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IMPLICATIONS OF AEROMYCOLOGICAL CHANGES ON SUNFLOWER AND SAFFLOWER YIELD: A CASE STUDY OF SPORE CONCENTRATIONS AND PLANT DISEASE DYNAMICS

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Abstract :
Aeromycological alterations driven by environmental changes significantly affect the yield of crops such as sunflower and safflower. This study aims to investigate the relationship between spore concentrations in the air and the dynamics of fungal diseases in sunflower and safflower crops. Using a combination of Burkard spore trapping, microscopic analysis, and molecular techniques, we identified the dominant fungal pathogens and quantified their spore concentrations. We further analyzed the relationship between spore concentrations, weather conditions, and the severity of plant diseases. The findings suggest that higher spore concentrations, coupled with conducive weather conditions, contribute to increased disease incidence and severity, leading to yield losses. This paper emphasizes the need for integrated disease management strategies, taking into account aeromycological changes and their implications for crop yield.

Keywords:
Aeromycology, Sunflower, Safflower, Fungal Pathogens, Spore Concentrations, Plant Disease Dynamics, Yield Loss, Disease Management

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RESEARCH PAPER

Introduction

In the realm of agriculture, sunflower and safflower crops hold paramount importance. Their oil seeds are extensively used in food industries and for biofuel production due to their high oil content and nutritional attributes, contributing significantly to global agricultural commodities. Nevertheless, these crops are frequently threatened by numerous challenges, among which airborne fungal pathogens pose a substantial risk. These pathogens directly impact the productivity and quality of sunflower and safflower crops, often leading to significant yield losses and consequent economic implications.

Aeromycology, the scientific study of airborne fungal spores and mycelium fragments, is pivotal in comprehending the intricacies of these airborne fungal pathogens. Through aeromycology, we can gain insights into the types of fungal spores present in the air, their concentrations, dispersal mechanisms, and the conditions favourable for their survival and propagation. This understanding is crucial, given that fungal spores in the air serve as the primary inoculum for many plant diseases. However, the complex dynamics of fungal diseases in crops cannot be understood merely by identifying the types of fungal spores in the air. The relationship between the concentrations of these spores and the manifestation of diseases in plants is equally important. Spore concentrations can provide an indication of the potential disease pressure on the crops, while plant disease dynamics can reveal the actual impact of

http://www.epitomejournals.com Vol. 8, Issue 12, December 2022, ISSN: 2395-6968

these spores. With this background, our research focuses on exploring the implications of aeromycological changes, particularly changes in spore concentrations, on the yield of sunflower and safflower crops. This study aims to fill a critical gap in our understanding of the complex interplay between aeromycology and plant disease dynamics. It is anticipated that the findings will offer valuable insights that could inform more effective and adaptive disease management strategies in the face of changing climatic and environmental conditions.

Methodology

The research methodology was designed to ensure a comprehensive understanding of the aeromycological changes and their implications on sunflower and safflower yield. The primary steps included the collection of airborne fungal spores, their identification and quantification, and the subsequent analysis of plant disease dynamics in relation to spore concentrations and weather conditions. To collect airborne fungal spores, we used a Burkard Spore Trap, a volumetric spore sampler that continuously samples air and deposits any particulates onto a sticky tape. This device was set up in various sunflower and safflower fields across different geographic regions, each representing a diverse set of environmental conditions. The collection was done over two consecutive growing seasons to account for seasonal variations in spore concentrations. Once the samples were collected, we proceeded with the identification of the fungal spores. This step involved microscopic analysis, where we visually examined the samples using light microscopy to distinguish the various types of spores based on their morphological characteristics. While microscopy allowed us to identify the spores at a genus or group level, we used molecular techniques for a more detailed identification. Specifically, we employed Polymerase Chain Reaction (PCR), a technique used to amplify and detect specific DNA sequences, to confirm the identity of the fungal species present in our samples. Following the identification of fungal species, we calculated spore concentrations. This was done by counting the number of spores of each species on a given length of the tape from the spore trap, using a formula that also takes into account the volume of air sampled, thereby providing a measure of the number of spores per cubic meter of air. Concurrently, we collected weather data, including temperature, humidity, wind speed and direction, and precipitation from weather stations located near our sampling sites. These data were used to understand the conditions under which different spore types and concentrations were observed. The final step involved analyzing the relationship between spore concentrations, weather conditions, and plant disease dynamics. We conducted field surveys

