Leaf Surface Fungi as Indicators of Plant Health and Disease in Forest Trees of Songadh Taluka, Gujarat, India

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Abstract:

Leaf surface fungi, or foliicolous fungi, are important components of the phyllosphere and can serve as useful indicators of plant health and disease status. Their occurrence on living leaves reflects host condition, environmental suitability, and host-pathogen interactions. The present study investigated the diversity of foliicolous fungi associated with selected host plants in Songadh Taluka, Tapi District, Gujarat, India. Field surveys were conducted from November 2025 to March 2026 in forested localities including Kelai, Kavla, Nishana, Achhalva, and the Kansari-Mavli sacred groves. Infected leaf samples were collected and examined using standard macroscopic and microscopic methods. Temporary mounts were prepared in water, glycerine, and lactophenol cotton blue, and fungal structures were identified on the basis of morphological characters.

A total of 25 species belonging to 16 genera were recorded and classified into three groups: Ascomycetes, Basidiomycetes, and Hyphomycetes. Hyphomycetes were the dominant group, represented by 16 species, followed by Ascomycetes with 8 species and Basidiomycetes with 1 species. The observed fungi showed clear host association and locality-wise variation. The findings indicate that foliicolous fungi can provide useful information on plant health, fungal diversity, and host specificity in tropical forest ecosystems. This study contributes baseline data for fungal biodiversity assessment and supports the importance of phyllosphere fungi in forest health monitoring and plant disease management.

1. Introduction:

Fungi represent one of the most diverse groups of organisms and play major roles in ecosystem functioning, including decomposition, nutrient cycling, and interactions with plants (Alexopoulos et al., 1996; Manoharachary et al., 2005). Among them, foliicolous fungi form a distinctive assemblage of leaf-inhabiting microorganisms that colonize the phylloplane (leaf surface) and establish parasitic, saprophytic, commensal, or occasionally mutualistic associations with their host plants (Andrews & Harris, 2000). These fungi are important components of tropical and subtropical biodiversity and contribute significantly to plant-microbe interactions.

The diversity and distribution of foliicolous fungi are strongly influenced by environmental factors such as temperature, humidity, rainfall, and host plant availability (Kumar et al., 2019). Many species are host-specific and may be associated with visible disease symptoms such as leaf spots, blights, mildews, chlorosis, necrosis, and premature leaf fall (Agrios, 2005). Because of these associations, leaf surface fungi may serve as excellent biological indicators of plant health and forest ecosystem dynamics.

India, as a megadiverse country, provides a wide range of ecological niches suitable for fungal growth (Manoharachary et al., 2005). However, compared with macro fungi and economically important crop pathogens, foliicolous micro fungi remain inadequately documented in many wild, forested regions. Songadh Taluka of Tapi District, Gujarat, supports rich forest vegetation and favourable humid conditions, making it a promising area for the study of phyllosphere fungal diversity.

The present investigation was undertaken to document the diversity of foliicolous fungi associated with forest plants in Songadh Taluka, to examine their morphological characteristics, and to assess their relevance as indicators of plant health and disease.

2. Materials and Methods

2.1 Study Area

The study was conducted in Songadh Taluka, Tapi District, Gujarat, India. The region is characterized by tropical moist and dry deciduous forests, varied topography, rocky hills, and rich floral diversity (Champion & Seth, 1968). The influence of the Tapi River and Ukai Reservoir contributes to relatively high humidity, creating favourable conditions for the occurrence of foliicolous fungi. Sacred groves such as Kansari-Mavli further enhance host plant diversity and provide pristine, protected habitats for fungal colonization. Field surveys were carried out systematically from November 2025 to March 2026.

2.2 Field Survey and Collection of Specimens

Periodic field surveys were conducted across five distinct forested localities: Kelai, Kavla, Nishana, Achhalva, and the Kansari-Mavli sacred groves. Leaves showing visible symptoms of fungal infection, including leaf spots, blights, mildew, and structural discoloration, were collected from various forest trees and vegetation. For each specimen, details of the specific locality, host plant species, date of collection, and macroscopic symptom type were recorded. Fresh, senescent, and necrotic infected leaves bearing visible fungal colonies were isolated in separate, labelled polythene bags and brought back to the laboratory for processing.

2.3 Macroscopic and Microscopic Examination

Macroscopic examination was carried out to record colony appearance, infection patterns, and symptom expression on the leaf surface (Agrios, 2005). For microscopic study, small portions of infected structures, fruiting bodies, or fungal scrapings were mounted in water, glycerine, and lactophenol cotton blue, a standard staining agent used to visualize fungal cell structures (Ainsworth et al., 1973). Slides were comprehensively examined under stereo and compound microscopes. Morphological characters such as hyphae, conidiophores, conidia, asci, ascospores, fruiting bodies (e.g., thyriothecia, perithecia, cleistothecia), and other reproductive structures were observed and measured for taxonomic identification.

