Study of Seasonal variation of fungal biodiversity in polluted Yamuna River from NCR Delhi region, India

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Abstract- The River Yamuna is the largest tributary of River Ganga. This river is as prominent and sacred as the great River Ganga itself. Deterioration in water quality as a result of discharge of allochthonous and autochthonous sources of pollution into water bodies in increasingly rendering the natural water bodies unsuitable for various beneficial purposes to the mankind, like drinking water source, bathing, navigation, fishing and irrigation. It is observed that, due to over pollution of such sacred rivers, the microbial diversity gets increases which increase the BOD and organic load in the water thus making the water polluted. The study showed that the fungal biodiversity is the result of increasing pollution in river Yamuna and is also variable as per the seasonal and climatic variations.

Index Terms- Yamuna river, catchment areas associated with Delhi-NCR, fungal diversity, seasonal variations.

I. INTRODUCTION

The Rivers Yamuna plays an important role in human development of NCR by providing drinking water and making the land fertile. The river passing through Delhi section is terribly polluted Delhi based Centre for Science and Environment has called a sewage canal. Biochemical Oxygen Demand (BOD), the oxygen required to oxidize and therefore purify organic waste. A higher BOD indicates a low level of oxygen and a higher level of pathogen content mainly fungi and bacteria earlier no detail survey of Fungal diversity in river Yamuna carried out The diversity of fungi in Delhi Yamuna is highly influenced by seasonal variation. Delhi experiences extreme weather conditions with subtropical humid climate ranging from extremely hot and long summers to a short monsoon and autumn, extreme cold winters and a short pleasant spring season, these fungal pathogens are cause of different serious human, plant and water animals diseases. A higher BOD indicates a low level of oxygen and a higher level of pathogen (microbial) content. The chronically polluted water contains higher number of different filamentous and aquatic (Zoosporic) group of fungi [1]. Amongst filamentous fungi causes many problems to health and leads to severe diseases to human population living along the catchment area of the river and the cities. The diseases due to filamentous fungi can cause of invasive Aspergillosis (IA), chronic granulomatous disease (CGD), pneumonia and pericardial tamponade, *tinea capitis*, oculomycosis, abdominal zygomycosis , mycotic keratitis, pericarditis in a patient with acute leukemia, Subcutaneous hyalohyphomycosis, liver necrosis, nephritis and irritation of the gastrointestinal mucosa, nasal mucous membrane ulcers, dermatitis and cancer and induces allergic reactions. Fungi may also cause conjunctivitis, eosinophilic, pneumonitis, and a potential human carcinogen resulting into lungs and nasopharyngeal cancers. Aquatic (Zoosporic) group of fungi *Chytrides* kills water amphibians while; *Saprolegnia* and *Achlya* are common and widespread fungal killers of fishes [2-5]. In view of this fungal diversity in different season of Delhi Yamuna was carried out. The present study was performed in order to determine the fungal diversity in river Yamuna associated with catchment areas of Delhi-NCR with reference to different seasonal variations.

II. MATERIALS AND METHODS

In the present study, soil and water samples were collected from each of the five different locations viz. Khyber Pass, ISBT, Maharani Bagh, Kalkaji and Sarita Vihar of Yamuna river bank. These samples were stored and kept in icebox during the transportation to the laboratory. The screening of different filamentous fungi was done by adopting conventional (1) Spread plate technique and (2) Dilution plating technique in four replicates [6].

III. RESULTS AND DISCUSSION

A total of 704 different fungal colonies observed. Out of which, 26 different genera of fungi and 54 different species identified. Samples collected during winter (December 20015 and Jan2016) when temperature recorded between 5^{o} to 25^{o} C the highest diversity (4.90 %) was recorded for *Arthoderma album*, *Trichoderma harzianum, and T viride*, followed by (3.92%)in *Aspergillus sclerotiorum* , *Chrysosporium keratinophilum*, *Penicillium expansum*, *P. oxalicum*, *Phoma sorghina*, *Trichophyton. tonsurans.* 2.94% in *Acremonium byssoide*, *Microsporum canis*, *Penicillium chrysogenum, Synecephalastram racemosum* , Trichoderma harzianum, *T. koningi*, , *Trichothecium roseum*, *Verticillium alboatrum* , *Verticillium lilacinus* .followed by (1.96%) in *Aspergillus candidus*, *A. nidulans*, *A. ochraceous, A. oryzae. Cladosporium cladosprioides*, *Curvularia pallescence*, *Paecilomyces variotii*, *Penicillium digitatum* and *Rhizopus stolonifer*. 0.98% in *Acremonium stictum*, *Alternaria alternata*, *Aspergillus sydowi*, *A terreus*,, *Chaetomium globosum*, *Chrysosporium indicum*, *Cladosporium herbarum*, *Colletotrichum gloeosporioides*, *Drechslera sativum*, *Epicoccum purpurascens*, *Fusarium oxysporum* , *Mucor recemosus*, *Myrothecium roridum*,

