and perhaps with each individual.

Clark et al. (2024) developed a multiplex qPCR assay to identify and quantify both *Peronospora effusa*, the causal agent of spinach downy mildew, and *Bremia lactucae*, the causal agent of lettuce downy mildew. Samples collected via cyclone and impaction spore traps were evaluated, with both systems providing concurrent detections, and these spore detection systems will be used to improve downy mildew forecasting.

These manuscripts demonstrate the breadth of research needed to address the challenges facing agroecosystem managers and the continued and emerging threat of exotic, emerging, and re-emerging pathogens and pests in an era of increasing global trade and rapidly changing climates. Due to societal, market, and technology challenges, managers will continue to need an increased understanding of pathogen and pest presence and dispersion to adapt their management tactics and strategies to address these challenges.

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