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Aeromycoflora of Moreh Area, Manipur

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The present investigation dealt with airborne fungal spores over Moreh area (Manipur), studied for two years (Jan, 2012-Dec, 2013) by employing two stage Andersen sampler. Air sampling were carried out over two sites of Moreh, viz., residential area and open area (near market). A total of 36 fungal types and 38 fungal types were trapped from residential and open area (near market) respectively. In both the sites *Aspergillus fumigatus* and *Aspergillus niger* occurred throughout the period of study. Distribution and occurrence of fungal spores was found to be varying according to location, seasons of the year and conditions of the surrounding environment such as, temperature, relative humidity and rainfall.

Key words: Aeromycoflora, Moreh, Manipur, seasonal variations

INTRODUCTION

Many important aspects of aerobiological research related to warning of epidemics by disease forecasting system and allergic human diseases in Manipur have not been explored. As such Aerobiological investigations in the state of Manipur were set up on 21st July, 1984 at the Life Science Department, Manipur University under the leadership of N.I. Singh. Since 1984 on ward both extramural and intramural aerobiological works in different districts of the state have been conducted. Recent study on airborne fungal diversity of residential dwelling in Imphal, Manipur is also quite informative (Devi, 2013).

Moreh (184.8 sq.km area, lies between 24°13'5"-24°26' N latitude and 94°23'51"E, 276 m-888 m asl) is inhabited ethnic Kuki and Meitei along with a sizeable population of Tamil, Nepali and Muslims under Chandel district of Manipur state. It is a fast developing and an important trade point in India bordering with Myanmar. Like other hill districts of Manipur, Chandel also has various kinds of orchids, ornamental plants, etc (Ningthoujam *et al.* 2014).

The present study was undertaken as a comparative aeromycological study pertaining to the occur-

rence of airborne fungal spores in an open area near the market and residential areas of Moreh, Chandel District, Manipur.

MATERIALS AND METHODS

The aeromycological surveys were carried out employing two stage Andersen air sampler. Sampler was operated for the period of two years (January, 2012 to December, 2013) over residential area and open area near market at Moreh, Manipur. The samplings were conducted three times a month.

Calculation of Conversion factor is given below

$$\text{Colony forming unit (CFU)} = \frac{\text{Total number of fungal colonies}}{\text{Total volume of air sampled}} \times 1000$$

Culture plate method was employed for identifying airborne fungal spores. The petridishes (in duplicate) containing Rose Bengal Agar media were used for trapping fungal spores in two stage volumetric Andersen sampler. The sampler was operated for 10 minutes and then incubated in an inverted position for 5-6 days at 27°C ±1°C. The fungal colonies so developed were isolated, examined and identified by using the standard literatures.

RESULTS AND DISCUSSION

A total of 36 fungal types were recorded from the residential area. The maximum numbers of spores

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Table 1 : Monthly mean data of fungal airspora over the residential area of Moreh, Chandel district, Manipur during 2012