Paecilomyces lilacinus Penicillium citrinum and , *P citrinum.* While no growth (0.00%)recorded in *Absidia corymbifera, Aspergillus niger, A. flavus, Chaetomium indicum, Curvularia lunata Drechslera rostrata, Fusarium pallidoroseum, Malebranche gypseum,* and *Thielavia terricola*.

During the Spring 2016 (Feb to March) when temperature recorded between 20^{o} to 25^{o} C the highest diversity recorded (3.75%) in *Epicoccum purpurascens Paecilomyces lilacinus P variotii Penicillium chrysogenum, P.expansum, Synecephalastram racemosum Trichoderma koningi Trichothecium roseum* and *Verticillium alboatrum.* 3.12% *in Microsporum. canis Myrothecium roridum Trichoderma harzianum,* 2.50% in *Acremonium byssoide Aspergillus ochraceous A. sydowi A terreus Cladosporium cladosprioides, C herbarum Chrysosporium indicum Drechslera sativum Fusarium equeseti Mucor recemosus Penicillium oxalicum , P digitatum, Phoma sorghina Rhizopus stolonifer Trichoderma viride* and *T virense.* 1.25% in *Alternaria alternata Colletotrichum gloeosporioides, Drechslera rostrata Fusarium oxysporum Fusarium pallidoroseum Fusarium solani,* 0.62% in *Arthoderma album Aspergillus nidulans Curvularia pallescence* and no growth 0.00% in *Absidia corymbifera. Acremonium stictum Aspergillus niger Aspergillus ochraceous, A. sclerotiorum, Chaetomium globosum, Chrysosporium indicum* and *C. keratinophilum*.

During Summer 2016 (April to June) when temperature range was 25^{o} to 45^{o} C the highest diversity 5.48% was observed in *Aspergillus oryzae* followed by 4.87% *in Aspergillus sclerotiorum* and *Drechslera specifer* 4.26% in *Aspergillus candidus* 3.75% in *Absidia corymbifera. Aspergillus flavus, A. nidulans , A. sydowi , Curvularia lunata,* , and. *Thielavia terricola* 3.12% in *Mucor recemosus and* 2.50% in *Alternaria alternata, Aspergillus niger, A. ochraceous ,A. terreus, Penicillium oxalicum ,Phoma sorghina ,Synecephalastram racemosum, Trichoderma harzianum ,T. koningi , Trichothecium roseum, Verticillium alboatrum* and *V. lilacinus* followed to 1.87% in *Chaetomium* globosum, *Epicoccum purpurascens ,Fusarium oxysporum F. pallidoroseum.* 1.25% in *Arthoderma album ,Chrysosporium keratinophilum ,Colletotrichum gloeosporioides, Curvularia pallescence, Fusarium equeseti,Microsporum.canis, Paecilomyces variotii, Trichophyton. tonsurans Rhizopus stolonifer ,Trichoderma virense ,Penicillium expansum,* and least (0.62%) recorded in *Trichoderma viride ,Cladosporium herbarum, Chrysosporium indicum ,Drechslera sativum ,Fusarium solani ,Malebranche gypseum , Paecilomyces lilacinus ,Penicillium citrinum ,Cladosporium cladosprioides.* While no growth (0.00%) observed in *Acremonium byssoide, A. stictum, Myrothecium roridum* and *Penicillium digitatum*.

