International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Preliminary Study on Distribution and Diversity of Microfungi in Brick Kiln Soils

Deepa Rekha AP[1], Shrikanth SK[2], Vinitha E[3], Girivasan KP[4]

[1,3,4]Government Arts College (Autonomous), Nandanam, (Affiliated to University of Madras), Chennai, India
[2]DST-TEC, Bundelkhand University, Jhansi/New Delhi, India

ABSTRACT
The impact of anthropogenic industrial activities, specifically brick kiln operations, on soil microbial health remains a critical area of environmental research. This study document the microfungal community in brick kiln soils at Alambadi village, Tamil Nadu. In addition, to have a comparative analysis soils from undisturbed site (Normal soil) was also screened for the presence of fungi. The soil dilution plating method, was adopted to isolate the fungi. A total of 20 fungal species belonging to 13 genera were identified. As a genera *Aspergilli* represented more number of species indicating the adaptability of this genus to inimical environment. Results revealed a significant reduction in fungal population in brick kiln-affected soils compared to normal soils(undisturbed). A decline in fungal propagule was observed in both the sites as soil depth increased. However, the species diversity remained relatively stable, suggesting that a specialized fungal community persists despite industrial stress. These findings highlight the resilience of certain microfungi to thermal and chemical stressors associated with brick manufacturing and underscore the influence of anthropogenic activity.

Keywords: Aspergillus, Brick kiln, Microfungi, Anthropogenic factors, species diversity.

INTRODUCTION
Fungi constitute a primary functional component of soil ecosystems and contributes multifunctional perspective to the soil ecosystem, especially drives essential processes such as nutrient cycling, decomposition, and maintaining soil structure(Xu *et al.,* 2025) .Recent estimates suggested approximately 2.2 and 3.8 million fungal species, of which only a fraction is formally described (Hawksworth and Lücking, 2017; Wijayawardene *et al*., 2022). Soil acts as a heterogeneous reservoir for these organisms, where their distribution is governed by nutrient availability, moisture, and pH (Baldrian *et al.,* 2023).
Brick kiln industries cause major source of localized soil degradation and air pollution(Biswas *et al.,* 2018). The manufacturing process involves intensive topsoil excavation and high-temperature due to firing, which releases a cocktail of pollutants including carbon oxides (CO_x), sulphur dioxide (SO_2), and various heavy metals (Skinder *et al.,* 2014). These stressors induce significant alterations in soil physicochemical properties, leading to a "biological desertification" effect where microbial biomass and enzymatic activities are severely curtailed (Chowdhury and Rasid, 2021).
Despite extensive documentation of soil fungi in natural ecosystems, comparative data on the resilience of mycoflora in industrially stressed environments like brick kilns remain sparse. The study aims to

document the microfungal population and assess the impact of depth on fungal community assemblages in the undisturbed soil (Normal) and Brick kiln soils.

MATERIALS AND METHODS

Study Area and Method of sampling

Soil samples were collected from Alambadi village (12.0049° N, 79.2957° E), Villupuram District, Tamil Nadu, India. Brick kiln operation site and undisturbed site – Normal site (approximately 100 m away from Brick kiln) were chosen for the study. For each site (Brick kiln and Normal), soil samples from approximately 1 cm below the ground surface and 10 cm depth were collected randomly from 5 regions. From each region approximately 200 gm of soil was collected. The 1 kg of soil thus collected were mixed thoroughly and brought to the laboratory in a sterile polythene bag. The samples were processed within 24 hours of collection. Samples collected were labelled separately as normal soil (undisturbed area) and Brick kiln area at two depths: 1 cm (surface) represent as Normal soil Ground Level (NSGL) and Brick Kiln Soil Ground Level (BSGL) and 10 cm (sub-surface) represent as Normal Soil Below Level (NSBL) and Brick Kiln Soil Below Level (BSBL). Samples were labelled separately, homogenized, and stored at 4°C in sterile polythene bags until processing.

Method of isolation of fungi

Soil dilution plating method (Garrett, 1963) was adopted to isolate the micro fungi from the soil samples. In this method one gram of the soil sample was dispersed thoroughly in 10ml of sterile distilled water. From this sample solution 1 ml was transferred into a sterile Petri plates containing antibiotic amended Potato Dextrose Agar medium(PDA). Six replicates were maintained and the data obtained in this method was used for ecological analysis.