Fungal type	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total	%	Contributions
Deuteromycotina															
<i>Aspergillus clavatus</i>	0	1	0	4	0	1	1	1	1	1	0	0	10		2.3
<i>A.fumigatus</i>	10	6	9	1	6	7	7	2	2	9	12	1	72		17.02
<i>A.humicola</i>	0	0	0	4	1	0	0	0	0	2	0	0	7		1.65
<i>A.nidulans</i>	0	0	0	0	1	0	0	1	1	0	0	0	3		0.7
<i>A.niger</i>	6	3	9	7	2	5	5	6	6	4	6	5	64		15.1
<i>A. flavus</i>	0	2	7	3	0	3	3	2	2	12	0	3	37		8.7
<i>A. ochraceus</i>	0	1	0	0	0	0	0	0	0	0	1	0	2		0.47
<i>A. oryzae</i>	0	0	0	0	0	0	0	0	0	1	0	0	1		0.2
<i>Alternaria alternata</i>	0	1	0	0	2	0	0	0	0	0	0	0	3		0.71
<i>Biospora</i> sp.	0	0	0	0	0	0	0	1	1	2	0	0	4		0.94
<i>Botrytis</i> sp.	0	0	1	0	0	2	2	0	0	0	2	5	12		2.83
<i>Candida</i> sp.	1	0	0	0	0	1	1	2	2	0	0	1	8		1.89
<i>Colletotrichum</i>	0	0	0	1	0	0	0	0	0	0	0	4	5		1.18
<i>Cladosporium cladosporoides</i>	0	0	4	0	0	0	0	0	0	0	0	0	4		0.94
<i>C.herbarum</i>	0	0	0	1	0	1	1	0	0	0	1	0	4		0.94
<i>Curvularia lunata</i>	0	0	5	0	0	0	0	1	1	0	1	0	8		1.89
<i>Curvularia</i> sp.	0	1	0	0	0	0	0	0	0	0	1	0	2		0.47
<i>Drechslera</i> sp.	0	0	0	0	0	1	0	0	0	0	0	1	2		0.47
<i>Epicocum nigrum</i>	0	0	0	0	1	0	0	0	0	1	0	0	2		0.47
<i>Fusarium oxysporum</i>	0	0	4	0	0	7	7	1	1	0	0	0	20		4.72
<i>Geotrichum</i> sp.	0	0	0	0	0	2	2	0	0	0	0	0	4		0.94
<i>Humicola</i> sp.	0	0	0	4	0	0	0	0	0	1	0	0	5		1.18
<i>Helminthosporum</i> sp.	0	1	0	0	0	0	0	1	1	0	0	0	3		0.71
<i>Mucor haemealis</i>	0	0	0	0	0	0	0	1	1	0	0	0	2		0.47
<i>Penicillium citrinum</i>	1	0	1	0	0	0	0	6	6	1	0	0	15		3.54
<i>P. granulatum</i>	0	0	1	1	1	2	2	1	1	0	0	0	9		2.13
<i>P. notatum</i>	0	0	0	0	0	4	4	0	0	0	0	0	8		1.89
<i>P.chrysogenum</i>	1	1	0	2	0	2	2	0	0	0	0	0	8		1.89
<i>P.italicum</i>	0	2	1	1	0	0	0	0	0	1	0	1	6		1.42
<i>P. expansum</i>	0	0	0	0	0	0	0	0	0	0	1	0	1		0.23
<i>P. granulatum</i>	2	0	1	0	0	1	1	0	0	3	0	4	12		2.83
<i>P. spinulose</i>	0	0	1	5	0	0	0	0	0	5	2	2	15		3.54
<i>Torula</i> sp.	0	0	0	0	0	1	0	0	1	0	0	0	2		0.47
<i>Trichoderma harzianum</i>	0	0	0	0	0	2	2	5	5	0	0	0	14		3.31
<i>T.viridae</i>	0	1	0	0	0	2	2	0	0	0	1	1	7		1.65

(Contd. part table 1)

Zygomycotina														
<i>Rhizopus</i> sp.	0	4	16	2	4	0	0	7	7	0	2	0	42	9.92
Grand total	21	23	60	35	17	42	42	38	38	42	30	28	423	100
Mean CFU/m ³	74.2	81.3	212	123.7	60.1	148.4	148.4	134	134	148	106	98		

Table 1.2 : Monthly mean data of fungal airspora over the residential area of Moreh, Chandel district, Manipur during 2013