During Monsoon 2016 (July to Sept) when temperature range between 30^{o} to 35^{o}C:, the highest diversity 8% in *Aspergillus terreus* followed to (3.75%) in *Aspergillus candidus ,Aspergillus flavus* and *Acremonium stictum* then 3.12%, *Alternaria alternata* 2.50% *Aspergillus niger* Drechslera specifer and *Aspergillus ochraceous*. followed to 1.87% in *Thielavia terricola, Aspergillus sydowi, Curvularia lunata ,Malebranche gypseum* and *Aspergillus nidulans;* 1.25 % in *Verticillium alboatrum ,Epicoccum purpurascens ,Fusarium equeseti, Mucor recemosus, Paecilomyces lilacinus, Penicillium citrinum ,P expansum, P.oxalicum ,Phoma sorghina ,Rhizopus stolonifer ,Synecephalastram racemosum, Trichoderma virense , T koningi* ,Colletotrichum gloeosporioides and least 0.62% in : *Arthoderma album, Chrysosporium keratinophilum, Cladosporium cladosprioides Fusarium pallidoroseum ,F. solani Microsporum. canis, Drechslera sativum ,Curvularia pallescence, Chaetomium globosum , Myrothecium roridum ,Paecilomyces variotii , ,Trichoderma viride Trichothecium roseum, Trichophyton. tonsurans, Trichoderma harzianum Verticillium lilacinus.* While no growth observed in *Acremonium byssoide, Cladosporium herbarum ,Chrysosporium indicum, Drechslera rostrata ,Fusarium oxysporum, Penicillium chrysogenum* and *P digitatum,*

During Autumn 2016 (Oct.to Nov) when temperature was between 20^{o} to 30^{o}C maximum diversity (3.33%) recorded in *Drechslera sativum ,Fusarium pallidoroseum* ,F solani,` Mi*Microsporum. canis* followed to (2.66 %)in *Absidia corymbifera. Aspergillus oryzae., Chrysosporium keratinophilum Colletotrichum gloeosporioides, Drechslera rostrata ,Epicoccum purpurascens, Fusarium oxysporum, Paecilomyces lilacinus Penicillium citrinum, P. oxalicum* and *Rhizopus stolonifer* followed to (2.0%) in *Acremonium stictum ,Alternaria alternata,,* Aspergillus flavus, A niger A. ochraceous, *A. sydowi, A terreus, Cladosporium cladosprioides, C. herbarum, Chaetomium indicum, Chrysosporium indicum, Mucor recemosus, Penicillium digitatum, P. expansum, Phoma sorghina, Trichoderma koningi ,Verticillium alboatrum* followed to (1.33%) in *Acremonium byssoide, Arthoderma album* ,Aspergillus candidus, *A nidulans ,A sclerotiorum, Chaetomium globosum, Curvularia pallescence, Drechslera specifer, Fusarium equeseti ,Myrothecium roridum ,Paecilomyces variotii ,Trichoderma harzianum ,T. virense ,Trichothecium roseum , Verticillium lilacinus* and least (0.66%) in *Curvularia lunata ,Penicillium chrysogenum, Synecephalastram racemosum, Trichoderma viride , Trichophyton. tonsurans. While no growth* 00.00% observed in Malebranche *gypseum* and *Thielavia terricola*. The results are shown in **Table 1** and **Figure 1**. Terrestrial fungi in aquatic habitats are likely to originate from air as well as from living or dead animal and plant, soil and litter being in contact with water. Different fungi were predominantly isolated from Turkey rivers viz. *Aspergillus, Cladosporium, Epicoccum, Penicillium* and *Trichoderma* species appear in comparison to *Epicoccum, Cladosporium* and *Trichoderma*. *Aspergillus fumigatus, A. niger, Penicillium chrysogenum* and many other species [7-14].

Table 1: Seasonal effect on diversity of fungi of polluted Yamuna from Delhi catchment areas

