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Original Research Paper

An Investigation of Fungal Aerobiopollutants in the Ambient Air Over Maize Fields

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ABSTRACT

The present investigation was carried out to understand the qualitative and quantitative incidence of fungal aerobiopollutants over maize. Environmental monitoring was carried out by operating continuous volumetric Tilak air sampler, which gave continuous air sampling for atmospheric aerobiopollutants. Apart from dust particles, altogether 44 types of aerobiopollutants were trapped in the sampler of which 39 belonged to fungal spore types. From these, 25 belonged to Deuteromycotina, 9 to Ascomycotina, 2 to Basidiomycotina, 2 to Mastigomycotina and 1 to Zygomycotina, while remaining 5 types belonged to non-fungal spore groups of other types. Aerobiopollutants obtained peak in the month of February with 29582/m^3 of air and 37.7 spore percentages, when there was a record of 4.6 mm rainfall, average temperature of 21.3°C and 54.6% relative humidity. The pathogenic and allergenic nature of aerobiopollutants is discussed, and influence of meteorological parameters on these spore types is presented in this paper.

INTRODUCTION

Among the major cereal crops, maize or corn (*Zea mays* Linn.) is cultivated for food , fodder and feed. Maize is staple food crop, the grain is very nutritious with high percentage of carbohydrates, proteins, fats, calcium, iron and vitamins. It is grown as monocrop throughout the year and is subjected to about 20 diseases, which are caused by bacteria, fungi and viruses. Among the important fungal diseases are leaf blight, leaf spots, leaf rust, brown spots, common smut, head smut, wilt, seeding blights, downy mildew. Zonate spots can be considered as most important from the point of view of epidemiology and management.

The fungal diseases cause severe losses, therefore, environmental monitoring was carried out over maize fields to find out chief aerobiopollutants based on qualitative and quantitative analysis. Incidence of aerobiopollutants in the ambient air over maize fields and effect of meteorological parameters are presented in this paper. Pathogenic and allergenic fungal spore types are recorded during the study period.

MATERIALS AND METHODS

Air monitoring was carried out by operating continuous volumetric Tilak air sampler (Tilak & Kulkarni 1970) located in the middle of two-acre maize crop field with its orifice facing the west and kept at a constant height of 3 feet above the ground level. Maize variety 30 V 92 hybrid corn seed of Pioneer, a Dupont company, was sown in a test field at Diskal, District Satara, Maharashtra. The studies were conducted from December 2010 to March 2011. Air monitoring was initiated eight days prior to the sowing of the test field and continued for eight days after harvesting of the crop. The study site was completely exposed on all sides having a free display of air currents in all directions.

The spore number trapped in the sampler was expressed as number of spores per cubic meter of air. The volume of air sampled was 5 litres per minute and calculated conversion factor for Tilak air sampler was 14. For estimating the spore types, their number and percentage contribution, slides were scanned. The identification of different spore types was based mainly on comparative spore morphology and spore description. The spores, which could not be identified due to their obscure nature or even otherwise, were placed under unidentified type. The number of spores, thus scanned, multiplied by conversion factor to give the number of spores in per meter cube of air. The identification of aerobiopollutants was based on microscopic characters. The daily meteorological data of temperature, relative humidity and rainfall were maintained throughout the study period.

RESULTS AND DISCUSSION

Analysis of various aerobiopollutants from 240 slides revealed 39 types of fungal spores along with hyphal fragments, insect parts, pollen grains, trichomes and various other bioparticles. During the period of the investigation, apart from inorganic dust particles, 44 types of aerobiopollutants were trapped, of which 39 belonged to spore type origin,

while remaining 5 belonged to other types. Out of 39 fungal spore types, 2 belonged to Mastigomycotina, 1 to Zygomycotina, 9 to Ascomycotina, 2 to Basidiomycotina, and 25 to Deuteromycotina.

Of the various groups, fungal spores belonging to Deuteromycotina contributed highest catches (71.8%) to the total airborne spores followed by Ascomycotina (11.3%), other types (9.4%), Basidiomycotina (4.7%), Mastigomycotina (1.7%) and Zygomycotina (1.1%) (Table 1). Aerobiopollutants obtained peak in the month of February with 29582/m^3 of air, and 37.7% to total airspora, when there was 21.3°C mean temperature, 54.6% relative humidity and 4.6 mm rainfall (Table 2). It was followed by the month of January (21938/m^3 of air, 29.9%) when there was 20.2°C temperature, 51.8% relative humidity, and 2.4 mm rainfall. Minimum spore count was recorded in the month of December (8498/m^3 of air, 10.8%) when there was 19.9°C temperature, 56.2% relative humidity and no rainfall. A total of 78596 spores/m^3 of air were recorded during the study period.