Culture medium and Incubation

Medium(PDA) and glassware other than petri dishes were sterilized in an autoclave at a pressure of 103 kPa for 20 min. Petri dishes were sterilized in hot air oven at 160^0C for 3 h.

The Petri dishes were incubated in light chamber where the light regimen was 12 h light followed by 12 h darkness. The light chamber had a bank of three 4 foot Philips day light fluorescent lamps.

Identification and maintenance of cultures

The fungi, thus isolated were identified using standard identification manuals (Raper and Fennell, 1965; Gilman,1967; Ellis,1971; Barnett and Hunter,1972; Ellis and Ellis,1988). The fungi which did not sporulate were included as sterile forms based on the morphology of the colony (colour, margin, texture etc.,).

Ecological analysis of data and statistical analysis

Ecological parameters were used for determining the fungal population of the soil sample. Number of propagules, Percentage frequency and Abundance were calculated by adopting the following formula (Girivasan *et al*., 1998)

1. Number of propagules/gm of soil

$$= \frac{\text{Average no. of colonies/plate}}{\text{Weight of the soil}} \times \text{dilution factor}$$

2. Percentage frequency

$$= \frac{\text{Total no. of plates in which the species occurs}}{\text{Total no. of plates}} \times 100$$

For calculating species diversity and to compare the fungal assemblage of soil samples correspondence analysis was computed using the following software
Biodiversity Pro (The Natural History Museum and The Scottish association for Marine Science) freeware application.