S.No.	Fungi isolated from Yamuna during different seasons	Winter Dec., 2015 to Dec., 2016 (5^0-25^0C)		Spring Feb., 2016 to March 2016 (20^0-25^0C)		Summer April 2016 to June 2016 (25^0-45^0C)		Monsoon July 2016 to Sep., 2016 (30^0C -35^0C)		Autumn Oct., 2016 to Nov., 2016 (20^0C -30^0C)	
		Mean CFU	%	Mean CFU	%	Mean CFU	%	Mean CFU	%	Mean CFU	%
1	*Absidia corymbifera.*	**0**	0	0	0	6	3.65	2	1.56	4	2.66
2	*Acremonium byssoide*	**3**	2.94	4	2.5	0	0	0	0	2	1.33
3	*Acremonium stictum*	**1**	0.98	0	0	0	0	6	4.68	3	2
4	*Alternaria alternata*	**1**	0.98	2	1.25	4	2.43	5	3.9	3	2
5	*Arthoderma album*	**5**	4.9	1	0.62	2	1.21	0	0	2	1.33
6	*Aspergillus flavus*	**0**	0	3	1.87	6	3.65	6	4.68	3	2
7	*Aspergillus candidus*	**2**	1.96	3	1.87	7	4.26	6	4.68	2	1.33
8	*Aspergillus nidulans*	**2**	1.96	1	0.62	6	3.65	3	2.34	2	1.33
9	*Aspergillus niger*	**0**	0	0	0	4	2.43	4	3.12	3	2
10	*Aspergillus ochraceous*	**2**	1.96	4	2.5	4	2.43	4	3.12	3	2
11	*Aspergillus oryzae.*	**2**	1.96	0	0	9	5.48	2	1.56	4	2.66
12	*Aspergillus sydowi*	**1**	0.98	4	2.5	6	3.65	3	2.34	3	2
13	*Aspergillus sclerotiorum*	**4**	3.92	0	0	8	4.87	2	1.56	2	1.33
14	*Aspergillus terreus*	**1**	0.98	4	2.5	4	2.43	8	6.25	3	2
15	*Cladosporium cladosprioides*	**2**	1.96	4	2.5	1	0.6	1	0.78	3	2
16	*Cladosporium herbarum*	**1**	0.98	4	2.5	1	0.6	0	0	3	2
17	*Chaetomium globosum*	**1**	0.98	0	0	3	0.6	1	0.78	2	1.33
18	*Chaetomium indicum*	**0**	0	0	0	2	1.21	1	0.78	3	2
19	*Chrysosporium keratinophilum*	**4**	3.92	0	0	2	1.21	1	0.78	4	2.66
20	*Chrysosporium indicum*	**1**	0.98	4	2.5	1	0.6	0	0	3	2
21	*Colletotrichum gloeosporioides*	**1**	0.98	2	1.25	2	1.21	2	1.56	4	2.66
22	*Curvularia lunata*	**0**	0	0	0	6	3.65	3	2.34	1	0.66
23	*Curvularia pallescence*	**2**	1.96	1	0.62	2	1.21	1	0.78	2	1.33
24	*Drechslera rostrata*	**0**	0	2	1.25	5	3.04	0	0	4	2.66
25	*Drechslera sativum*	**1**	0.98	4	2.5	1	0.6	1	0.78	5	3.33
26	*Drechslera specifer*	**0**	0	0	0	8	4.87	4	3.12	2	1.33
27	*Epicoccum purpurascens*	**1**	0.98	6	3.75	3	1.82	2	1.56	4	2.66
28	*Fusarium equeseti*	**0**	0	4	2.5	2	1.21	2	1.56	2	1.33
29	*Fusarium oxysporum*	**1**	0.98	2	1.25	3	1.82	0	0	4	2.66
30	*Fusarium pallidoroseum*	**0**	0	2	1.25	3	1.82	1	0.78	5	3.33
31	*Fusarium solani*	**3**	2.94	2	1.25	1	0.6	1	0.78	5	3.33
32	*Malebranche gypseum*	**0**	0	0	0	1	0.6	3	2.34	0	0
33	*Microsporum. canis*	**3**	2.94	5	3.12	2	1.21	1	0.78	5	3.33
34	*Mucor recemosus*	**1**	0.98	4	2.5	5	3.04	2	1.56	3	2
35	*Myrothecium roridum*	**1**	0.98	5	3.12	0	0	1	0.78	2	1.33