Fungal type	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total	% Contributions
Deuteromycotina														
<i>Aspergillus clavatus</i>	0	0	0	0	0	3	0	0	0	1	0	0	4	1.16
<i>A. fumigatus</i>	7	12	2	1	5	12	2	11	11	1	4	5	73	21.34
<i>A. humicola</i>	0	1	0	0	0	1	0	0	0	0	0	1	3	0.87
<i>A. nidulans</i>	0	0	0	0	0	0	1	0	0	2	0	0	1	0.29
<i>A. niger</i>	3	0	15	2	2	2	1	2	9	1	1	1	39	11.40
<i>A. flavus</i>	0	1	0	9	6	1	0	1	7	1	7	1	34	9.94
<i>A. ochraceus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0.29
<i>A. oryzae</i>	1	0	0	0	0	0	1	0	2	0	0	0	4	1.16
<i>Alternaria alternata</i>	1	0	0	6	0	0	0	1	0	0	0	0	8	2.33
<i>Biospora</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	10	3.92
<i>Botrytis</i> sp.	0	4	0	0	1	0	1	0	0	2	0	2	7	2.04
<i>Candida</i> sp.	2	0	0	0	0	0	0	1	0	2	1	1	4	1.16
<i>Colletotrichum</i> sp.	0	0	0	0	0	0	0	0	0	0	1	3	17	4.97
<i>Cladosporium cladosporioides</i>	0	0	0	0	2	5	8	0	0	1	0	1	4	1.16
<i>Cladosporium herbarum</i>	1	0	0	0	0	0	1	0	2	0	0	0	11	3.21
<i>Curvularia lunata</i>	0	0	0	1	8	0	0	0	0	0	0	2	5	1.46
<i>Curvularia</i> sp.	0	0	0	1	0	4	0	0	0	0	0	0	4	1.16
<i>Drechslera</i> sp.	0	0	0	0	0	0	0	0	3	0	0	1	2	0.58
<i>Epicocum nigrum</i>	0	0	0	0	0	0	1	0	0	0	1	0	8	2.33
<i>Fusarium oxysporum</i>	1	0	2	2	0	0	0	0	0	1	2	0	1	0.29
<i>Geotrichum</i> sp.	0	0	0	0	0	0	0	1	0	0	0	0	2	0.58
<i>Humicola</i> sp.	0	0	0	1	0	0	0	1	0	0	0	0	3	0.87
<i>Helminthosporium</i> sp.	0	0	0	1	0	0	0	0	0	0	0	2	5	1.16
<i>Mucor haemealis</i>	1	0	1	0	0	0	2	1	0	0	0	0	12	3.51
<i>Penicillium citrinum</i>	0	2	0	0	0	0	0	1	0	9	0	0	18	5.26
<i>P. glanulatum</i>	0	0	0	0	0	0	8	2	7	0	1	0	2	0.58
<i>P. notatum</i>	0	0	0	0	0	1	0	1	0	0	0	0	1	0.29

(Contd. part Table 1.2)

<i>P.chrysogenum</i>	1	0	0	0	0	0	0	0	1	2	0	0	8	2.33
<i>P.italicum</i>	0	2	0	0	0	0	2	0	0	0	3	1	7	2.04
<i>P. expensum</i>	0	0	1	0	0	1	1	0	1	0	0	3	2	0.58
<i>P. granulatum</i>	0	0	0	0	0	1	0	0	1	0	0	0	8	2.33
<i>P. spinulose</i>	4	0	0	0	4	0	0	0	0	0	0	0	1	0.29
<i>Torula</i> sp.	0	0	0	0	0	0	0	0	0	1	0	0	2	0.58
<i>Trichoderma harzianum</i>	0	0	0	0	0	1	0	0	1	0	0	0	6	1.75
<i>T.viridae</i>	0	0	3	0	1	1	0	1	0	0	0	0	4	1.16
Zygomycotina														
<i>Rhizopus</i> sp.	0	0	12	0	0	12	0	0	0	1	0	0	25	7.31
Grand total	22	22	36	23	29	40	29	22	44	24	20	23	342	100
Mean CFU/m ³	77.7	77.7	127	81.3	102.5	141	102	77.7	155	84	70.6	81		

Table 2.1 : Monthly mean data of fungal airspora over the open area (near market) of Moreh, Chandel district, Manipur during 2012