RESULTS AND DISCUSSION

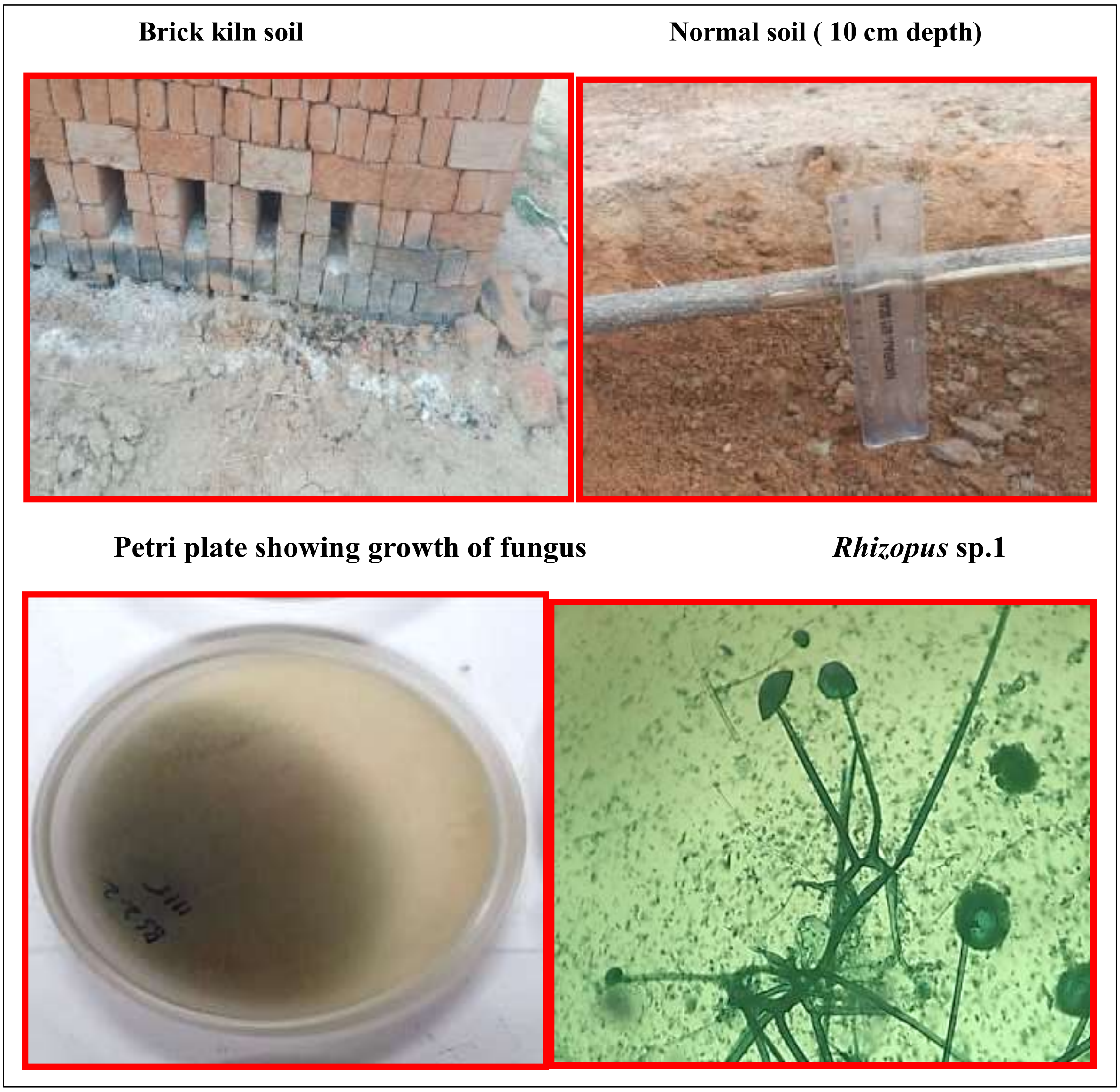
A study was conducted to document and understand the diversity of microfungi in Brick kiln soil and undisturbed site (Normal soil). Fungi were recovered from all the soil samples studied (Table 1 and Plate 1). Fungi are successful eukaryotic organisms reported from various harsh environments. These include solar saltern, hot springs, deserts, saline water, ocean depth and low pH environments (Hassan *et al.,* 2016).A total of 20 fungal species belonging to 13 genera were isolated during the study (Table 1 Plate 1)). Fungal species like *Aspergillus niger, Aspergillus terreus, Curvularia lunata* were recovered from all the soil samples. Similar studies on soil mycoflora and stressful environment also reported the presence of similar fungal species (Suryanarayanan and Hawksworth, 2010 ;Rani and Kalaiselvam,2016). *Aspergillus* represented more number of species (Table 1). According to the World Data Center of Microorganisms (WDCM), there are approximately 378 *Aspergillus* species(El-Hawary et al.,2020). *Aspergillus* have been recorded from various stressful environments like corals(Kendrick *et al.,* 1982) Solar saltern (Suryanarayanan et al., 1996) and peat soil(Girivasan *et al.,* 1998) dead sea(Buchalo *et al.,* 2000) Desert soil(Christensen and Tuthill, 1985) Marine sponges(Thirunavukkarasu et al., 2012) sea grasses(Venkatachalm, *et al*.,2015) Endophytes in many host plants growing in sea weeds(Govindarajulu *et al.,* 2022)Polar regions(Arenz *et al.,* 2014) .The survival of Aspergilli in different environments are related to metabolic diversity, high reproductive capacity and competitive capabilities of the species(Shehu and Bello, 2011; Mehl and Cotty,2013). This indicates the wide ecological amplitude and adaptations in these fungi. The percentage frequency of most of the fungal species recorded in Normal soils declined in the Brick kiln soils. *Aspergillus fumigatus* a thermotolerant species could be isolated from the Brick kiln soil samples. Studies on different substrates including soils exposed to high temperature recorded *Aspergillus fumigatus* as one of the successful thermotolerant species (Korfanty *et al.,*2023; Sharma,2025). A pronounced attenuation in fungal propagule density was observed within the brick kiln-affected surface soils (BSGL) relative to the undisturbed controls (NSGL). *A. fumigatus* possesses a distinct competitive advantage, flourishing in high-temperature niches where traditional mesophilic fungi face physiological exclusion . The percentage frequency of most of the fungal species decreased with increasing soil depth(Fig 1 to 4). Correspondence analysis revealed the presence of different fungal assemblage in the soil samples surveyed (Fig. 5). Number of fungal propagules decreased with increasing soil depth in both the type of soils(Fig. 6). Similar studies on soil fungi with increasing depth also reported a decline in number of fungal propagules and species diversity as the depth increased (Jumpponen *et al.,*.2010;Schlatter *et al.,*2018). In our study, species diversity was found consistent in all the samples studied (Fig. 6). The survival and continued metabolic activity of these fungal assemblages under extreme thermal and chemical stressors point toward advanced physiological adaptations. These isolates, particularly those retrieved from the deeper kiln horizons, represent a nascent reservoir of extremophilic