36	*Paecilomyces lilacinus*	**1**	0.98	6	3.75	1	0.6	2	1.56	4	2.66
37	*Paecilomyces variotii*	**2**	1.96	6	3.75	2	1.21	1	0.78	2	1.33
38	*Penicillium chrysogenum*	**3**	2.94	6	3.75	4	2.43	0	0	1	0.66
39	*Penicillium citrinum*	**1**	0.98	3	1.87	1	0.6	2	1.56	4	2.66
40	*Penicillium digitatum*	**2**	1.96	4	2.5	0	0	0	0	3	2
41	*Penicillium expansum,*	**4**	3.92	6	3.75	2	1.21	2	1.56	3	2
42	*Penicillium oxalicum*	**4**	3.92	4	2.5	4	2.43	2	1.56	4	2.66
43	*Phoma sorghina*	**4**	3.92	4	2.5	4	2.43	2	1.56	3	2
44	*Rhizopus stolonifer*	**2**	1.96	4	2.5	2	1.21	2	1.56	4	2.66
45	*Synecephalastram racemosum*	**3**	2.94	6	3.75	4	2.43	2	1.56	1	0.66
46	*Trichoderma harzianum*	**3**	2.94	5	3.12	4	2.43	1	0.78	2	1.33
47	*Trichoderma viride*	**5**	4.9	4	2.5	1	0.6	1	0.78	1	0.66
48	*Trichoderma virense*	**5**	4.9	4	2.5	2	1.21	2	1.56	2	1.33
49	*Trichoderma koningi*	**3**	2.94	6	3.75	4	2.43	2	1.56	3	2
50	*Trichothecium roseum*	**3**	2.94	6	3.75	4	2.43	1	0.78	2	1.33
51	*Trichophyton. tonsurans*	**4**	3.92	0	0	2	1.21	1	0.78	1	0.66
52	*Thielavia terricola*	**0**	0	0	0	6	3.65	3	2.34	0	0
53	*Verticillium alboatrum*	**3**	2.94	6	3.75	4	2.43	2	1.56	3	2
54	*Verticillium lilacinus*	**3**	2.94	3	1.87	4	2.43	1	0.78	2	1.33
	Grand total of Average CFU from different season was 704	102		160		164		128		150	

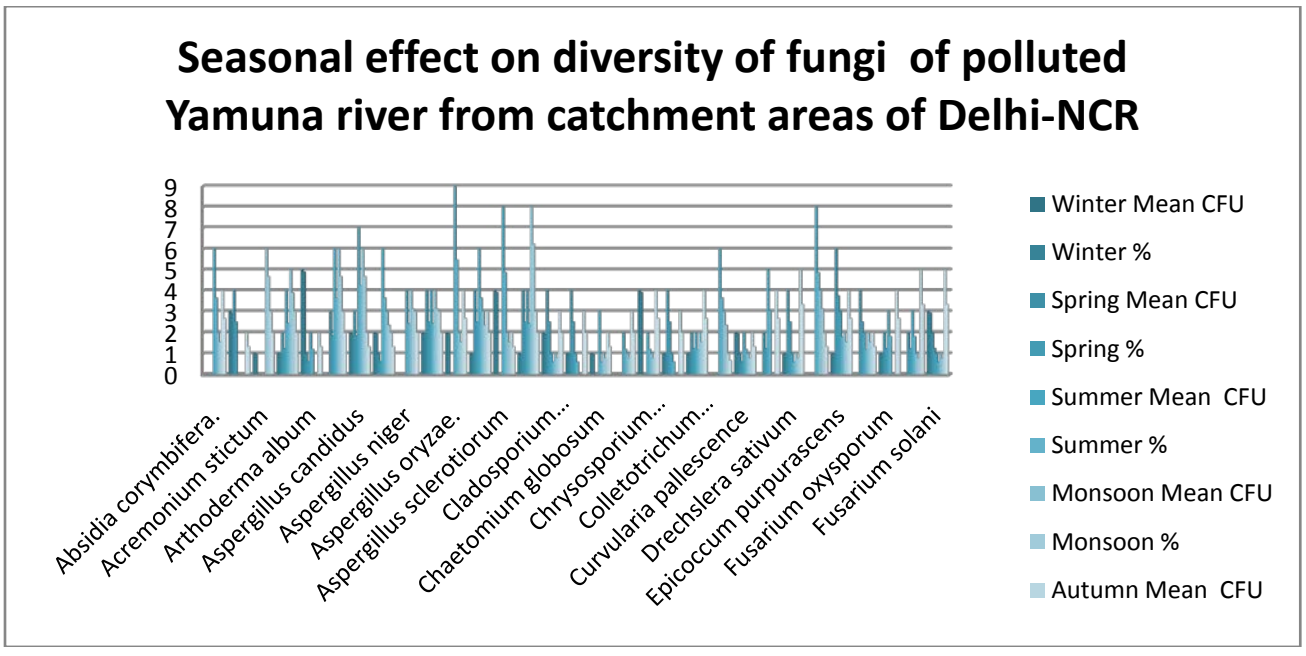

Figure 1: Seasonal effect on diversity of fungi of polluted Yamuna from Delhi catchment areas

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