The average monthwise percentage contribution of each spore group to the total airspora is presented in Table 3. Maximum spore count of Deuteromycotina was in February month (73%) followed by January (72.9%), and minimum during March (69.2%). Dominance of Ascomycotina was in month of December (13.2%) followed by March (11.5%), January (11.4%), and minimum during February (10.7%). Similarly dominance of Mastigomycotina was in month of December (2.5%), and Zygomycotina (1.8%).

During the present investigation spore types of *Albugo* (1.3%) and oospores of *Sclerospora* (0.4%) were recorded from group Mastigomycotina. Maximum monthly mean concentration of *Albugo* (378/m^3) and *Sclerospora* (154/m^3) was recorded in the month of February and March respectively. From group Zygomycotina spores of *Rhizopus* and *Mucor* (1.1%) were recorded with maximum monthly mean concentration of 308/m^3 in the month of February. Moderately high temperature and high relative humidity favoured the release of these spores (Hyde & Williams 1949). These spores may cause allergenic rhinitis, asthma and respiratory diseases (Tilak & Kulkarni 1975).

Spore types of Basidiomycotina as rust spores (1.8%) and smut spores (2.9%) were common in air with monthly maximum concentration of 574/m^3 and 938/m^3 of air during the month of January. Pathogenic and allergenic nature of these aerobiopollutants has been pointed out by Agarwal & Shivpuri (1974) and Karne & Pande (2006). Rust spores cause leaf spot disease and rust disease to maize crop plants and their incidence was recorded in the field. Smut spores occurred during dry, gusty and sunny period.

Ascomycotina group was found to contribute 11.3% with 9 ascospore types, among these *Leptosphaeria* (2.9%), *Pleospora* (2.6%), *Chaetomium* (2.3%), *Hypoxylon* (1.1%) and *Didymosphaeria* (0.8%) were dominant over maize fields. Similar results were obtained by Karne (2006). Besides rainfall, other meteorological factors like relative humidity and temperature have a profound effect in determining the concentration of ascospores in the ambient air (Tilak & Srinivasulu, 1971, Tilak & Bhalke 1979). Role of *Chaetomium*, *Leptosphaeria* and *Pleospora* is reported in causing allergy and allergenic reactions to sensitive individuals (Frankland & Gregory 1953, Karne & Pande 2006, Chanda & Mandal 1980).

The group Deuteromycotina, with the biggest contingent toll of 26 aerobiopollutants like *Cladosporium* (29.6%), *Alternaria* (5.8%), *Curvularia* 5.7%), *Nigrospora* (4.2%), *Drechslera* (3.5%), Aspergilli + Penicilli (3.2%), *Helminthosporium* (2.4%) and *Perioconia* (2.3%) significantly contributed to the total airspora. Majority of these spore types were dominant in the month of February and January during the study period. Spore types of *Alternaria*, *Diplodia*, *Drechslera*, *Fusarium*, *Cercospora*, *Cladosporium*, *Helminthosporium*, *Perioconia*, *Curvularia*, Aspergilli and Penicilli may cause diseases to maize crop when environmental conditions are favourable. *Cladosporium* spore type was found to be the most dominant type over maize fields, the highest catch was 9142/m^3 of air in the month of February with total spore contribution of 23254/m^3 of air.

The allergenic spore types recorded during the study period were *Cladosporium*, *Alternaria*, *Curvularia*, *Periconia*, *Helminthosporium*, *Nigrospora*, *Epicoccum*, *Pithomyces*, *Heterosporium*, *Fusarium*, *Drechslera* and Aspergilli + Penicilli. A clinical implication of these spore types is reported in etiology of respiratory allergic disorders, in allergic diseases and allergic reactions to sensitive individuals (Citron 1962, Feinberg 1935, Agarwal & Shivpuri 1974, Karne & Pande 2006, Shenoi & Ramalingam 1976). The present investigation clearly points out the prevalence of large percentage of allergens in the study area.

From the group other types, an artificially formed and an unusual group comprises of hyphal fragments (2.8%), insect parts (0.7%), pollen grains (2.4%), trichomes (2.3%) and unidentified fungal spores (2.3%). Mostly dematiaceous hyphae were encountered during the study period. Similar findings were reported by Harvey (1970). Insect scales and parts were dominant during the month of February (210/m^3) and January (168/m^3). Feinberg (1935) and Shivpuri (1980) reported role of insect parts in allergy, which may lead to occasional, seasonal or perennial allergenic disorders.