http://www.epitomejournals.com Vol. 8, Issue 12, December 2022, ISSN: 2395-6968

to assess disease incidence and severity in the sunflower and safflower fields, linking these observations with our spore concentration data and weather records. This analysis provided insights into how aeromycological changes influence the dynamics of fungal diseases and subsequently impact crop yield.

Results and Discussion

Our research revealed a complex pattern of airborne fungal pathogens affecting sunflower and safflower crops. The dominant species identified were Alternaria, Botrytis cinerea, and Sclerotinia sclerotiorum, each with different spore dispersal and disease manifestation characteristics. Alternaria species, well-known for causing leaf spot and blight, were found in significant quantities in the air samples. Similarly, Botrytis cinerea, responsible for the gray mold disease, and Sclerotinia sclerotiorum, the agent of Sclerotinia stem rot, were also frequently observed. It was interesting to note that the presence of these fungi in the air samples correlated strongly with the incidence and severity of diseases in the field, providing tangible evidence of the role of airborne spores in plant disease dynamics. Furthermore, our data revealed that spore concentrations played a crucial role in disease occurrence. Higher spore concentrations in the air corresponded to increased disease incidence and severity in both sunflower and safflower crops. This finding supports the hypothesis that higher amounts of airborne inoculum increase the likelihood of disease occurrence, contributing to significant yield losses. Simultaneously, we found that weather conditions exerted a significant influence on spore dispersal and disease development. Specifically, high humidity and temperature appeared to favour spore release and dispersal, thus increasing the risk of disease outbreak. In addition, favourable weather conditions also appeared to accelerate disease development, leading to an increase in the severity of the diseases. Analyzing these findings in tandem, our study underscores the complex interplay between aeromycological changes, including alterations in spore concentrations, and plant disease dynamics. The dynamics of these fungal diseases are governed not only by the presence of specific fungal species but also by their concentrations in the air and the prevailing weather conditions. This interplay profoundly influences the yield of sunflower and safflower crops, underlining the critical need for incorporating aeromycological considerations in disease management strategies.

Conclusion

The study unveils the significant implications of aeromycological changes, particularly alterations in spore concentrations, on the yield of sunflower and safflower crops. The presence and abundance of airborne fungal spores, along with weather conditions, were found to be critical determinants in the incidence and severity of fungal diseases, ultimately impacting crop yield. These findings shed light on the intertwined dynamics of airborne fungal pathogens and plant disease progression, underscoring the importance of continuous aeromycological studies. They highlight the need to monitor and quantify airborne fungal spores, analyze their relationship with weather variables, and assess their impact on plant disease dynamics regularly. This knowledge could enhance early disease prediction and aid in the timely implementation of disease management strategies. In addition to continuous monitoring, the development of comprehensive and adaptive disease management strategies is paramount. These should include cultivar selection based on resistance to prevalent airborne fungal diseases, changes in cropping practices, use of fungicides, and other biological control measures. Such strategies need to be adaptive, considering the variable nature of aeromycological changes and the potential impacts of climatic conditions. Future research in this domain should extend towards predictive modelling. Given the backdrop of climate change, it becomes imperative to predict spore dispersal patterns under different climate change scenarios. Understanding how changes in temperature, humidity, wind patterns, and other weather variables influence fungal spore concentrations and dispersal could provide valuable insights for preparing against potential shifts in disease dynamics. This forward-looking approach could equip farmers and agricultural stakeholders to proactively manage disease threats and protect the productivity of essential crops like sunflower and safflower. In conclusion, understanding the implications of aeromycological changes on crop yield is a complex but critical aspect of securing global food production systems. By reinforcing the importance of this line of inquiry, our study hopes to inspire further research and practical applications in this essential field.

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