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DIVERSITY ASSESSMENT OF FUNGAL COMMUNITIES ASSOCIATED WITH LEAF BLIGHT DISEASE OF MAIZE (*Zea mays*) AND PURPLE BLOTCH DISEASE OF ONION (*Allium cepa*) IN SAMARU, ZARIA, NIGERIA

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ABSTRACT

Leaf blight of maize and purple blotch of onion are economically important foliar diseases that significantly reduce crop yield and quality in tropical and subtropical agro-ecosystems. This study comparatively investigated the fungal communities associated with leaf blight symptoms of maize (*Zea mays* L.) and purple blotch symptoms of onion (*Allium cepa* L.) in Samaru, Zaria, Nigeria. Diseased leaf samples were collected from farmers' fields and analyzed using standard mycological techniques. Fungal isolates were cultured on Potato Dextrose Agar (PDA) supplemented with chloramphenicol and identified based on macroscopic and microscopic characteristics. The frequency of occurrence of each fungal genus was determined, and diversity indices were calculated to assess community structure. Three fungal genera were isolated from maize: *Helminthosporium*, *Colletotrichum*, and *Fusarium*, while onion samples yielded *Alternaria*, *Botrytis*, and *Fusarium*. *Fusarium* was the only genus common to both crops. The Jaccard similarity index (0.20) indicated low similarity between the fungal communities, despite the similarity in disease symptoms. Shannon diversity indices revealed moderate and comparable fungal diversity in both crops. Molecular identification and pathogenicity assays are recommended to confirm the causal roles of the isolated fungi and improve disease management strategies.

Keywords: *Zea Mays*, *Allium Cepa*, Leaf Blight, Purple Blotch, Fungal Diversity, Jaccard Similarity, Nigeria

INTRODUCTION

Maize (*Zea mays*) and onion (*Allium cepa*) are among the most economically important crops globally and in sub-Saharan Africa, contributing significantly to food security and livelihoods (IPNI, 2023; Savary *et al.*, 2019). Maize is a major staple cereal crop, providing carbohydrates, proteins, and essential nutrients for human consumption and animal feed (Adebayo *et al.,* 2021). Onion is an economically important vegetable crop widely valued for its culinary uses, nutritional benefits, and medicinal properties (Adewale *et al.*, 2021). The productivity of these crops is, however, severely constrained by foliar fungal diseases that reduce photosynthetic area, yield, and market quality worldwide (Savary *et al.*, 2019; Alemu and Mekonnen, 2020).

Leaf blight disease of maize is commonly associated with helminthosporioid fungi, including *Bipolaris*, *Exserohilum*, and *Helminthosporium* species, which cause extensive necrotic lesions on leaves and can result in significant yield losses (Piperno *et al.*, 2022). Purple blotch disease of onion is primarily caused by *Alternaria porri*, although other fungal genera such as *Botrytis* and *Fusarium* have been reported to colonize diseased tissues and contribute to disease complexes (Schwartz, 2004; Sharma and Tripathi, 2017; Alemu and Mekonnen, 2020). These diseases are favored by warm temperatures, high relative humidity, and prolonged leaf wetness, conditions typical of the Northern Guinea Savanna agro-ecological zone.

Understanding the diversity and composition of fungal communities associated with foliar diseases is essential for effective disease diagnosis, epidemiological studies, and the development of integrated disease management strategies. While numerous studies have focused on single-crop pathogen identification, comparative studies across different crops in the same agro-ecological region are limited. Such comparative analyses can provide insights into host specificity, pathogen overlap, and environmental influences on fungal community structure.

The objective of this study was to compare the fungi associated with maize leaf blight and onion purple blotch diseases in Samaru, Zaria, Nigeria, and to evaluate the similarity and diversity of fungal communities between the two crops using descriptive ecological indices.

MATERIALS AND METHODS

Study Area

The study was conducted in Samaru, Zaria, Kaduna State, Nigeria, located in the Northern Guinea Savanna zone. The area experiences a tropical climate with a distinct rainy season (May–October) and dry season (November–April). Average annual rainfall ranges from 900 to 1200 mm, and temperatures typically range from 18°C to 35°C. The region supports intensive cultivation of maize and vegetable crops, including onion.

