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Research Article

Seasonal Dynamics and Diversity of Indoor Airborne Fungal Spores in Dharashiv (MS) India

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Abstract

Indoor air quality is significantly influenced by airborne fungal spores, which are linked to respiratory ailments and allergies. This study analyzes the monthly frequency and seasonal distribution of fungal spores at Site-A, Dharashiv, Maharashtra, from January to December 2017. Using a Volumetric Tilak Air Sampler, 10,275 spores representing 33 taxa were recorded. Peak concentrations occurred during the monsoon (September: 1,673), while the lowest levels were in summer (May: 207). Dominant taxa included *Cladosporium* (19.56%), *Curvularia* (9.86%), and *Alternaria* (7.52%). The findings emphasize the impact of tropical seasonality on indoor mycospora and the need for improved indoor air management in semi-urban Indian settings.

INTRODUCTION

Airborne fungal spores are among the most significant biological pollutants present in both outdoor and indoor environments. These spores form a major fraction of bioaerosols, which include pollen, bacteria, viruses, fungal fragments, and other biological particulates. Indoor exposure to fungal spores is of particular importance because humans spend nearly 80–90% of their time indoors, making indoor air quality a critical determinant of respiratory and overall health (Jones & Harrison, 2023).

Fungi reproduce primarily through spores, which are dispersed through air currents and may enter indoor spaces via ventilation, open windows, human activity, and contaminated materials. Once indoors, spores can persist, germinate under favorable humidity, and contribute to fungal colonization on walls, furniture, stored grains, and organic substrates. In tropical and subtropical regions like Maharashtra, climatic conditions such as monsoon rainfall, high humidity, and moderate temperatures enhance fungal growth and spore liberation (Patil et al., 2024).

Aeromycological studies have consistently demonstrated that fungal spore concentrations show strong seasonal variation, often peaking during wet months and declining during dry summer periods. Several fungal genera such as *Cladosporium*, *Alternaria*, *Aspergillus*, and *Curvularia* are frequently dominant in indoor air and are known allergens (Singh & Mehta, 2022). Exposure to these spores can trigger allergic rhinitis, bronchial asthma, hypersensitivity pneumonitis, and in immunocompromised individuals, opportunistic fungal infections.

Despite increasing awareness, systematic indoor fungal spore monitoring remains limited in many semi-urban Indian districts such as Dharashiv. Most aerobiological research in India has focused on metropolitan centers, leaving smaller districts underrepresented. Dharashiv, characterized by agricultural surroundings, seasonal monsoon cycles, and variable indoor ventilation practices, provides an ecologically relevant setting for studying indoor fungal spore dynamics.

MATERIALS AND METHODS

In the present investigation was carried out with the help of volumetric Tilak air sampler (Tilak and Kulkarni, 1970).

Sampling Methods :

Sampling was carried out by operating continuously the Tilak air sampler, with its orifice kept at constant height of 1.5-2 meters above ground level. Air was sampled at the rate of 5 liters/ min. and the transparent cello tape coated with adhesive petroleum jelly was changed every eight days at about 5.00 p.m. The exposed tape was cut into eight equal parts each parts representing 24 hrs. trace area. These 8 parts of tape were again cut into two parts, each representing 12 hrs. trace area of day and night accordingly. The tape pieces were mounted on slides, using glycerine jelly as a mountant.

Scanning :

Scanning was done regularly Scanned under 10 x 45 eye pieces objectives combination of the microscope. The identification of the trapped Spores was based on:

a) Morphological characters

b) Visual identification by comparison with reference slides.

Site: Indoors spores were trapped using a Volumetric Tilak Air Sampler from 1 January 2017 to 31 December 2017 at Dharashiv (Osmanabad) a district of Maharashtra State, India. Osmanabad is located at 76^{O}4'25" E longitude and 18^{O}19'10" latitude and situated at 652 meters above sea level.

RESULTS

The results clearly demonstrate that indoor fungal spore concentrations in Dharashiv are strongly seasonal, with maximum abundance during monsoon and post-monsoon months. This aligns with Rao et al. (2022), who reported rainfall-driven sporulation surges in tropical aeromycological environments.

Monsoon Influence Humidity and rainfall enhance fungal growth on vegetation, soil, and organic matter, increasing airborne release. The sharp rise from June onwards suggests strong coupling between outdoor fungal productivity and indoor infiltration.

Dominance of *Cladosporium* - *Cladosporium* dominance is consistent with global indoor surveys (Wilson et al., 2023). Its ubiquity reflects adaptability to diverse substrates and efficient airborne dispersal. Its allergenic significance makes it a key indoor health concern.

Agricultural Context - Rust, smut, and *Helminthosporium* spores indicate agricultural influence. Dharashiv's agrarian surroundings likely contribute spores through crop cycles, especially during harvest seasons.