traits. Their ability to maintain biological integrity under industrial-scale heat regimes identifies them as prime candidates for bioprospecting initiatives focused on the discovery of novel, thermostable biocatalysts and enzymes, which are in high demand for diverse industrial applications ranging from biofuel production to bioremediation (Maheswari *et al.,*2000; Le *et al.,* 2024).
Thus this study throw some light on the distribution of microfungi in Brick kiln soils. Further studies are required to reveal the adaptability and potential applications of these microfungi in Industrial , Pharmaceutical and other potential sectors.

CONCLUSION

This study reports the presence of microfungi in soils collected from Brick kiln operated site. *Aspergillus* represented more number of species in the soil samples. Thus, attesting the ubiquity and adaptability of this genus to harsh environment. The genus *Aspergillus* emerged as a hallmark of this industrial resilience, exhibiting remarkable ecological plasticity. These findings provide a compelling foundation for exploring the physiological adaptations of these stress-tolerant isolates, specifically regarding their potential as bioprospecting candidates for high-value thermostable enzymes.

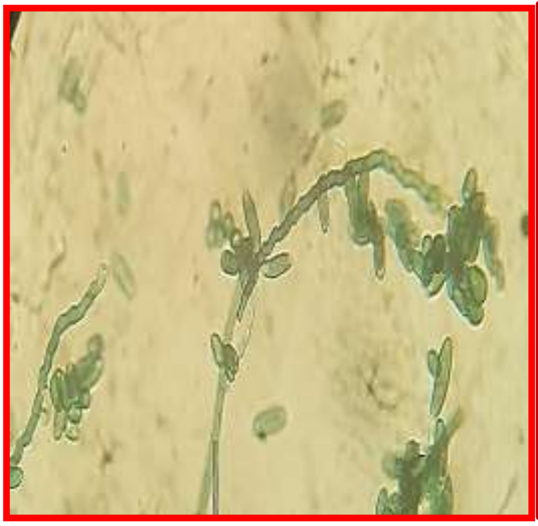
Plate 1



International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

***Dreschlera* sp.1**



Aspergillus terreus

Table 1 Comparison of microfungi from Normal and Brick kiln soil

S.No.	Fungus	NSGL	NSBL	BSGL	BSBL
1	*Acremonium* sp.1	-	+	-	+
2	*Absidia* sp.1	+	-	-	-
3	*Aspergillus candidus*	+	-	-	-
4	*Aspergillus flavus*	+	-	+	+
5	*Aspergillus fumigatus*	-	-	+	+
6	*Aspergillus niger*	+	+	+	+
7	*Aspergillus terreus*	+	+	+	+
8	*Aspergillus* sp.1	+	-	+	+
9	*Aspergillus ochraceus*	-	+	-	-
10	*Chaetomium* sp.1	+	-	-	-
11	*Cladosporium* sp.1	-	-	+	-
12	*Curvularia lunata*	+	+	+	+
13	*Drechslera* sp.1	-	-	+	-
14	*Penicillium* sp.1	+	+	-	+
15	*Penicillium* sp.2	-	+	-	-
16	*Rhizopus* sp.1	-	-	+	-
17	Sterile form 1	+	-	-	-
18	Sterile form 2	+	-	-	-
19	Sterile form 3	-	+	-	-
20	Sterile form 4	-	-	+	-

Fig. 1 Percentage Frequency of fungal species isolated from Normal soil (Ground level) NSGL