Sample **Collection and Experimental Design**

Diseased leaves of maize (*Zea mays*) and onion (*Allium cepa*) exhibiting characteristic symptoms of leaf blight and purple blotch, respectively, were collected from multiple farmers' fields in Samaru, Zaria, Nigeria. Sampling was conducted using a complete randomized design to minimize selection bias. For each crop, three independent biological replicates were obtained from spatially separated fields (≥500 m apart) to account for field-level variability. Each biological replicate consisted of a composite sample of five symptomatic leaves collected from different plants within the same field. The leaves were pooled, transported to the Mycology laboratory, Department of Botany, Ahmadu Bello University, Zaria, in sterile sampling bags, and processed separately to maintain replicate independence.

This design resulted in three biological replicates per crop, allowing for reproducible isolation and comparative analysis of associated fungal communities.

Symptom Observation

Following collection, diseased maize and onion leaf samples were observed under laboratory conditions for 5–7 days to observe the progression of visible symptoms. Observations focused on changes in lesion size, shape, coalescence and coloration to characterize symptom progression.

Preparation of Culture Medium

Potato Dextrose Agar (PDA) was prepared following the manufacturer's instructions and supplemented with chloramphenicol (50 mg/L) to inhibit bacterial growth. The medium was sterilized by autoclaving at 121°C for 20 minutes and poured into sterile Petri dishes under aseptic conditions in a laminar flow cabinet.

Isolation of Fungi

Infected leaf tissues were excised from the advancing margins of lesions into 3–5 mm^2 segments. The segments were surface-sterilized in 1% sodium hypochlorite solution for 3 minutes and rinsed three times with sterile distilled water to remove residual disinfectant. Sterilized segments were blotted dry on sterile filter paper and plated onto PDA. Plates were incubated at 25–28 °C for 5–7 days, and emerging fungal colonies were sub-cultured to obtain pure cultures.

Identification of Fungal Isolates

Fungal isolates were identified based on colony morphology, pigmentation, growth patterns, and microscopic characteristics of spores and hyphae using lactophenol cotton blue staining. Identification was performed using standard mycological keys and manuals (Barnett and Hunter, 1998).

Data Analysis and Diversity Indices

The frequency of occurrence of each fungal genus was calculated using the formula:

Frequency (%) = (Number of isolates of a genus / Total number of isolates) × 100.

Comparative community similarity between maize and onion fungal assemblages was assessed using the Jaccard similarity index (J):

$J = a / (a + b + c)$,

Where a is the number of shared genera, b is the number of genera unique to maize, and c is the number unique to onion. Shannon diversity index (H') was estimated at the genus level based on relative frequencies to provide a descriptive measure of fungal diversity. Given the exploratory nature of the study and the use of three biological replicates per crop, statistical analysis was limited to descriptive metrics, and results were presented accordingly.

RESULTS AND DISCUSSION

Disease Symptomatology in Maize and Onions

Purple blotch symptoms were observed on onion leaves collected from Samaru village. Initial symptoms appeared as small, water-soaked lesions that developed into elliptical to elongated necrotic spots with purplish-brown margins. During the observation period, lesions expanded and coalesced, resulting in extensive leaf blighting and tissue collapse (Plate 1).

Plate 1: Purple Blotch Symptoms on Onion Leaves (Arrow Indicates Lesion)

Similarly, Maize leaves exhibited typical symptoms of leaf blight disease. Early symptoms appeared as small, brown, water-soaked spots that enlarged into elongated, spindle-shaped necrotic lesions with chlorotic margins. As the disease progressed during the observation period, lesions increased in size and, in some cases, coalesced to form larger blighted areas, leading to a reduction in functional leaf surface (Plate 2).

Plate 2. Leaf Blight Symptoms on Maize Leaves (Arrow Indicates Lesion).

Morphological Characterization of Fungal Isolates

Fungal isolates recovered from diseased maize and onion leaves were identified based on colony morphology and detailed microscopic features, including hyphae, conidiophores, and conidia.

