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Impact of mechanised threshing on the variability of airborne fungal spores over a paddy field in Imphal valley, Manipur

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ABSTRACT

Sampling was conducted from August, 2013 to November, 2015 in a large paddy field to investigate variability of airborne fungal spores over the area using Tilakrotorod air sampler. The result showed that the average monthly spore count was 185 spores/m^3, with a maximum level in October and November, and the minimum level in January. In all 28 fungal spore types were identified. A grand total of 1,33,200 spores /m^3 of air (October, 2013 to September, 2014) and 121,358 spores/m^3 of air (October, 2014 to October, 2015) were trapped. Within a day, the maximum level occurred at 16:00 hours, followed by 09:00 hrs and then 13:00 hrs. The predominant genera identified were *Helminthosporium, Nigrospora, Trematosphaeria, Drechslera, Alternaria, Pleospora, Cladosporium, Pyricularia, Aspergillus, Penicillium, Tetraploa* and *Torula* comprising 78.4% of the total spore count. During the month of threshing, spore count was maximum in all the study periods.

Keywords: Airborne fungal spores, mean monthly spore count, predominant, paddy field.

INTRODUCTION

Bio-aerosols are small particles, such as bacteria, fungi, viruses, dust mites, pollen, spores, and decomposers of cracked animals or plants. They are mainly derived from soil, water bodies, animals, plants and human beings (Ariya and Amyot, 2004).

Diffused and transmitted through the air, bio-aerosols spread human diseases, such as infectious diseases, allergies, or poisoning,as well as animals and plant diseases (Ho and Duncan 2005; Kodama and McGee, 1986). In recent years, airborne fungi have been paid much attention by the medical researchers as well as environmentalists (Liu *et al.*, 2008). Further, fungal spores caused diseases of plants and animals. But their concentration varies with meteorological parameters, source, altitude, etc. (Agarwal *et al.*,1968).

Rice cultivation is the major occupation in Manipur, and is the principal income source of the state as well. After rice harvesting, seasonal crops plantation are becoming common practice over many places of Manipur. The valley of Manipur is situated in between 24º5' to 25º16'N, Latitude and 94º 15' Longitude at an average height of about 763 m to 1,000 m contour above sea level. The plain is approximately 2,640 sq. Km accounting for 12 per cent of the state's total area of 22,332 sq. Km. Out of the total plain areas stated, about 546 sq.Km is occupied by lakes, marshes, barren upland and hillocks.

The climate of Imphal is tropical but modified by local factors such as site, situation, altitude, topography, direction of prevailing local wind, and seasonal rhythm. However, humidity index reveals that the valley remain largely humid. Considerable amount of information is available on the spore and pollen content of the atmosphere in various regions of the world but very little is known about airspora over paddy fields.

The diurnal spore release of *Pyricularia oryzae* (*Magnaporthe grisea*) from rice leaves and, again that when lesions of *P.oryzae* on attached leaves of the rice varieties were kept in 100% RH and 70-80ºF, conidia were released only at night. The release of spores began 6-8 hours after the start of the dew period and stopped soon after dawn (Barksdale and Asai, 1961). The present paper deals with impact of mechanised threshing on the variability of airborne fungal spores over a paddy field.

MATERIALS AND METHODS

Sampling site and time: The sampling site was at a paddy field located in the Kongba Uchekon, Imphal East district, around 7 km away south east from the Manipur University, Canchipur. Both the ends of the paddy field are residential areas and, drained by the Kongba River from North to South. A chain of hill known as Nongmaijhing, is around 2 Km East of the paddy field.The area is characterized by regularly grown tree of species of *Bambusa*, *Ficus*, *Carica*, *Eucalyptus* and *Citrus*. Continuous sampling was carried out for a period of two years (2013 to 2015) by employing rotorod air sampler.