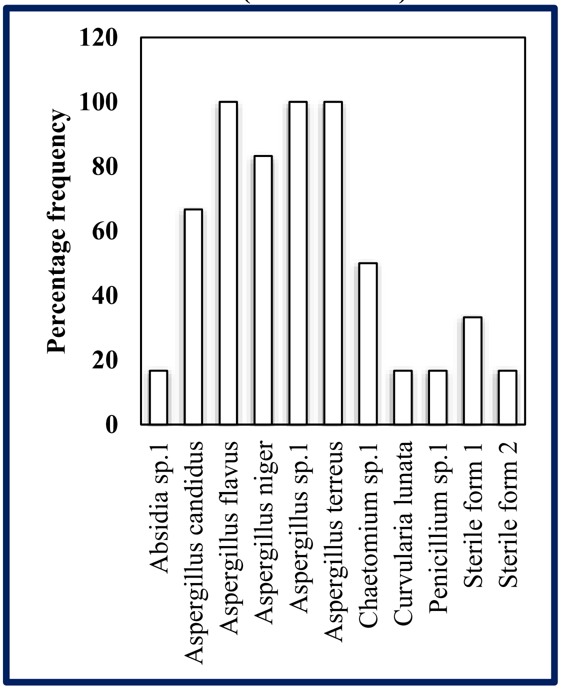


Fig. 2 Percentage Frequency of fungal species isolated from Brick kiln soil - Ground level (BSGL)

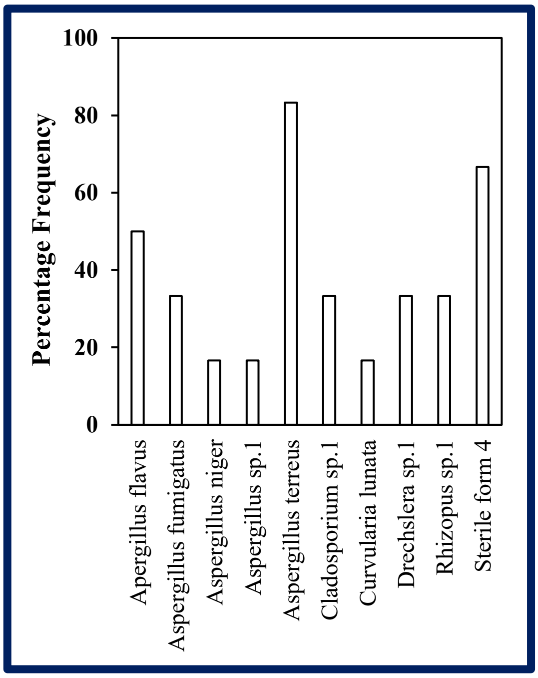


Fig. 3 Percentage Frequency of fungal species isolated from Normal soil - (10 cm Depth) NSGL

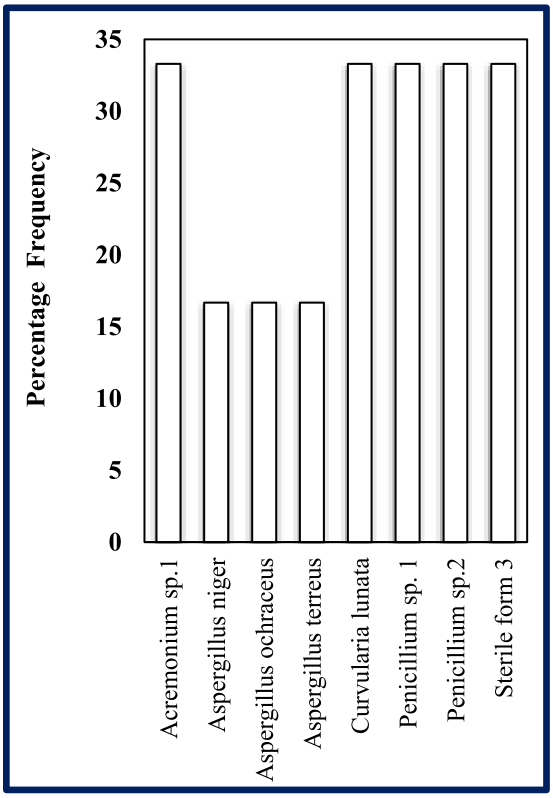


Fig. 4 Percentage Frequency of fungal species isolated from Brick kiln soil (10 cm Depth) BSBL