From maize leaves, three fungal genera were consistently isolated: *Helminthosporium* sp., *Colletotrichum* sp. and *Fusarium* sp. *Helminthosporium* sp. produced greyish-white colonies with brown reverse pigmentation and exhibited septate hyphae and elongated, multicellular conidia. *Colletotrichum* sp. formed pinkish colonies with dark reverse pigmentation and was characterized by septate hyphae, acervuli with setae, and cylindrical hyaline conidia. *Fusarium* sp. showed whitish to pink colonies with dark reverse pigmentation and produced septate hyphae, branched conidiophores, and both macroconidia (sickle-shaped) and microconidia.

Similarly, three fungal genera were isolated from onion leaves: *Alternaria* sp., *Botrytis* sp., and *Fusarium* sp. *Alternaria* sp. was characterized by dark olive-grey colonies and muriform, obclavate conidia with transverse and longitudinal septa, which are typical diagnostic features of the genus. *Botrytis* sp. exhibited greyish colonies with branched conidiophores bearing clusters of ovoid conidia, consistent with its known morphological profile. *Fusarium* sp. Displayed whitish-grey colony with dark reverse pigmentation and produced curved, septate macroconidia.

The distinguishing morphological and microscopic characteristics of the isolates are summarized in Table 1 (maize) and Table 2 (onion). Representative micrographs and colony morphologies are presented in Plates 3–5 (maize) and Plates 6–8 (onion).

Table 1: Morphological Characteristics of Fungi Isolates from Maize Leaves

;	Colony morphology	Microscopic characteristics
Helminthosporium sp.	Greyish-white colony with brown reverse pigmentation	Septate, branched hyphae; conidiophores simple or geniculate; conidia multicellular, elongated, and slightly curved with rounded ends
Colletotrichum sp.	Pinkish colony with dark brown reverse pigmentation	Septate hyphae; presence of acervuli with setae; conidiophores short; conidia cylindrical, hyaline, and aseptate
Fusarium sp.	Whitish to pink colony with dark reverse pigmentation	Septate hyphae; branched conidiophores; macroconidia sickle-shaped, multicellular; microconidia present, oval to ellipsoidal

Table 2: Morphological Characteristics of Fungi Isolates from Onion Leaves

Fungal genus	Colony morphology	Microscopic characteristics
Alternaria sp.	Dark olive-grey colony with brown reverse	Muriform, obclavate conidia with transverse and longitudinal septa
Botrytis sp.	Greyish colony with brown reverse	Branched conidiophores bearing clusters of ovoid conidia
Fusarium sp.	Whitish-grey colony with dark reverse pigmentation	Curved, septate macroconidia

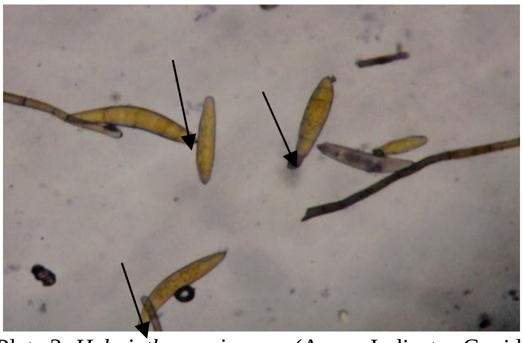

Plate 3: *Helminthosporium* sp. (Arrow Indicates Conidia)

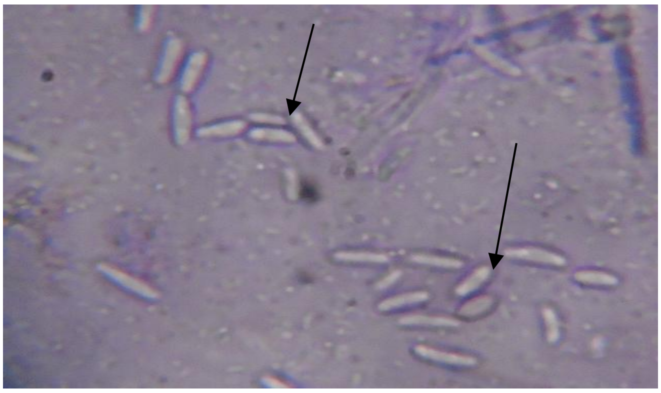

Plate 4: *Colletotrichum* sp. (Arrow Indicates Conidia)

