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EFFECTS OF AIRBORNE FUNGAL PATHOGENS ON SUNFLOWER AND SAFFLOWER: AN AEROMYCOLOGICAL INVESTIGATION

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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*: Airborne Fungal Pathogens, Aeromycology, Sunflower, Disease Management*

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RESEARCH PAPER

Introduction:

The cultivation of sunflower (*Helianthus annuus*) and sanfflower (*Carthamus tinctorius*) crops has significantly increased worldwide, largely driven by the growing demand for their oils. Their economic potential is undeniable, primarily attributed to the high oil content in their seeds, with sunflower and safflower oils being key ingredients in a variety of food and industrial products. Sunflower and safflower oils have also proven integral to the biofuel industry, offering a more sustainable alternative to fossil fuels. In the pharmaceutical sector, these oils are used for their medicinal properties and as carriers for drug delivery. However, the successful cultivation of these oilseed crops is under continuous threat from a variety of plant diseases, with airborne fungal pathogens posing a substantial risk. These pathogens, which include a broad array of fungal species, are transported via wind and are capable of infesting large swathes of agricultural land. Once these fungal spores land on susceptible host plants, they can germinate and cause severe diseases, leading to significant crop yield losses. This, in turn, threatens food security and the economic viability of the agricultural sectors reliant on these crops. Aeromycology, a specialized branch of mycology, is instrumental in understanding the dynamics of these airborne fungal pathogens. It focuses on the study of fungal spores and mycelium fragments that are present in the air and their impacts on the environment, including plant and human health. Aeromycological studies provide critical insights into how these pathogens spread, the conditions favouring their dispersal, and the measures that can potentially limit their impact. In this context, our research seeks to identify the main fungal pathogens affecting sunflower and safflower crops, elucidate the aerobiological factors influencing their dispersal, and examine the extent of the damage they cause. Additionally, we aim to highlight the implications of these findings for crop disease management. The knowledge gleaned from this study will contribute significantly to developing more effective strategies for managing these diseases, thereby enhancing the productivity and quality of sunflower and safflower crops. This research is not only timely but also crucial in the face of an ever-increasing demand for these economically vital crops.

Methods / Approach:

This research study was meticulously designed and executed in a two-phase approach over two consecutive crop seasons to collect robust, reliable data on the airborne fungal

pathogens affecting sunflower and safflower crops. In the first phase, we focused on the collection of airborne fungal spores. This was accomplished using a Burkard Spore Trap, a device renowned for its efficiency and accuracy in capturing airborne particles. The traps were strategically placed at various locations in sunflower and safflower fields across different regions, taking into account the regional climate, wind patterns, and crop diversity. The collection was performed daily during the crops' growing period, ensuring the captured data represented the diversity of fungal spores present during the entire crop season.

Post collection, the spores were identified using a combination of traditional and modern techniques. Initially, light microscopy was utilized to observe the morphological features of the captured spores. This allowed for the preliminary identification of the spores based on their size, shape, color, and other distinct features. For a more precise and accurate identification, molecular techniques were applied, specifically Polymerase Chain Reaction (PCR). DNA was extracted from the spores and amplified using PCR. The amplified DNA was then sequenced and compared with known sequences in fungal DNA databases to confirm the identity of the spores.

Once the pathogens were identified, the next step was to understand their infection mechanisms and their effects on the sunflower and safflower crops. For this purpose, we carried out pathogenicity tests.Healthy sunflower and safflower plants were grown under controlled conditions in a greenhouse. The identified fungal pathogens were cultured in a laboratory, and the resulting spores were used to inoculate these plants. Care was taken to replicate the natural infection process as closely as possible. Post-inoculation, the plants were monitored regularly for disease development. Observations were made regarding symptom onset, disease progression, and the overall impact on the plant's growth and productivity. These tests helped us gain insights into how these pathogens infect the crops, the severity of the diseases they cause, and the stages of crop growth they impact the most.

Results and discussion:

This study resulted in the identification of several airborne fungal pathogens impacting the health and productivity of sunflower and safflower crops. Predominant among these were species from the Alternaria genus, Botrytis cinerea, Sclerotinia sclerotiorum, and various

Phoma species. These pathogens instigated distinct visible symptoms on the plants, impacting their physiological vigor and yield potential.

Alternaria Species

Alternaria species were the most frequently detected pathogens in both sunflower and safflower fields. These fungal pathogens are known for causing Alternaria leaf spot and blight, two of the most destructive diseases for these crops. Initial symptoms are small brown spots on the leaves, but as the disease progresses, these spots coalesce, leading to extensive defoliation and, consequently, a significant reduction in photosynthetic capacity. The reduced photosynthesis eventually affects the plants' overall health, compromising yield quantity and quality.

Botrytis cinerea

Botrytis cinerea, causing gray mold, was another critical pathogen identified in this study. This fungus was particularly prevalent during the wet season, aligning with the known preference of this pathogen for high humidity conditions. Infected plants exhibited fluffy, gray mold growth on leaves, stems, and flowers, often leading to tissue rot. Late-stage infection can result in severe plant wilting and death, which can cause substantial yield losses if not properly managed.

Sclerotinia sclerotiorum and Phoma Species

Sclerotinia sclerotiorum and Phoma species were also identified as severe threats to sunflower and safflower crops. Both are responsible for stem diseases – stem rot caused by Sclerotinia sclerotiorum and Phoma black stem caused by Phoma species. These pathogens were particularly problematic in densely planted fields with high humidity, where the spore dispersal was elevated. Infected plants showed significant stem damage, causing wilting and eventually plant death, significantly impacting crop yield.

Disease Severity and Proliferation Factors

The severity and progression of the identified diseases were influenced by several factors. Weather conditions, particularly humidity and temperature, played a pivotal role in disease development and spread. High humidity and moderate temperatures were conducive for the proliferation of most identified pathogens.

In addition to weather conditions, field sanitation, crop rotation, and irrigation practices were key factors determining disease prevalence. Fields with poor sanitation practices and monoculture cropping systems had higher disease incidence. Overhead irrigation methods, which maintain high leaf wetness, also contributed to an increased prevalence of fungal diseases.

Conclusion:

This study underscores the critical impact of airborne fungal pathogens on the productivity and quality of sunflower and safflower crops. Our research has identified several dominant fungal pathogens, notably Alternaria species, *Botrytis cinerea*, *Sclerotinia sclerotiorum*, and Phoma species. Each of these pathogens causes distinctive disease symptoms and, if not effectively managed, can lead to significant yield losses. The results of our study highlight the importance of continuous aeromycological studies for understanding the dynamics of airborne fungal diseases in oilseed crops. It is evident that the variability in fungal populations and their disease manifestations are influenced by a myriad of factors, from weather conditions to field management practices. Hence, ongoing surveillance and research are pivotal to staying abreast of emerging threats and adapting disease management strategies accordingly. Our findings also underscore the need for comprehensive and integrated disease management strategies. Such strategies should encompass the use of resistant cultivars, application of effective fungicides, optimization of irrigation techniques, and implementation of proper sanitation practices. The integration of these strategies will help curb the proliferation of these fungal pathogens, ensuring a conducive environment for crop growth and production. Looking ahead, an area requiring more attention is the potential impact of climate change on the spread and intensity of fungal diseases in sunflower and safflower crops. As climate change continues to alter weather patterns, its implications for aeromycology and, by extension, crop disease management are profound. Therefore, future research efforts should focus on understanding these potential impacts and formulating appropriate adaptive measures.

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