Fungal type	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total	% Contribution
Basidiomycotina														
Smut spores	1	0	0	0	0	0	0	0	0	0	0	2	3	0.56
Deuteromycotina														
<i>Aspergillus clavatus</i>	2	0	0	0	0	0	0	1	0	3	0	1	7	1.31
<i>A.fumigatus</i>	9	1	2	7	11	5	6	8	2	13	15	2	81	15.14
<i>A.humicola</i>	0	1	0	0	0	0	0	0	0	0	0	0	1	0.18
<i>A.nidulans</i>	0	0	2	0	0	5	0	1	0	0	0	0	8	1.49
<i>A.niger</i>	27	1	12	25	4	18	6	1	16	5	11	4	130	24.29
<i>A. flavus</i>	3	4	7	1	1	0	2	2	15	4	0	1	39	7.28
<i>A. ochraceus</i>	0	0	1	0	0	0	0	2	0	0	0	0	3	0.56
<i>Alternaria alternata</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0.18
<i>A.peponicola</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Biospora</i> sp.	0	2	0	0	0	0	0	1	0	5	1	0	9	1.68
<i>Botryosporium pulchrum</i>	0	0	0	0	0	0	0	0	2	0	0	0	2	0.37
<i>Botrytis</i> sp.	0	0	1	1	0	0	0	2	0	0	0	4	8	1.49
<i>Cladosporium cladosporoides</i>	0	0	3	0	0	0	0	0	0	0	1	1	5	0.93
<i>Curvularia lunata</i>	0	2	1	2	0	0	0	1	0	0	3	0	9	1.68
<i>Curvularia</i> sp.	0	1	0	0	0	0	1	0	0	2	1	0	5	0.93
<i>Drechslera</i> sp.	0	0	0	0	3	0	0	0	0	0	1	0	4	0.74
<i>Epicocum nigrum</i>	0	0	0	0	1	0	0	0	0	0	0	0	1	0.18
<i>Fusarium oxysporum</i>	2	0	0	0	0	0	0	1	1	0	0	4	8	1.49
<i>Fusarium moniliforme</i>	0	0	0	0	2	0	1	0	0	1	0	1	5	0.93
<i>Geotrichum</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Humicola</i> sp.	0	0	0	0	0	0	2	0	0	1	0	0	3	0.56
<i>Nigrospora</i> sp.	0	0	0	0	5	0	2	0	0	2	1	0	10	1.86
<i>Penicillium citrinum</i>	3	1	0	1	0	0	1	11	0	0	0	3	19	3.55

(Contd. part Table 2.1)

<i>P. glanulatum</i>	0	0	3	0	1	0	0	11	8	0	0	0	23	4.29
<i>P. notatum</i>	0	0	0	0	0	3	0	0	0	1	0	0	4	0.74
<i>P. chrysogenum</i>	5	1	0	2	0	0	0	2	0	0	0	1	6	1.12
<i>P. italicum</i>	0	0	0	2	1	0	1	1	0	1	0	0	6	1.12
<i>P. expansum</i>	0	1	0	1	0	0	0	0	0	0	1	0	3	0.56
<i>P. oxalicum</i>	8	4	3	0	6	0	0	0	0	3	0	0	24	4.48
<i>P. spinulose</i>	0	3	1	0	4	0	2	0	0	11	2	0	23	4.29
<i>Torula</i> sp.	0	0	0	0	0	0	0	0	1	0	0	0	1	0.18
<i>Trichoderma harzianum</i>	0	0	0	0	0	0	0	0	0	1	0	0	1	0.18
<i>T. viridae</i>	5	0	0	0	0	0	0	0	0	0	1	0	6	1.12
<i>Verticillium dialae</i>	0	2	0	0	2	4	0	1	1	0	1	0	11	2.05
Zygomycotina														
<i>Mucor</i> sp.	1	0	0	0	0	0	0	0	0	0	0	0	1	0.18
<i>Rhizopus</i> sp.	0	1	13	0	7	0	6	3	0	0	3	0	33	6.16
Grand total	66	25	49	42	48	35	30	49	44	53	42	24	535	100
Mean CFU/m ³	233	88.3	173	148	169	123	106	173	155	187	148	84		

Table 2.2 : Monthly mean data of fungal airspora over the open area (near market) of Moreh, Chandel district, Manipur during 2013

