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Editorial: Insights in disease management

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Editorial on the Research Topic
Insights in disease management

The Research Topic "*Insights in Disease Management*" brings together innovative Research Topics from the disease management sector. This is a key time to reduce losses to diseases so that we can produce more food that we need for the growing global population but also to control diseases in a way that minimises the environmental footprint of crop production. The issue covers insights using examples in both protected and field crops, covering most pathogen groups – bacteria (Reglinski et al.), viruses (Codod et al.), fungi (Dutta et al.; Sangiorgio et al.), and oomycetes (Sharma et al.). Underpinning many current approaches to disease management is the idea of integrated pest management, which is often portrayed as a triangle representing different tiers of approaches. The foundations of the IPM triangle are practices such as crop rotation to separate crops and pathogens in space and time, use of resistant varieties, and various effects of management practices such as under-sowing or inter-cropping to alter the microclimate, release biofumigants, maintain beneficial microbes or to act as a physical barrier. Papers in this issue connected with this layer of the IPM triangle cover aspects such as improved host resistance with marker-assisted selection, genome sequencing, and improved understanding of resistance genes (Sharma et al.). Also connected to host resistance is the paper by Reglinski et al. except that this concerns host resistance induced by application of a chemical elicitor. This human intervention is preferable to applications of chemical pesticides (usually depicted at the top of the IPM triangle to represent a measure used only as a last resort), which despite often providing efficient disease control and associated benefits of enhanced yield, is acknowledged to have potential non-target effects in the environment. One such non-target effect is the impact of fungicides and other pesticides on microbial endophytes and more broadly, the phytobiome, which Sangiorgio et al. argue, has potential to confer a degree of natural biological control, protecting against pathogens both on the plant surface and within host tissues. They review how genetic sequencing techniques are providing new insights into the degree of protection conferred by the phytobiome towards pathogens in addition to other roles affecting resistance to abiotic

stress and nutrient uptake, ultimately affecting plant phenotype, growth, yield and quality. They conclude that future research on plant disease control should also consider impacts to microbe-mediated plant fitness. Indeed, even applications of biological control agents have potential to affect the phytobiome, but this approach is nevertheless regarded as less damaging to the environment compared to chemical control. One of the main biocontrol agents that has been used successfully for over 50 years is *Trichoderma*. This fungal genus is reviewed by Dutta et al., covering its use as a bio-fungicide, long-term biocontrol agent, defence activator and plant growth stimulator.

The use of available biologicals or chemical control options are greatly enhanced by monitoring and forecasting schemes to indicate exactly when the target pathogen will occur. This is increasingly being seen as a form of precision agriculture, directing not only where but also when to make an intervention to protect crops from imminent disease. Various processes have been investigated, ranging from optical sensing from platforms such as satellites, drones or tractor and hand-held devices, to weather-based forecasts, or taking environmental samples (irrigation water, soil or the air) and performing various diagnostic tests, some of which are compatible with being automated and linked to wireless reporting. One key step in determining an efficient sampling or monitoring regime is to understand the spatial distribution of the pest or pathogen in question. The paper by Codod et al. is an example of this – explaining how the whitefly-transmitted virus complex affecting yellow squash (*Cucurbita pepo*) occurs initially in a sparse, random pattern, mainly around edges of fields but becomes aggregated, with spread mainly along rows, which will inform future developments to improve scouting, monitoring, and management strategies.

This issue therefore brings together the core components of IPM, including traditional epidemiological studies, bio-control and cutting-edge 'omics', which are currently reshaping IPM, particularly through studies of functional genomics and the microbiome. These approaches are increasingly necessary to deliver sustainable crop production that will feed the world, while having a low environmental impact.

Author contributions

The authors contributed to editing and reviewing the articles and to writing the editorial. All authors contributed to the article and approved the submitted version

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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.

Publisher's note