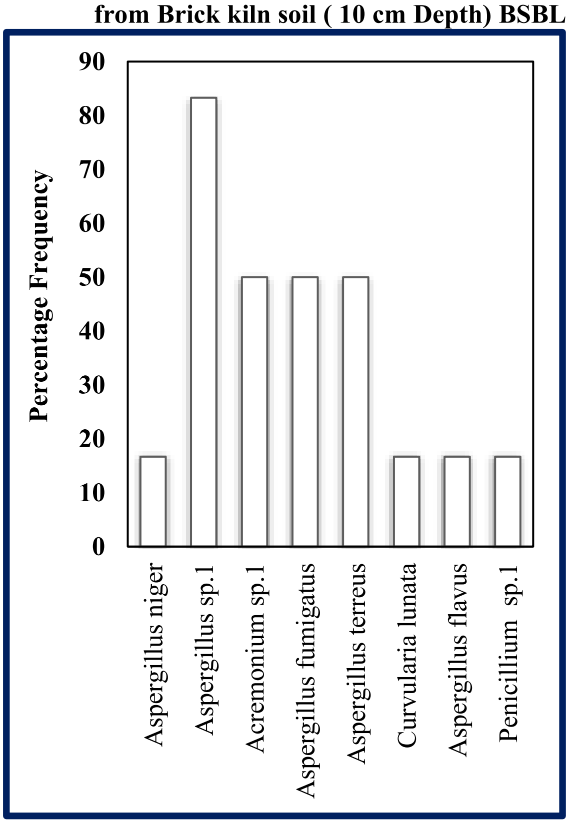
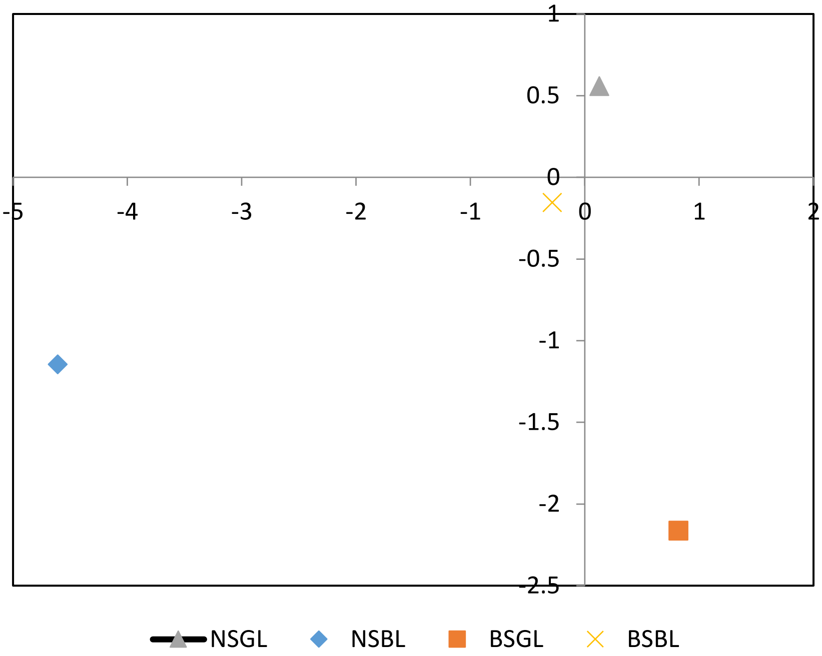
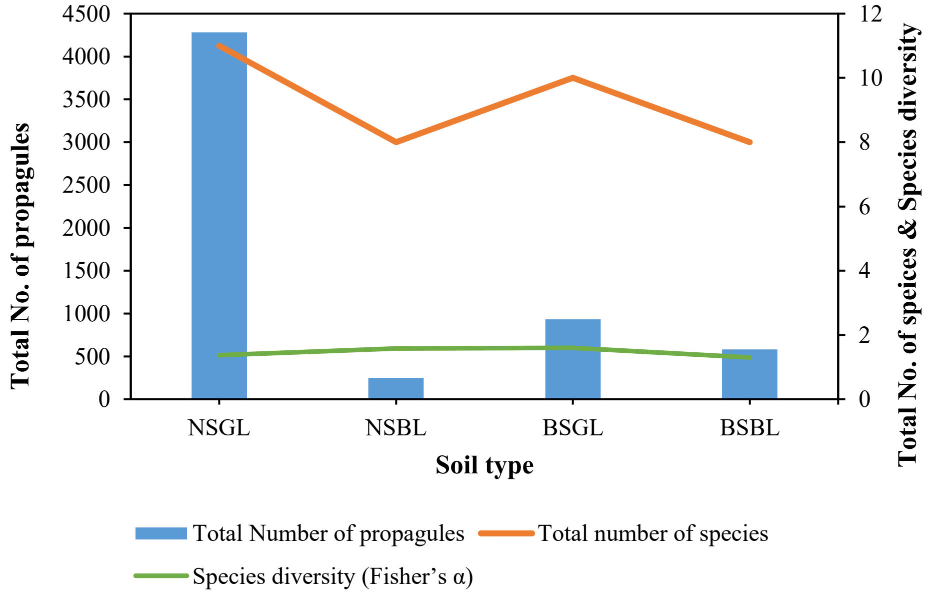