2.4 Photomicrography and Identification

Representative fungal structures were photographed using a digital camera coupled with a Labomed microscope. Fungal identification was carried out on the basis of diagnostic morphological features and extensive comparison with relevant monographs, taxonomic keys, and established mycological literature (Barnett & Hunter, 1998; Ellis, 1971; Subramanian, 1971).

3. Results and Discussion

3.1 Diversity of Foliicolous Fungi

The mycological survey resulted in the documentation of 25 species belonging to 16 genera associated with different forest host plants of Songadh Taluka, Tapi District, Gujarat. These fungi were distributed among three major taxonomic groups, namely Ascomycetes, Basidiomycetes, and Hyphomycetes.

Hyphomycetes represented the dominant group with 16 species, followed by Ascomycetes with eight species and Basidiomycetes with one species. The distribution of these fungal classes is summarized below in Table 1.

Table 1. Distribution of foliicolous fungi among major fungal groups

Class	Number of Genera	Number of Species	Percentage Contribution (%)
Ascomycetes	6	8	32.0%
Basidiomycetes	1	1	4.0%
Hyphomycetes	9	16	64.0%
Total	**16**	**25**	**100.0%**

The clear predominance of Hyphomycetes agrees with previous studies on tropical phyllosphere fungi, where conidial (asexual) fungi constitute the most resilient and abundant component of leaf surface microflora (Andrews & Harris, 2000; Hyde et al., 2020; Subramanian, 1971). Environmental factors such as humidity, microclimate rainfall patterns, and diverse host canopy architectures are known to highly influence fungal colonization success (Bhat et al., 2022; Kumar et al., 2019). Their abundance can be directly attributed to their efficient, rapid asexual reproduction mechanisms and light, easily dispersible conidia that can adapt to rapid changes on exposed leaf surfaces.

Several host plants, including Kigelia pinnata, Cassia fistula, Pongamia pinnata, Syzygium cumini, Annona reticulata, and Cocos nucifera, harboured more than one fungal species, indicating intricate host association and ecological adaptation. Similar host-specific preferences have been routinely highlighted across rich tropical forest ecosystems (Hyde et al., 2022; Tibpromma et al., 2018).

The detailed breakdown of identified species, host associations, and specific sampling locations is recorded below in Table 2.

Table 2. Recorded foliicolous fungi from Songadh Taluka, Gujarat

Group	Fungal Species	Host Plant(s)	Locality
Ascomycetes	*Asterina benghalensis*	*Annona reticulata, Holoptelea integrifolia*	Nishana
	Asterina jambolana	*Syzygium cumini*	Kavla
	Kamalia indica	*Cassia fistula*	Achhalva
	Meliola mangiferae	*Mangifera indica*	Kelai
	Cochliobolus bicolor	*Pongamia pinnata*	Nishana
	Microthelia cassiae	*Cassia fistula*	Kansari-Mavli
	Protomyces macrosporus	*Coriandrum sativum*	Kelai
	Uncinula sp.	*Azadirachta indica*	Kavla
Basidiomycetes	*Olivea tectonae*	*Tectona grandis*	Nishana
Hyphomycetes	*Alternaria alternata*	*Cassia fistula*	Kavla
	Alternaria tenuissima	*Pongamia pinnata*	Kelai
	Cercospora personata	*Arachis hypogaea*	Achhalva
	Cercospora kikuchii	*Glycine max*	Nishana
	Cladosporium cladosporioides	*Cocos nucifera*	Kansari-Mavli
	Memnoniella echinata	*Kigelia pinnata*	Nishana
	Pseudocercospora sp.	*Syzygium cumini*	Kavla
	Stachybotrys atra	*Cassia fistula*	Achhalva
	Sporidesmium sp.	*Pongamia pinnata*	Kelai
	Sirosporium sp.	*Holoptelea integrifolia*	Nishana
	Tripospermum sp.	*Kigelia pinnata*	Kavla

3.2 Locality-wise Distribution

Among the surveyed localities, Nishana exhibited the highest overall fungal diversity, followed sequentially by Kavla and Achhalva (Table 3). The sacred grove of Kansari-Mavli, while yielding fewer overall species counts, supported unique host-specific fungi. This underscores the crucial ecological role that sacred groves play as undisturbed micro-refugia for maintaining indigenous microbial and plant genetic diversity (Bills & Polishook, 1994).

Table 3. Locality-wise occurrence of foliicolous fungi

Locality	**Number of Species**	**Key Ecological Characteristic**
Nishana	10	High canopy density, proximity to moisture
Kavla	6	Moderately disturbed mixed forest
Achhalva	4	Rocky terrain, dry deciduous pockets
Kelai	3	Forest fringe, agricultural interfaces
Kansari-Mavli Sacred Grove	2	Undisturbed habitat, highly specialized hosts
Total	**25**	

3.3 Morphological Characteristics

Microscopic examination revealed a wide range of specialized vegetative and reproductive structures including thyriothecia, asci, ascospores, conidiophores, conidia, chlamydospores, and urediniospores. Hyphomycetes exhibited the most striking variation in conidial morphology, septation (cell-wall divisions), and pigmentation, which served as foundational taxonomic traits (Barnett & Hunter, 1998; Ellis, 1971, 1976).

