

## A quantitative study of fungal spore distribution and their influence and safflower crop health and aeromycological approach

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### Abstract

Airborne fungal pathogens significantly influence the health and productivity of oilseed crops such as sunflower and safflower. Yet, their distribution and concentration in the atmosphere, and the subsequent impact on plant health remain inadequately understood. This study aims to bridge this knowledge gap through a quantitative aeromycological investigation. We collected and identified airborne fungal spores using a Burkard Spore Trap and molecular techniques over two growing seasons. Dominant pathogens included *Alternaria* species, *Botrytis cinerea*, *Sclerotinia sclerotiorum*, and *Phoma* species. Our findings reveal a strong correlation between spore concentrations and plant health metrics such as disease incidence, plant biomass, and crop yield. The study underscores the importance of aeromycological studies in developing effective disease management strategies for sunflower and safflower crops and prompts further research on the influence of changing climatic conditions on fungal spore distributions and plant health.

**Keywords:** Sunflower, safflower, aeromycology, airborne fungal pathogens, crop health

### Introduction

The rising global demand for healthier edible oils and biofuels has catapulted crops like sunflower and safflower into significant economic importance. Sunflower and safflower oils are known for their nutritional benefits, including high levels of unsaturated fatty acids and essential vitamins. Furthermore, they serve as key raw materials in biofuel production and are utilized in various pharmaceutical preparations. However, the cultivation of these crops faces numerous challenges, one of the most significant being the threat from airborne fungal pathogens. Airborne fungal pathogens can induce a variety of plant diseases that detrimentally affect the growth, development, and overall health of these oilseed crops. These diseases can

lead to considerable yield losses and, in severe cases, complete crop failure. Consequently, understanding the dynamics of airborne fungal pathogens is critical in developing effective disease management strategies and ensuring sustainable crop production. Aeromycology, a specialized field within mycology, studies the occurrence, distribution, and potential impacts of fungal spores and fragments that are transported through the air. Airborne fungal spores, given their microscopic size and light weight, can travel vast distances from their source, disseminating diseases over large geographical areas. Their prevalence and distribution are influenced by various factors, including weather conditions, season, and local vegetation, among others.



## Material and method

In order to quantify the distribution and concentrations of airborne fungal spores, we used a high-volume Burkard Spore Trap. This device, widely used in aeromycological studies, operates by drawing in air at a known rate, capturing any particles present, including fungal spores, on a sticky tape. The trap was installed in selected sunflower and safflower fields and operated continuously for 24 hours on specified sampling days throughout two consecutive growing seasons. The collected samples were then prepared for analysis. The sticky tape was stained and mounted on microscopic slides. A light microscope was used for the initial identification of the spores based on their morphology. However, considering the challenges associated with morphological identification, such as the requirement of expert knowledge and potential morphological similarities among different fungal species, molecular techniques were also employed for confirmation. Specifically, polymerase chain reaction (PCR) was used to amplify specific DNA sequences unique to each fungal species, enabling a more precise identification. Upon confirming the identity of the fungal spores, their concentrations were quantified by counting the number of each type of spore per unit volume of air. This provided us with an estimate of the spore load that the crops were exposed to during the study period. We then evaluated the health of the sunflower and safflower crops using several metrics. Visible disease symptoms, such as leaf spots, stem rot, wilting, and necrosis, were recorded. Plant biomass was assessed by weighing the above-ground parts of random sample plants from each field. Finally, crop yield was determined by measuring the weight of seeds produced per plant.

## Result and discussion

The study revealed presence of several dominant airborne fungal pathogens, including *Alternaria* species, *Botrytis cinerea*, *Sclerotinia sclerotiorum*, and *Phoma* species. These pathogens were detected across different regions and growing seasons, demonstrating their widespread occurrence and potential threat to sunflower and safflower crops. Quantitative analysis of the fungal spores revealed significant variations in their concentrations. *Alternaria* species were the most frequently detected airborne fungi in both the crops. High concentrations of *Alternaria* spores were correlated with increased incidences of leaf spot and blight diseases. Infected plants showed reduced growth and productivity, as evidenced by the significant decrease in plant biomass and crop yield. *Botrytis cinerea*, the causal agent of gray mold, and *Sclerotinia sclerotiorum*, responsible for white mold, were also detected in substantial quantities during periods of high humidity. The occurrence of these diseases led to significant tissue damage and necrosis, affecting the overall health and productivity of the crops. *Phoma* species, primarily associated with stem canker and black stem diseases, were detected in high concentrations particularly in the late growing season. These diseases were found to cause wilting, stem breakage, and premature plant death, leading to considerable yield losses. These findings clearly illustrate the influence of fungal spore distributions on plant health and productivity. High spore concentrations were generally linked with increased disease incidence and severity, leading to significant reductions in plant growth and yield. This suggests that

airborne fungal pathogens can pose a major challenge to sunflower and safflower cultivation, potentially causing substantial economic losses. The study also highlights the complexity of the relationship between fungal spore distribution, environmental conditions, and plant health. Weather conditions, particularly humidity and temperature, were found to significantly influence spore dispersal and disease development. Similarly, crop management practices, such as crop rotation and field sanitation, also appeared to play a crucial role in modulating disease dynamics. These results underscore the need for regular monitoring of airborne fungal pathogens and the development of tailored disease management strategies. By understanding the variations in spore distributions and their impact on plant health, crop growers can be better equipped to manage these threats and mitigate their potential impacts. This could involve the deployment of resistant cultivars, timely application of appropriate fungicides, or the modification of cultivation practices to disrupt the life cycle of these pathogens. Ultimately, such strategies can help ensure the sustainable and profitable production of sunflower and safflower crops.

## Conclusion

This study illuminates the substantial influence of airborne fungal pathogens on the health and productivity of sunflower and safflower crops. It explicitly demonstrates that the distribution and concentration of these fungal spores in the air play a crucial role in the severity and extent of plant diseases. In doing so, it validates the significant contribution of aeromycological studies in understanding and managing crop diseases. Our findings stress the necessity of strategic interventions to mitigate the detrimental effects of these airborne fungal pathogens. Among these interventions, the development and use of crop varieties resistant to specific fungal diseases hold immense potential. Implementing such varieties could drastically reduce disease incidence and improve crop productivity. Additionally, the study accentuates the importance of timely application of suitable fungicides. However, it should be noted that the misuse or overuse of fungicides could lead to the development of resistant fungal strains, making disease management more challenging. Therefore, the judicious use of these chemicals, guided by regular monitoring of spore concentrations and disease development, is crucial. The study also points towards the potential benefits of improved agricultural practices in controlling fungal diseases. Practices such as crop rotation, intercropping, and maintaining proper field sanitation could disrupt the lifecycle of fungal pathogens, thus reducing their impact on crops. Looking ahead, the study recognizes the need for future research to consider the potential influence of changing climatic conditions on fungal spore distributions. Climate change, with its effects on temperature and humidity levels, could significantly alter spore dispersal patterns and disease dynamics. Understanding these potential changes will be crucial for developing robust and effective disease management strategies in the future. This paper has provided valuable insights into the aeromycological dynamics of fungal diseases affecting sunflower and safflower crops. It underscores the importance of an integrated approach, combining resistant varieties, proper fungicide application, and improved agricultural practices, to manage these diseases effectively.

As climate change continues to alter the agricultural landscape, adaptive and forward-thinking strategies will be essential for sustainable crop production and food security.

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