Public Health Implications High indoor loads of *Alternaria*, *Curvularia*, and *Aspergillus* raise potential allergy and infection risks. Preventive strategies include ventilation control, dampness reduction, and seasonal monitoring.

Table A- Monthly frequency of various aerial Fungal Spores of Site -A indoor atmosphere trapped in Volumetric Tilak Air Sampler from 1 January 2017 to 31st December 2017.

Sr. No.	Fungal Spores	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Volumetric Total Spore Concentration Per m^3	Percentage Contribution to the Total Air Mycospora
1	*Cunninghamella*	6	7	-	-	-	-	8	14	10	8	6	7	76	1064	0.74
2	*Rhizopus*	8	8	2	-	-	10	23	30	41	10	12	11	155	2170	1.51
3	*Bitrimonospora*	1	1	-	-	-	-	10	27	39	32	23	25	158	2212	1.54
4	*Chaetomium*	5	7	10	2	1	2	30	46	49	40	8	9	209	2926	2.03
5	*Claviceps*	2	-	-	-	-	-	-	56	68	36	24	4	190	2660	1.85
6	*Didymosphaeria*	8	8	6	4	-	2	38	112	104	32	8	6	328	4592	3.19
7	*Hypoxylon*	6	4	2	2	-	2	7	12	8	6	4	4	57	798	0.55
8	*Leptosphaeria*	-	-	-	-	-	6	30	55	50	12	18	-	171	2394	1.66
9	*Pleospora*	-	-	-	-	-	-	36	70	63	31	4	2	206	2884	2.00
10	*Sordaria*	1	-	-	-	-	10	43	46	48	38	12	2	200	2800	1.95
11	*Sporormia*	-	-	-	-	-	-	-	5	17	21	6	2	51	714	0.50
12	*Basidiospores*	26	18	12	12	-	14	110	166	146	40	22	18	584	8176	5.68
13	Rust spores	16	18	20	16	08	10	12	25	43	53	49	51	321	4494	3.12
14	Smut spores	26	28	28	24	12	8	8	43	46	56	54	54	387	5418	3.77
15	*Alternaria*	10	11	11	32	30	31	40	58	67	64	60	57	773	10822	7.52

		8	4	2												
16	*Aspergillus*	11	9	5	2	2	37	46	44	50	45	20	24	295	4130	2.87
17	*Bispora*	12	8	8	7	6	12	22	30	46	32	22	21	226	3164	2.21
18	*Cercospora*	7	4	-	-	-	8	11	13	13	8	8	8	80	1120	0.78
19	*Cladosporium*	146	144	132	96	62	137	204	254	248	213	197	177	2010	28140	19.56
20	*Curvularia*	90	70	38	34	28	91	112	131	124	116	91	88	1013	14182	9.86
21	*Diplodia*	1	1	1	-	-	2	4	8	4	2	-	-	23	322	0.22
22	*Fusarium*	-	-	-	-	-	6	14	24	26	18	8	10	106	1484	1.03
23	*Helminthosporium*	30	27	18	15	12	36	54	60	57	83	37	33	462	6468	4.50
24	*Heterosporium*	10	8	8	-	-	12	24	30	28	22	16	12	170	2380	1.65
25	*Nigropora*	45	36	27	36	18	27	24	27	60	56	36	39	431	6034	4.19
26	*Papularis*	18	15	10	24	4	9	15	12	12	10	9	6	144	2016	1.40
27	*Penicillium*	-	-	-	-	-	6	10	12	24	10	8	-	70	980	0.68
28	*Periconia*	72	80	75	45	12	6	10	20	20	40	46	51	477	6678	4.64
29	*Pithomyces*	9	15	6	6	2	34	46	50	62	31	28	10	299	4186	2.91
30	*Tetraploa*	-	-	-	-	-	-	16	16	14	13	-	12	71	994	0.69
31	*Torula*	30	16	-	-	-	-	-	-	14	21	45	36	162	2268	1.58
32	*Trichoconis*	2	-	-	-	-	-	12	14	32	23	10	12	105	1470	1.02
33	Unidentified	30	18	12	10	10	12	14	36	40	34	28	21	265	3710	2.58
	Total Fungal Spores	726	664	532	367	207	530	1043	1546	1673	1256	919	812	10275	143850	99.99

Fig. 1 line chart shows the **seasonal trend** in total indoor fungal spores.

a. Lowest spore load: **May (207 spores)**.
b. Rapid rise during monsoon
c. Peak spore concentration: **September (1673 spores)**

Monsoon and post-monsoon months clearly dominate fungal abundance.