Fungal type	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total	% Contribution
Basidiomycotina														
Smut spores	0	0	0	0	0	1	0	0	0	0	2	0	3	0.71
Deuteromycotina														
<i>Aspergillus clavatus</i>	0	0	1	0	0	2	1	0	0	0	0	0	2	0.47
<i>A. fumigatus</i>	5	6	5	2	12	2	1	2	7	4	12	1	59	14.01
<i>A. humicola</i>	0	0	0	0	0	0	0	0	1	0	0	0	1	0.23
<i>A. nidulans</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>A. niger</i>	5	11	13	9	11	6	2	5	18	6	15	7	108	25.65
<i>A. flavus</i>	1	14	3	12	0	1	6	1	9	1	8	0	56	13.30
<i>A. ochraceus</i>	2	0	0	0	0	0	0	0	2	0	1	0	5	1.18
<i>Alternaria alternata</i>	1	0	2	0	0	0	1	0	0	2	0	0	6	1.42
<i>A. peponicola</i>	5	0	0	0	4	0	0	0	0	1	0	0	10	2.37
<i>Biospora</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Botryosporium pulchrum</i>	0	0	0	0	0	3	1	0	1	0	0	0	5	1.18
<i>Botrytis</i> sp.	0	0	0	0	0	2	0	0	0	0	1	2	5	1.18
<i>Cladosporium cladosporoides</i>	1	0	1	1	2	0	4	1	7	1	0	1	19	4.51
<i>Curvularia lunata</i>	0	0	4	1	0	0	0	0	0	0	1	0	6	1.42
<i>Curvularia</i> sp.	0	0	0	1	0	3	0	0	0	0	0	1	5	1.18
<i>Drechslera</i> sp.	0	0	0	0	0	0	0	0	1	1	0	0	2	0.47
<i>Epicocum nigrum</i>	0	0	0	0	0	1	0	0	0	0	0	0	1	0.23
<i>Fusarium oxysporum</i>	1	1	3	2	6	0	1	0	0	1	2	0	17	4.03
<i>Fusarium moniliforme</i>	1	0	0	0	0	0	1	0	0	0	0	2	4	0.95
<i>Geotrichum</i> sp.	0	0	0	0	0	0	0	0	3	1	0	0	4	0.95
<i>Humicola</i> sp.	0	0	2	0	0	0	0	0	0	0	0	0	2	0.47
<i>Nigrospora</i> sp.	0	0	2	0	0	0	0	0	0	0	0	0	2	0.47
<i>Penicillium citrinum</i>	6	0	7	0	5	0	0	2	0	2	0	0	22	5.22

(Contd. part Table 2.2)

<i>P. glanulatum</i>	2	1	0	3	0	8	10	0	4	0	5	0	33	7.83
<i>P. notatum</i>	0	0	0	0	0	0	0	0	0	0	0	0		
<i>P. chrysogenum</i>	0	3	0	0	0	1	0	0	0	0	0	0	4	0.95
<i>P. italicum</i>	3	0	9	0	0	4	0	0	1	0	4	1	22	5.22
<i>P. expansum</i>	4	0	1	0	5	0	1	2	4	0	0	2	19	4.51
<i>P. oxalicum</i>	0	0	0	0	0	0	0	1	1	0	3	0	5	1.18
<i>P. spinulose</i>	0	1	0	3	1	0	0	0	0	0	0	4	9	2.13
<i>Torula</i> sp.	0	0	2	0	0	0	0	0	0	0	0	0	2	0.47
<i>Trichoderma harzianum</i>	0	0	0	0	0	4	0	0	0	1	0	0	5	1.18
<i>T. viridae</i>	0	0	0	4	0	1	0	0	0	0	0	2	7	1.66
<i>Verticillium dialae</i>	0	0	0	0	0	0	0	0	0	0	0	0		
Zygomycotina														
<i>Mucor</i> sp.	3	0	0	0	0	0	0	0	0	1	0	0	4	0.95
<i>Rhizopus</i> sp.	4	0	0	0	0	11	0	9	1	1	0	1	27	6.41
Grand total	44	37	55	38	46	50	29	23	60	23	54	24	421	100
Mean CFU/m ³	155	130	194	98	162	176	102	81	212	81	190	84.8		

were trapped during the month of September 2012 and March 2013, whereas the minimum spores were trapped in the month of May, 2012 (Table.1.1,1.2). In the open area (near market) altogether 38 spore types were trapped, the maximum spores were trapped in the month of January, 2012 and September, 2013 whereas minimum number of fungal spores were trapped during the month of August 2013 (Table.2.1,2.2).