Diagnostic Insights:

The occurrence of these fungi on symptomatic leaves indicates their utility as primary biological indicators of early disease development and host plant stress. Modern phytopathology heavily emphasizes the importance of tracking phyllosphere balance to map overall ecosystem health trends (Bhat et al., 2022; Hyde et al., 2020; Wanasinghe et al., 2020).

The key morphological characters that enabled the precise identification and taxonomic delineation (Chethana et al., 2021) of these species are detailed comprehensively below in Table 4.

Table 4. Morphological characteristics of representative foliicolous fungi

Fungal Species	Group	Important Morphological Characters	Reproductive Structures Observed	Host Plant(s)
Asterina benghalensis	Ascomycetes	Superficial dark mycelium with circular thyriothecia	Asci and bicelled ascospores	*Annona reticulata*, *Holoptelea integrifolia*
Asterina jambolana	Ascomycetes	Black colonies with shield-shaped thyriothecia	Asci and septate ascospores	*Syzygium cumini*
Kamalia indica	Ascomycetes	Brown mycelium with immersed fruiting bodies	Asci and ascospores	*Cassia fistula*
Meliola mangiferae	Ascomycetes	Dark superficial hyphae with rigid setae	Perithecia and ascospores	*Mangifera indica*
Cochliobolus bicolor	Ascomycetes	Septate hyphae with dark pseudothecia	Asci and multiseptate ascospores	*Pongamia pinnata*
Protomyces macrosporus	Ascomycetes	Thick-walled, highly spherical systemic spores	Chlamydospores	*Coriandrum sativum*
Uncinula sp.	Ascomycetes	White powdery, superficial mycelial colonies	Cleistothecia and ascospores	*Azadirachta indica*
Olivea tectonae	Basidiomycetes	Bright orange/rust-like pustules on lower leaf surface	Urediniospores	*Tectona grandis*
Alternaria alternata	Hyphomycetes	Dark brown septate hyphae; branched conidiophores	Muriform (hand-grenade shaped) conidia	*Cassia fistula*

Alternaria tenuissima	Hyphomycetes	Simple conidiophores bearing long chains of conidia	Beaked, multicelled tapering conidia	*Pongamia pinnata*
Cercospora personata	Hyphomycetes	Fasciculate (clustered) dark conidiophores	Long, needle-like hyaline conidia	*Arachis hypogaea*
Cercospora kikuchii	Hyphomycetes	Dense brown stromata with clustered conidiophores	Elongated, multi-septate cylindrical conidia	*Glycine max*
Cladosporium cladosporioides	Hyphomycetes	Olive-green, velvety colonies with branched systems	Fragile chains of lemon-shaped conidia	*Cocos nucifera*
Memnoniella echinata	Hyphomycetes	Erect dark conidiophores with distinct apical phialides	Globose, roughly ornamented conidia	*Kigelia pinnata*
Pseudocercospora sp.	Hyphomycetes	Pigmented conidiophores emerging directly through stomata	Pale brown, smooth septate conidia	*Syzygium cumini*
Stachybotrys atra	Hyphomycetes	Dark, aggregated branched conidiophores	One-celled, dark, slimy oval conidia	*Cassia fistula*
Sporidesmium sp.	Hyphomycetes	Thick, erect conidiophores with dark pigmented spores	Solitary, multiseptated long conidia	*Pongamia pinnata*
Sirosporium sp.	Hyphomycetes	Simple conidiophores with elongated, dark spores	Verrucose, multi-septate conidia	*Holoptelea integrifolia*
Tripospermum sp.	Hyphomycetes	Distinctive stauroconidia architecture	Characteristic star-shaped, branched conidia	*Kigelia pinnata*

4. Conclusion

The present study maps the baseline diversity of foliicolous fungi associated with forest plants in Songadh Taluka, Tapi District, Gujarat, demonstrating their prospective significance as early-warning indicators of plant health. A total of 25 species spanning 16 genera were confirmed, with Hyphomycetes dominating the landscape at 64% of total species output. The distinct distribution patterns across host plants and individual forest localities suggest that host specificity, relative humidity gradients, and regional forest canopy structures play highly influential roles in fungal distribution.

Morphological and microscopic protocols proved reliable for accurate, field-level taxonomic documentation. These baseline results establish solid groundwork for future research regarding mycological taxonomy, forest microbial ecology, and targeted plant disease conservation management in South Gujarat. Future studies integrating advanced high-throughput molecular tools will further accelerate species confirmation and resolve complex phylogenetic boundaries among these essential micro fungi.

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