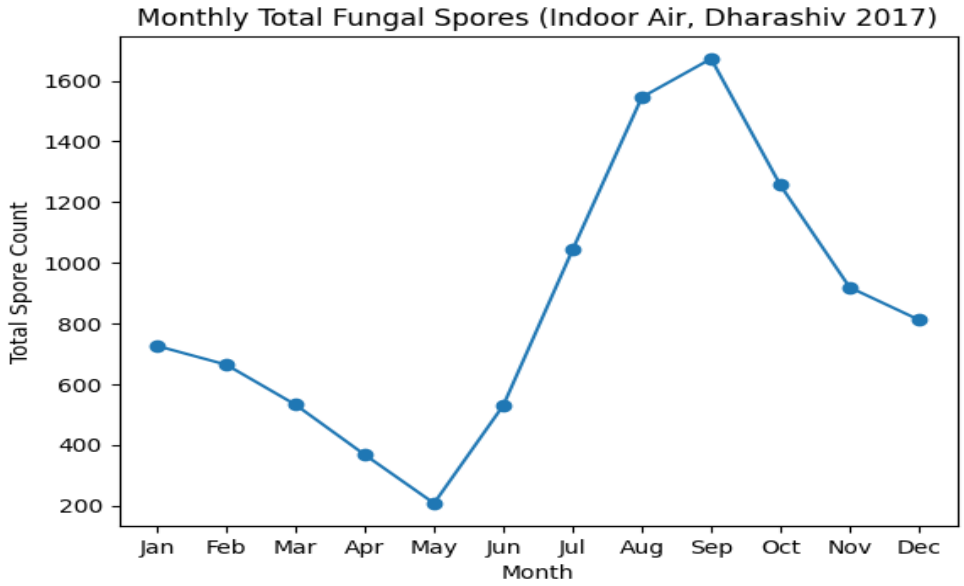

Figure 1: Monthly Total Fungal Spores (Indoor Air, Dharashiv 2017)

This pie chart highlights
the major fungal contributors:
Cladosporium(largest share), ***Curvularia, Alternaria, Basidiospores***and***Smut spores***
These taxa represent the most significant indoor airborne allergens and ecological spores.

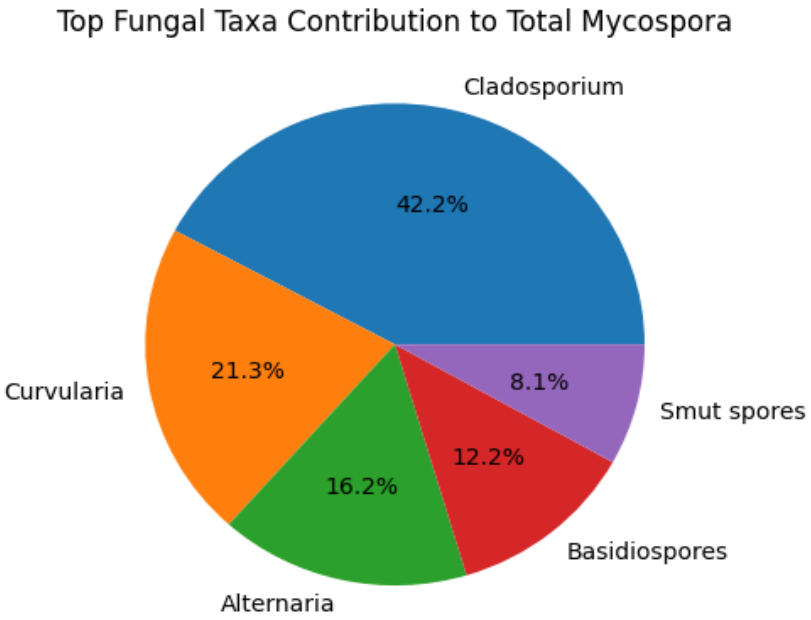

Figure 2: Top Fungal Taxa Contribution (%)

Conclusion

This empirical dataset analysis provides a comprehensive overview of indoor airborne fungal spore diversity and seasonal dynamics in Dharashiv during 2017. A total of **10,275 spores** across 33 taxa were recorded, with monsoon months contributing the highest spore loads. September represented the annual peak, while May showed minimal fungal presence.

The fungal community was dominated by *Cladosporium* (19.56%), followed by *Curvularia* (9.86%) and *Alternaria* (7.52%). These genera are globally recognized allergens, indicating potential respiratory health risks for indoor occupants.

The study highlights the strong role of climatic seasonality and agricultural surroundings in shaping indoor fungal bioaerosols. Findings emphasize the importance of routine aeromycological surveillance, improved indoor dampness management, and awareness of seasonal allergen exposure.

Overall, this work contributes valuable district-level evidence to the broader understanding of indoor air mycospora in India and provides a foundation for future environmental health and epidemiological research.

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