Among the 36 spore types trapped from the residential site, 35 belongs to the group Deuteromycotina and 1 belongs to the group Zygomycotina and among the 38 spore types trapped from the open area (near market), 1 belongs to the group Basidiomycitina, 34 belongs to the group Deuteromycotina and 2 belongs to the group Zygomycotina. In both the sites, the group Deuteromycotina occupied the maximum number of fungal species followed by Zygomycotina. Similar findings were recorded from the air over Khwairamband market and Lamlong market of Imphal, Manipur (Hidangmayum, 2007). Seasonal variation affects aeromycoflora of the area. Impact of airborne fungal spores including their release, dissemination, deposition and effect is of great significance in identifying the health hazards and physiological disorders in living beings (Verma *et al.* 2013). Meteorological conditions clearly have profound influences on the production, dispersal, and deposition of fungal spores. Rain, wind speed, wind direction, humidity, temperature, and flora and fauna of the testing area are among the major fac-

tors, which affect the concentration of airborne fungal spores.

For the residential site, the greatest total colony count was attributed to *Aspergillus fumigatus* (15.4%), followed by *Aspergillus niger*, *Aspergillus flavus*, *Penicillium granulatum* (13.2%, 11.61%, 7.57 % respectively) and for open area (near market) the greatest total colony count was attributed to *Aspergillus niger* 25.8% followed by *Aspergillus fumigatus*, *Aspergillus flavus*, *Rhizopus* sp. 13.9%, 9.59%, 5.99% respectively. In both the study sites, *Aspergillus fumigatus* and *Aspergillus niger* occurred in every month of the entire study. The results provides similar data as reported by the previous workers (Ghosh *et al.* 2014; Nayak, *et al.* 2013; Ghatge *et al.* 2013). The *Aspergillus* spp. can live in extreme conditions in almost all the regions and in wide and variable climatic condition. Due to its wide ecological amplitude, the spores of *Aspergillus* can be dispersed widely into the atmosphere owing to various factors (Devi and Sharma, 2011).

There was difference in the number of fungal spores in the atmosphere of residential and open area of Moreh during spring and rainy seasons. The least number of fungal spores were isolated in the rainy season while maximum in the spring. During two year survey, in the residential area the maximum spores were observed in the months of March, 2012 when minimum (11.1°C) and maximum (28.7°C) temperature were recorded and

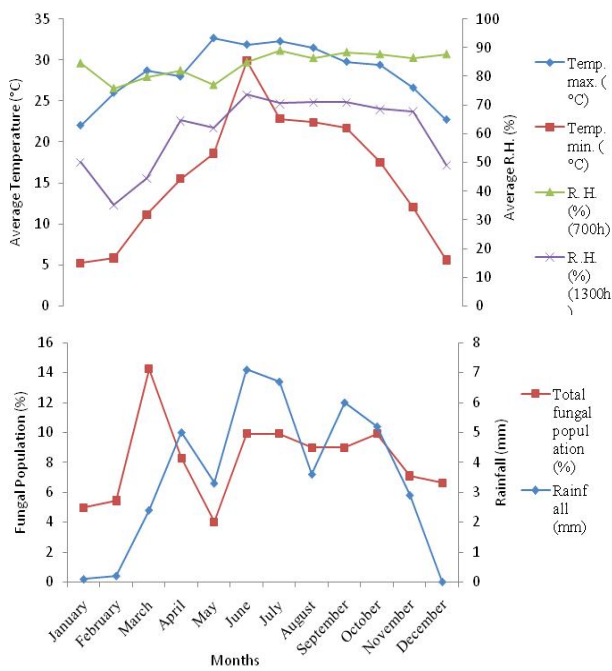


Fig. 1.1 :The occurrence of airborne fungal spores (%) for residential site at Moreh, Chandel District, Manipur and meteorological parameters during 2012

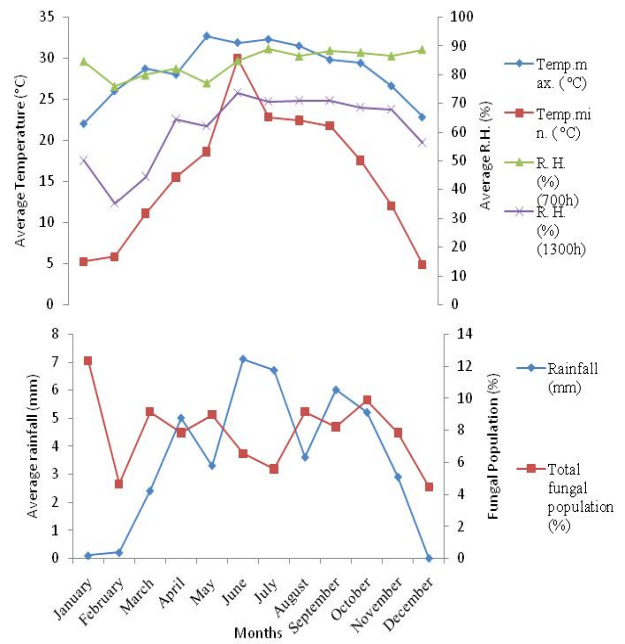


Fig. 1.3 :The occurrence of airborne fungal spores (%) for open area (near market) at Moreh, Chandel District, Manipur and meteorological parameters during 2012