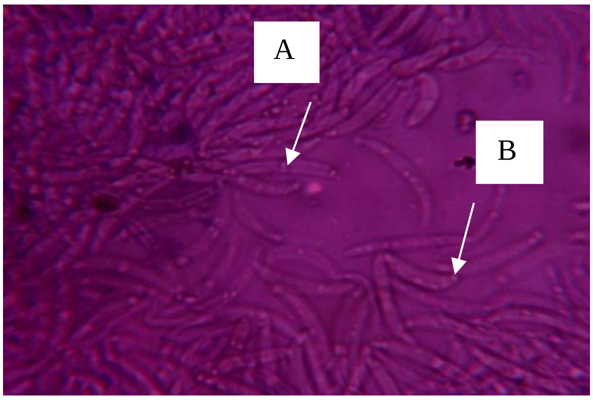

Plate 5. *Fusarium* sp.: (A) Microscopic Septate Macroconidia (arrow); (B) Colony Morphology

Plate 6: *Alternaria* sp. (Arrow Indicates Conidia)

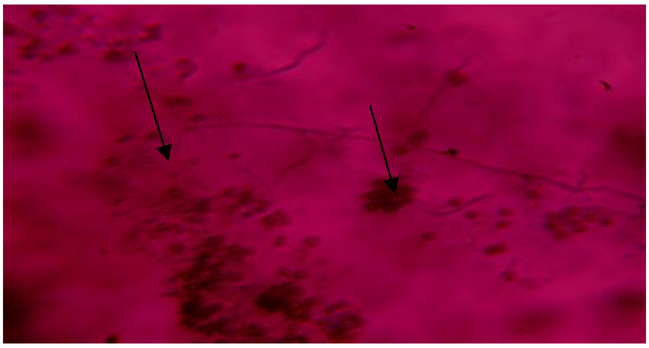

Plate 7: *Botrytis* sp. (Arrow Indicates Conidia)

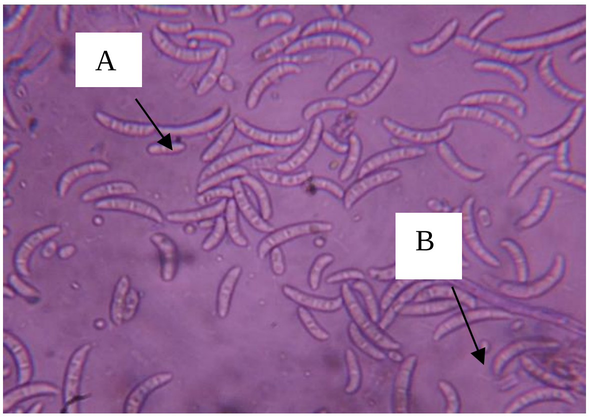

Plate 8: *Fusarium* sp. (A) Microscopic; (B) Macroscopic Conidia

Frequency of Occurrence of Fungal Isolates

The frequency of distribution of fungal genera varied between maize and onion.

In maize, *Helminthosporium* sp. was the most frequently isolated genus (66.6%), while *Colletotrichum* sp. and *Fusarium* sp. each occurred at a frequency of 33.3%. This distribution indicates the predominance of helminthosporioid fungi in maize leaf blight samples.

In onion, *Alternaria* sp. was the dominant genus (66.7%), whereas *Botrytis* sp. and *Fusarium* sp. each showed a frequency of 33.3%. The predominance of *Alternaria* sp. is consistent with its established role as the principal pathogen associated with purple blotch disease in onion.

These frequency distributions are illustrated in Figure 1 (maize) and Figure 2 (onion).

