

Interdisciplinary Insights: Airborne Inoculum Monitoring and Epidemiology

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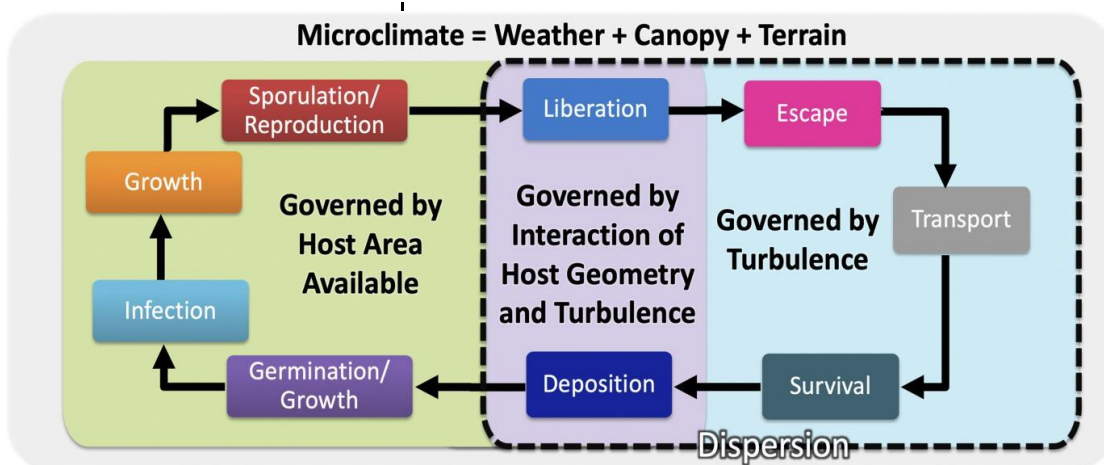
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Global demand for pesticide-free food products is increasing rapidly. Crops of all types are under constant threat from various plant pathogens. To achieve adequate control with minimal pesticide use, close monitoring is imperative. Many

plant pathogens spread through the air, so the atmosphere is composed of a wide variety of plant pathogenic and non-plant pathogenic organisms, particularly in agricultural environments. Air is the means of transport for many plant pathogens, some of which can travel thousands of kilometers while maintaining their viability and ability to cause new epidemics. Many plant pathogenic fungi are remarkably well adapted to airborne spread. The fact that fungal spores are spread by air currents has been known for almost as long as the existence of the spores themselves. The atmosphere in agricultural environments is therefore full of particles ranging in size from 0.1 µm for viruses to 100 µm for pollens. Monitoring spores and other particles in the air requires a specific field of scientific expertise, which is called aerobiology. Aerobiology has developed to a large extent in response to the need to know the quality of air in buildings and of pollen responsible for allergies in humans.

Purposes of sampling airborne fungal spores

Sampling airborne fungal spores serves various critical purposes in aerobiology. It enhances our understanding of airborne disease epidemiology on different scales and aids in modeling disease development and forecasting systems. Comparative epidemiology utilizes airborne inoculum data to study its role in disease progression under varying



conditions. Combining aerobiological data with genetics allows for studying pathogen communities, including fungicide resistance and aggressiveness. Moreover, it supports biovigilance efforts to assess climate change impacts, emerging pathogens, and genetic diversity. Surveillance involves long-term monitoring of sporadic pathogens or new arrivals, while monitoring aids day-to-day disease management decisions. These strategies help optimize disease prevention and control measures, enhancing overall agricultural and environmental health.

Dispersal

Disease development is typically conceptualized by the disease triangle that represents interactions among the host, pathogen and environment. Dispersion is a spatiotemporal process that operates across numerous scales in space and time. Success of dispersion is dependent on the factors that influence liberation, escape, transport, survival and deposition of propagules.

Advantages of Airborne Spore Sampler Monitoring

- **Early Disease Detection:** Airborne spore sampler monitoring allows for the early detection of pathogens before visible symptoms appear on plants. This timely information enables growers to initiate control measures proactively, preventing disease outbreaks.

- **Precision Control:** By tracking the presence and concentration of airborne spores, growers can implement targeted and precise control measures. This reduces the need for broad-spectrum pesticide applications and minimizes environmental impact.
- **Real-time Monitoring:** Some modern airborne spore samplers provide real-time data, allowing growers to receive timely alerts and make informed decisions quickly. This is especially crucial in dynamic disease scenarios.
- **Data-driven Decision Making:** Airborne spore sampler data provides valuable insights into pathogen dynamics, helping growers make evidence-based decisions about the timing of treatments, planting, and other management practices.
- **Risk Assessment:** Monitoring spore concentrations helps in assessing disease risk and understanding disease development patterns. This knowledge guides the deployment of control strategies effectively.
- **Integrated Pest Management (IPM):** Airborne spore sampler data can be integrated into IPM strategies, promoting a holistic approach to disease management that considers various factors like cultural practices, weather conditions, and biological controls.
- **Reduced Pesticide Use:** With accurate monitoring, growers can optimize pesticide use, minimizing overuse and reducing the development of pesticide-resistant strains.
- **Climate Change Adaptation:** Airborne spore sampler data can aid in studying the impact of climate change on disease dynamics, allowing for adaptive management strategies to be developed.
- **Technical Expertise:** Proper operation and maintenance of airborne spore samplers require technical expertise, which might be a barrier for some growers.
- **Equipment Costs:** Acquiring and maintaining airborne spore sampler equipment can be expensive, particularly for smaller farms or regions with limited resources.
- **Data Interpretation:** Analyzing spore sampler data and translating it into actionable decisions can be complex, requiring knowledge of both plant pathology and data analysis.
- **Limited Pathogen Coverage:** Airborne spore samplers are designed to target specific pathogens or groups of pathogens. This limits their usefulness if a diverse range of pathogens needs monitoring.
- **Variability:** Spore concentration in the air can vary greatly due to factors such as weather conditions, topography, and local sources of inoculum. This variability can make data interpretation challenging.
- **Limited Spatial Resolution:** The spatial resolution of airborne spore sampler data might not capture fine-scale disease variation within a field. Additional localized monitoring may be necessary.

Disadvantages of Airborne Spore Sampler Monitoring

Conclusion

The understanding of aerobiology combined with the variations of pathogen-specific biology and disease epidemiology, can serve as a guide to designing improved monitoring approaches. By deploying specialized samplers, researchers have unlocked a wealth of information about spore concentrations, dispersion patterns and temporal dynamics. This information not only enhances our understanding of disease epidemiology, but also guides the development of innovative disease management strategies.

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