Collection of samples: Tilakrotorod air sampler was placed almost at the centre of the paddy field, 5m above the ground level with the help of stand. Transparent cellotape was applied to the rods of the sampler, trimmed back to the width of the rods and coated with Vaseline. The sampler was operated thrice in a day, each operation lasted for an hour (09:00, 13:00, 16:00 hrs) and four times a month (weekly). Slides were prepared using glycerine jelly mountant and scanned regularly.

The trapped fungal spores were identified by consulting authentic literature (Lacey, 1962; Ellis,1971; Lacey,1981) and also by comparing with reference slides. The spore count was multiplied by the conversion factor, 5. During the sampling period, meteorological parameters were obtained from Tulihal Airport, Imphal and Department of Geography, Manipur University, Canchipur, Imphal.

RESULTS

The spores trapped and identified were grouped under *Ascomycota*, *Eu-Ascomycota*, *Basidiomycota*, Mitosporic Fungi and *Zygomycota* (**Table 1, Fig. 1**).

Table 1: Airborne fungal spores identified from the air trapped during the sampling periods.

Subdivision	Genera
Ascomycota	*Cercosporadium, Chaetomium, Didymosphaeria, Emericella, Helminthosporium, Heterosporium Inermisia, Leptosphaeria, Trematosphaeria*
Eu-Ascomycota	*Hypoxylon*
Basidiomycota	*Puccinia*
Mitosporic Fungi	*Alternaria, Aspergillus, Beltrania, Bispora, Cladosporium, Curvularia, Drechslera, Diplodia, Penicillium Pericornia, Pithomyces, Pleospora, Sordaria, Tetraploa, Trichonosis, Torula, Nigrospora*
Zygomycota	*Circinella*

Monthly changes of airborne fungal spores: The grand total in the environment of the rice cultivation area was 1,33,200 spores /$m^3$of air (October, 2013 to September, 2014) and 121,358 spores/$m^3$of air (October, 2014 to October, 2015).The monthly mean concentration was 185 spores/m^3. Maximum count was recorded in the month of October followed by November, February and June, and minimum spore count was found in the month of August, July and January for the 1st year period (October, 2013 to September, 2014). Maximum count was found in October, followed by November, March and June, and minimum spore count was found in the month of August, July and January for 2nd year period (October, 2014 to October,2015).

Diurnal changes of airborne fungal spores: The monthly mean concentrations of airborne fungal spore count at the three sampling time-points,i.e. 08:00h, 12:00h and 14:00h was from 145 spores/m^3 to 185 spores/m^3, 134 spores/m^3 to 168 spores/m^3, and 120 spores/m^3 to 153 spores/m^3 air, respectively. The spore count at 08:00 was significantly higher than that at the other two time-points.

Composition of the airborne fungal spore: A total of 28 different fungal spore types were identified (**Table1**). The predominant fungal spores were those of *Apergillus, Penicillium, Helminthosporium, Nigrospora, Alternaria, Curvularia, Trematosphaeria, Drechslera, Pleospora, Curvularia, Pyricularia* and *Chaetomium* whereas the spores of *Circinella , Tetraploa , Hypoxylon, Trichonosis, Sordaria* were the least common amongst the airborne mycobiota. The spores of *Alternaria, Apergillus, Penicillum, Nigrospora* and *Tetraploa,* were documented in the air throughout the year.

DISCUSSION

Spores of *Curvularia, Helminthosporium, Cercospora, Tetraploa* and *Aspergillus* were documented in the air over paddy fields near Pentapadu in the West Godavary district of Andhra Pradesh by using Hirst spore trap continuously from 21st September to 31st December, 1957, throughout the study period in uniform concentrations (Sreeramulu and Ramalingam, 1963). Airborne *Pyricularia oryzae* spore concentration has been documented over rice field in Imphal area by using glass cylinder exposure method and the spores are reported to appear in the air 3 to 6 days prior to the first onset of disease on the crop. The high percentage of disease incidence and disease intensity indexis closely related to high percentage of *Pyricularia* spores in the air (Singh and Singh, 1987).