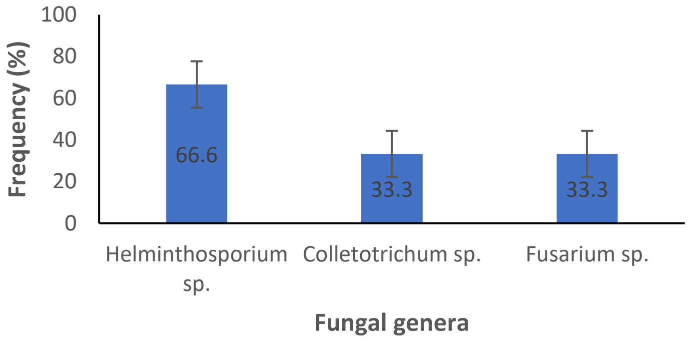

Figure 1: Frequency of Fungal Genera Isolated from Maize Leaves

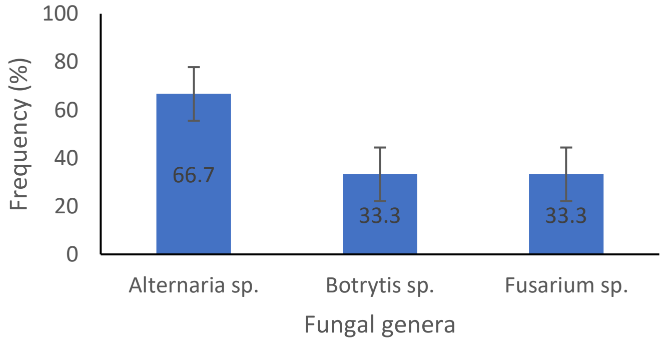

Figure 2: Frequency of Fungal Species Isolated From Onion Leaves

Comparative Fungal Diversity and Community Structure

Although maize and onion exhibited similar foliar symptoms, the associated fungal communities differed markedly. As summarized in Tables 1 and 2 and illustrated in Figures 1 and 2, *Fusarium* sp. was the only genus common to both crops. Maize-associated genera included *Helminthosporium* sp. and *Colletotrichum* sp., whereas onion-associated genera included *Alternaria* sp. and *Botrytis* sp.

The overlap and uniqueness of fungal genera between the two crops are further illustrated in Figure 3.

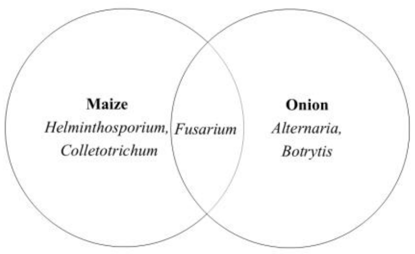

Figure 3: Jaccard Similarity Diagram Showing Shared and Unique Fungal General

Using one shared genus and two unique genera for each crop, the Jaccard similarity index between the fungal communities of maize and onion was calculated as 0.20, indicating low similarity.

Shannon diversity indices revealed moderate diversity in both crops (H’ ≈ 0.90 for maize and H’ ≈ 0.95 for onion), suggesting comparable levels of fungal diversity despite differences in species composition. The relative frequencies used for these calculations are shown in Figures 1 and 2, and a summary of diversity and similarity indices is presented in Table 3 below.

Table 3: Diversity and Similarity Indices of Fungal Communities Associated With Maize and Onion

Parameter	Maize	Onion
Number of genera	3	3
Shared genera	1	1
Unique genera	2	2
Shannon diversity index (H’)	0.90	0.95
Jaccard similarity index	-	0.20

Discussion

This study provides a comparative evaluation of fungal genera associated with leaf blight of maize and purple blotch of onion in Samaru, Zaria, Nigeria. Although both crops exhibited visually similar foliar symptoms characterized by necrotic, water-soaked lesions that expanded into elongated blighted areas, the associated fungal communities differed markedly. Notably, *Fusarium* sp. was the only genus common to both crops, while the remaining genera were crop-specific, indicating host-associated fungal assemblages despite comparable symptom expression.