Fig. 5 Correspondence analysis of fungal assemblage in different soil samples.



NSGL = Normal soil(Ground level) NSBL (Normal soil -10cm depth)
BSGL = Brick kiln soil(Ground level) BSBL(Brick kiln soil – 10 cm depth)

Fig. 6 Comparison of Total number of fungal propagules, Number of species and Species diversity



NSGL = Normal soil(Ground level) NSBL (Normal soil -10cm depth)
BSGL = Brick kiln soil(Ground level) BSBL(Brick kiln soil – 10 cm depth)

References

3. Arenz, B., Blanchette, R. and Farrell, R.L. 2014. Fungal Diversity in Antarctic Soils. In book: *Antarctic Terrestrial Microbiology* (Eds.D.A.Crown) pp.35-53, Springer Verlag Berlin Heidelberg.

4. Baldrian, P., López-Mondéjar, R. and Kohout, P. 2023. Forest microbiome and global change. *Nature Review Microbiology,* **21**, 487–501.
5. Barnett, H.L. and Hunter, B.B. 1972. *Illustrated genera of imperfect fungi*. Burgess Publishing Company, Minneapolis, Minnesota, U.S.A.
6. Biswas, D., Gurley, E.S., Rutherford, S., Luby, S.P., 2018. The drivers and impacts of selling soil for brick making in Bangladesh. Environmental Management **62**(4), 792–802.
7. Buchalo, A. S.,Nevo,E.,Wasser, S.P., Molitoris, H.P., Oren, A. and Volz, P.A. 2000. Fungi discovered in the dead sea. *Mycological Research,* **104**,132-133.
8. Chowdhury,N and Rasid,M.M. 2021. Evaluation of brick kiln operation impact on soil microbial biomass and enzyme activity. *Soil Science Annual* **72**(1) 1-16.
9. Christensen, M. and Tuthill,D.E.1985. *Aspergillus an overview*. In R.A. Samsonand Pitt J.I.(eds.), Advances in *Penicillium* and *Aspergillus* systematics pp.195- 209.Plenum, New York.
10. El-Hawary, S. S. and Moawad, A. S. and Bahr, H. S. and Abdelmohsen, U.R and Mohammed, R. 2020. Natural product diversity from the endophytic fungi of the genus *Aspergillus*, *Royal Society of Chemistry Advances.* **10**(37):22058–22079
11. Ellis,M.B. and Ellis,J.P. 1988. *Microfungi on Miscellaneous Substrates*. An identification Handbook, Crom Helm.Londan and Sydney, Timber Press Portland Oregan.
12. Ellis,M.B.1971. *Dematiaceous Hyphomycetes*. CMI,Kew,Surrey, England.
13. Garrett,S.D.1963.Soil fungi and soil fertility.Pergamon Press,Oxford,London, 71-90.
14. Gilman,J.C.1967.*A manual of soil fungi*.Oxford and IBH Publishing Co., Calcutta,.
15. Girivasan,K.P., Rajagopal,K.,Muruganandam,V. and Suryanarayanan,T.S. 1998. Isolation of fungi from tropical peat of Southern Indian. *Current Science*,**74**:359-360.
16. Govindarajulu ,M.B., Rajamani,T. Murali,T.S., Suryanarayanan, T.S.and Minj, D.. 2022. The fungal endobiome of seaweeds of the Andaman Islands, India. *Current Science*. **123**. 1508-1514.
17. Hassan N,Rafiq M ,Hayat M, Shah, A.A., Hasan F. 2016. Psychrophilic and psychrotropic fungi: a comprehensive review. Reviews in Environmental Science and Biotechnology, **15**: 147-172.
18. Hawksworth, D.L. and Lücking, R .2017. Fungal diversity revisited: 2.2 to 3.8 million species. *Microbiol Spectrum* **5**(4): 1–17.
19. Jumpponen,A, John,K,I and Blair,J 2010. Vertical distribution of fungal communities in tallgrass praire soil, *Mycologia*,**102**(5) 1027-1041
20. Kendrick,B.,Risk,M.J.,Michaelides,J. and Bergman,K.1982. Amphibious microborers: Bioeroding fungi isolated from live corals. *Bulletin of Marine Science*, **32**:862-867
21. Korfanty G, Heifetz, E. and Xu, J .2023. Assessing thermal adaptation of a global sample of *Aspergillus fumigatus*: Implications for climate change effects. *Frontiers in Public Health*. 11:1059238.