In the present experiment, 28 airborne fungal spores types

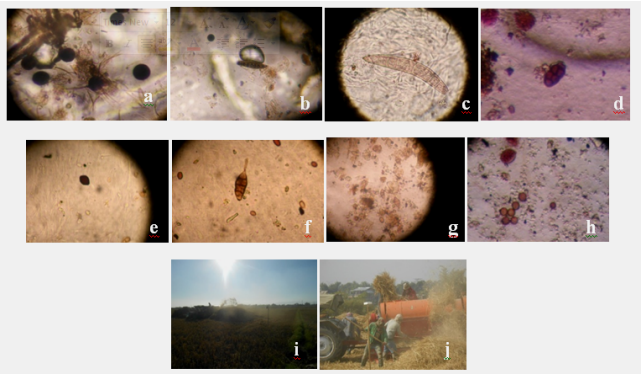

Fig. 1. Airborne fungal spores trapped and mechanised threshing over paddy field. a) *Nigrospora* sp., b) *Drechslera* sp., c) *Helminthosporium* sp., d) *Pithomyces* sp., e) *Chaetomium* sp., f) *Alternaria* sp., g) *Beltrania* sp., h) Aspergillus sp. & Penicillium sp., i & j) - mechanised threshing rotorod, over paddy field.

were identified including many infectious fungal spores. The spores of *Apergillus*, *Penicillium*, *Helminthosporium*, *Nigrospora*, *Alternaria*, *Curvularia*, *Trematosphaeria*, *Drechslera*, *Pleospora*, *Curvularia* and *Pyricularia* were present predominantly throughout the year of the study period.

Similar results were also reported from the atmosphere over a paddy field from Cuttak,Odhisa and the seasonal changes in the concentration of spores of *Curvularia, Nigrospora, Cercospora, Cladosporium, Aspergillus, Helminthosporium* and *Alternaria* over the paddy field (Chandwani *et al.*,1963).

We could not figure out variation of airborne fungal spores during the night time. However, this experiment clearly revealed the concentration of different airborne fungal spores in the environment. As no boundary for air around, extra-mural composition could be intra-mural as well.

Aspergillus fumigatus is reported to cause allergic alveolitis, asthma, pulmonary aspergillosis, and mycotoxicosis (Lacey and Crook 1988; Lacey and Dutkiewicz, 1994). *Penicillium* has been the causal organism of penicilliosis, often secondary to leukemia and lymphoma, leading to cerebral or pulmonary lesions. While *Alternaria* is known to cause skin alternariosis, and also allergic pneumonia and asthma, and possibly esophageal cancer (Johannes *et al.*, 2000).

Prolonged exposure to such environment would readily result in infections of various airborne fungal spores to local residents and farmers around the sampling areas. So far, no safe levels of airborne fungal spore concentration were studied, but high concentration would result in threats to the health of human beings and animals besides crops. Different fungal species may have different pathogenic capabilities; and meanwhile, body resistance is also vital against the fungal infection. Therefore, in-depth investigation of airborne fungal pathogenecity and body immunity is required to know harms of airborne fungal spores to human beings and animals.

CONCLUSION

Apergillus, Penicillium, Cladosporium, Curvularia, Helminthosporium, Pleospora, Nigrospora,

Trematosphaeria, Alternaria and *Tetraploa* were predominant airborne fungal spores over the paddy fields in the Imphal valley of Manipur. The concentration of airborne fungal spores changes significantly during the day and also varies throughout the year. More such experiments on airborne fungal spores would throw more light about the abundance and variability over the paddy field and nearby areas, and would also help us to regulate and take precautionary measures to protect the human and animal population from fungal infections. In this experiment, no unknown fungal spores were documented during the survey. Pollen grains, hyphal fragments, insect wings, detached plant parts, etc. which could have the similar effect on human beings were trapped with no significant intervals.

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