The predominance of *Helminthosporium* sp. in maize leaf blight samples is consistent with previous reports identifying helminthosporioid fungi as major causal agent for foliar diseases in maize, particularly under warm and humid conditions typical of tropical agro-ecosystems (Alemu and Mekonnen, 2020; Sharma *et al.,* 2019). These fungi are known to impair photosynthetic efficiency through extensive leaf necrosis, ultimately resulting in reduced crop productivity. The detection of *Colletotrichum* sp. further suggests the presence of anthracnose-associated pathogens, which are capable of causing foliar necrosis, stem rot, and ear rot in maize. The coexistence of *Helminthosporium and Colletotrichum* in the present study indicates a potential multi-pathogen disease complex, a phenomenon increasingly reported in field conditions where multiple fungi interact to influence disease severity (Savary *et al.,* 2019).

In onion, *Alternaria* sp. was the most frequently isolated genus, corroborating its widely established role as the primary pathogen responsible for purple blotch disease (Asghar *et al.*, 2025; Coumo *et al.,* 2019). *Alternaria porri* is known to produce characteristic purple lesions with concentric rings and can significantly reduce bulb yield and quality (Schwartz, 2004; Sharma and Tripathi, 2017; Kumar and Singh, 2018). The characteristic necrotic lesions observed in this study are consistent with earlier reports describing *Alternaria porri* infection, which reduced photosynthetic area, leaf collapse, and significant bulb yield losses. The isolation of *Botrytis* sp. further suggests the presence of opportunistic or secondary pathogens, which can contribute to disease progression under favorable environmental conditions such as high humidity and prolonged leaf wetness (Gupta and Pathak, 2016).

The occurrence of *Fusarium* sp. in both maize and onion samples underscore its ubiquitous nature and ecological adaptability. Species within this genus are commonly associated with soil and plant debris and can function as pathogens, endophytes, or saprophytes depending on environmental and host factors (Leslie and Summerell, 2006). Its presence across both crops may reflect cross-host colonization potential or shared environmental reservoirs, particularly in intensively cultivated systems.

The low Jaccard similarity index observed between fungal communities of maize and onion indicates limited overlap and highlights the host specificity of many foliar fungi pathogens. This finding emphasizes the limitation of relying solely on symptom-based diagnosis, as similar visual symptoms may arise from distinct pathogen assemblages. In contrast, the Shannon diversity indices obtained for both crops suggest moderate and comparable levels of fungal diversity, despite differences in taxonomic composition. This pattern reflects ecological filtering, where host characteristics and environmental conditions shape fungal community structure.

Environmental conditions in Samaru, characterized by high relative humidity, moderate temperatures, and seasonal rainfall, likely contributed to the proliferation and dissemination of fungal spores. Such conditions are known to favor the development of foliar fungal diseases and may influence both pathogen diversity and infection dynamics (Savary *et al.,* 2019). Additionally, agronomic practices such as irrigation, fertilization, and crop residue management may have further influenced fungal community composition and disease incidence. Host plant factors, including leaf surface properties and physiological status, may also have contributed to the observed differences in fungal colonization patterns.

CONCLUSION

This study comparatively assessed fungal genera associated with leaf blight of maize and purple blotch of onion in Samaru, Zaria, Nigeria. Although both crops exhibited similar foliar symptoms, the associated fungal communities differed markedly, with *Fusarium* sp. being the only genus common to both hosts. Maize was predominantly associated with *Helminthosporium* sp. and *Colletotrichum* sp., whereas onion was dominated by *Alternaria* sp. alongside *Botrytis* sp.

The Low Jaccard similarity index indicates minimal overlap between fungal communities, highlighting the limitations of symptom-based diagnosis and the importance of pathogen-specific identification. Shannon diversity indices revealed moderate and comparable fungal diversity in both crops despite differences in community composition.

These findings underscore the need for targeted, crop-specific disease management strategies in tropical agro-ecosystems. Future studies incorporating molecular identification techniques and pathogenicity testing are recommended to improve taxonomic resolution and confirm the roles of the associated fungi in disease development. Such approaches will enhance the accuracy of disease diagnosis and inform more effective control strategies for sustainable crop production.

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