22. Le Y, Zhang M, Wu P, Wang H, Ni J. 2024.Biofuel production from lignocellulose via thermophile-based consolidated bioprocessing. *Engineering Microbiology*. 10;4(4):100174. doi: 10.1016.
23. Maheshwari, R., Bharadwaj, G and Bhat, M.K. 2000. Thermophilic fungi: their physiology and enzymes. *Microbiol Mol Biol Rev*. **64**(3):461-88.
24. Mehl,,H,.L. and Cotty,P.J. 2013. Influence of Plant host species on intraspecifgic competition during infection by *Aspergillus flavus*. Plant pathology 62, 1310-1318.

25. Raper,K.B. and Fennell,,D.I. 1965.*The genus Aspergillus*.Williams and Wilkins, Baltimore.
26. Rani M.H.S., Kalaiselvam, M., 2018. Diversity of halophilic mycoflora habitat in saltpans of Tuticorin and Marakkanam along southeast coast of India. *International Journal of Microbiology and Mycology* ,**7**(1) 1-17.
27. Schlatter, D.C., Kahl,K., Carlson,B. Huggins,D.R. and Paulitz,T. 2018. Fungal community composition and diversity vary with soil depth and landscape position in a no-till wheat-based cropping system FEMS Microbiology Ecology **94**(7).
28. Sharma, J 2025.*Aspergillus fumigatus* Adaptation in a Warming Climate.*Fungal Genome Biology*,**15,** 277.
29. Shehu, K and Bello, M.T.. 2011. Effect of environmental factors on the growth of *Aspergillus* species associated with stored millet grains in sokoto. *Nigerian Journal of Applied and Basic Sciences,* **19**. 218-223.
30. Skinder, B.M., Sheikh, A.Q., Pandit, A.K., Ganai, B.A., 2014. Brick kiln emissions and its environmental impact: *A review. Journal of Ecology and the Natural Environment* ,**6**(1), 1–11.
31. Suryanarayanan, T.S. and Hawksworth, D.2010. Fungi from little-explored and extreme habitats. In book(Eds.) Sunil K. Deshmukh, M. K. Rai *Biodiversity of fungi: their role in human life* (pp.33-48) Science Publishers.
32. Suryanarayanan, T.S., Muruganandam,V.,Rajagopal,K. and Girivasan,K.P. 1996. Soil mycoflora of a commercially operated Solar Saltern.*Kavaka* **24**:11-13.
33. Thirunavukkarasu,N., Suryanarayanan T.S., **Girivasan K.P**., Venkatachalam,A., Ravishankar,J.P. Geetha, V. and Doble. M. 2012.Fungal symbionts of marine sponges from Rameswarm, southern India:species composition and bioactive metabolites. *FungalDiversity*, **55** , 37-46.
34. Venkatachalam,A. Thirunavukkarasu, N. and Suryanarayanan, T.S. 2015. Distribution and diversity of endophytes in seagrasses. *Fungal Ecology*. **13.** 60-65.
35. Xu, Z., Guo, X., Allen, W.J. Hu,Y.,Wang,J.,Li,M.,Wu,L and Guo, W. 2025. Soil fungi influence the relationship between plant diversity and ecosystem multifunctionality. *Nature Communication,* **16**, 10.1038/s41467-025-60661-0.
36. Wijayawardene, N.,N..,Hyde, K.D., Dai, D.Q. *et al.,* 2022. Outline of Fungi and fungus-like taxa. *Mycosphere*. **13**(1). 53-453.