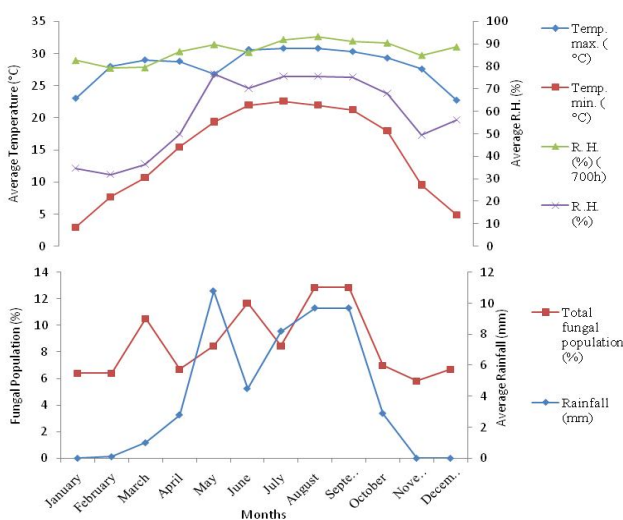


Fig. 1.2 : The occurrence of airborne fungal spores (%) for residential site at Moreh, Chandel District, Manipur and meteorological parameters during 2013.

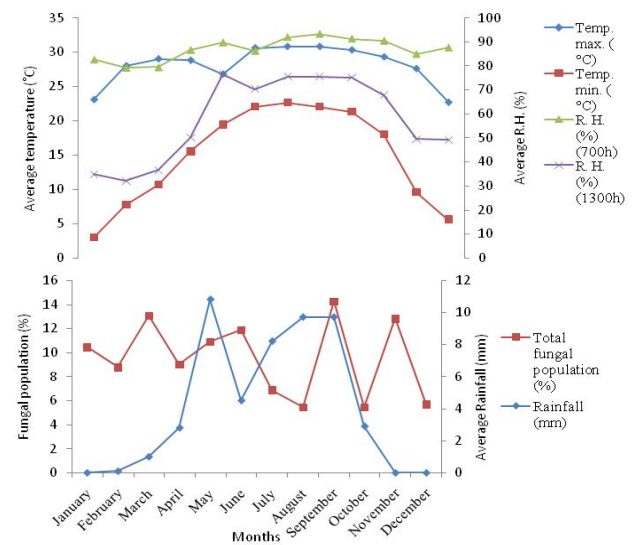


Fig. 1.4: The occurrence of airborne fungal spores (%) for open area (near market) at Moreh, Chandel District, Manipur and meteorological parameters during 2013

relative humidity was 77% and 62.1% respectively, whereas minimum number of spores were isolated in the month of May, 2012, when minimum (18.6°C) and maximum (32.7°C) temperature and relative humidity were 62.1% (Fig. 1.1, 1.2). While for open area (near market) the maximum spores were observed in the month of September, 2013 (Fig. 1.3, 1.4), when minimum (21.3°C) and maximum (30.3°C) temperature and relative humidity (75.2%) were recorded whereas minimum num-

ber of spores were recorded in the month of December, 2012, when minimum (4.9°C) and maximum (22.8°C) temperature and relative humidity (56.2% and 88.7%) were recorded (Fig.1.3 and 1.4). Seasonal and diurnal aeromycoflora in and around Moreh, Manipur was found to be related with the variation of the climatic conditions.

Abundance of airborne fungal spores in the open area (near market) might be due to the unhygienic

condition which prevails in the area. As such it can be suggested that use of accurate, quantitative sampling methods will provide exhaustive data for air quality of Moreh area, Manipur for proper control of biopollutants.

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