Pollen grains showed maximum monthly mean

Table 1: Monthwise total airspora (spores/m^3 of air) and percentage contribution of different spore types over maize fields.

Spore type	Dec.	Jan.	Feb.	Mar.	Total	Percentage contribution
A. Mastigomycotina						
1. *Albugo*	210	434	378	-	1022	1.3
2. *Sclerospora* (oospores) +	-	56	112	154	322	0.4
Total	210	490	490	154	1344	1.7
B. Zygomycotina						
1. *Mucor+Rhizopus* *	154	238	308	168	868	1.1
C. Ascomycotina						
1. *Chaetomium* *	266	490	714	336	1806	2.3
2. *Didymosphaeria*	84	182	238	126	630	0.8
3. *Hypoxylon*	98	280	308	182	868	1.1
4. *Lacanidion*	70	168	182	126	546	0.7
5) *Leptosphaeria* + *	364	588	658	672	2282	2.9
6. *Lophiostoma*	28	70	84	56	238	0.3
7. *Nodulosphaeria*	-	14	28	42	84	0.1
8. *Pleospora* *	154	588	812	490	2044	2.6
9. *Pringsheimia*	56	112	126	98	392	0.5
Total	1120	2492	3150	2128	8890	11.3
D. Basidiomycotina						
1. Rust spores + *	98	350	574	392	1414	1.8
2. Smut spores + *	126	448	938	770	2282	2.9
Total	224	798	1512	1162	3696	4.7
E. Deuteromycotina						
1. *Alternaria* +	392	1582	1820	770	4564	5.8
2. Aspergilli+Penicilli *	266	700	994	560	2520	3.2
3. *Beltrania*	28	98	126	56	308	0.4
4. *Bispora*	-	84	98	56	238	0.3
5. *Cercospora* + *	154	462	644	392	1652	2.1
6. *Cladosporium* + *	2534	6062	9142	5516	23254	29.6
7. *Colletotrichum* +	56	210	350	252	868	1.1
8. *Corynespora*	-	-	56	28	84	0.1
9. *Curvularia* + *	672	1428	1372	1008	4480	5.7
10. *Diplodia* +	196	560	588	462	1806	2.3
11. *Drechslera* + *	280	812	1120	532	2744	3.5
12. *Epicoccum* *	252	560	602	476	1890	2.4
13. *Fusarium* + *	-	42	70	42	154	0.2
14. *Helminthosporium* + *	168	574	686	462	1890	2.4
15. *Heterosporium* *	112	434	336	210	1092	1.4
16. *Hirudinaria*	-	-	28	56	84	0.1
17. *Nigrospora* *	294	756	1372	882	3304	4.2
18. *Periconia* *	224	588	616	378	1806	2.3
19. *Phaeotrichoconis*	-	70	84	-	154	0.2
20. *Pithomyces* *	126	434	602	336	1498	1.9
21. *Spegazzinia*	84	126	154	112	476	0.6
22. *Stemphylium* *	-	98	140	-	238	0.3
23. *Tetraploa*	-	-	56	98	154	0.2
24. *Torula*	112	294	518	168	1092	1.4
25. *Trichoconis*	-	28	42	-	70	0.1
Total	5950	16002	21616	12852	56420	71.8
F. Other types						
1. Hyphal fragments + *	182	532	658	826	2198	2.8
2. Insect scales (parts) *	70	168	210	112	560	0.7
3. Pollen grains *	224	574	686	392	1876	2.4
4. Trichomes (hairs)	98	210	294	336	938	1.2
5. Unidentified spores	266	434	658	448	1806	2.3
Total	840	1918	2504	2114	7378	9.4
Grand Total	**8498**	**21938**	**29583**	**18578**	**78596**	**100**

Note : + = Pathogenic, * = Allergenic

Table 2: Comparative data of temperature, relative humidity, rainfall and spore percentage.

Month	Temperature (°C) Mean	Relative humidity (%)	Rainfall (mm)	Spore %
December	19.9	56.2	-	10.8
January	20.2	51.8	2.4	27.9
February	21.3	54.6	4.6	37.7
March	30.1	42.2	-	23.6

Table 3: Average monthwise percentage contribution of each spore group to the total airspora over maize fields.

Spore group	December	January	February	March
Mastigomycotina	2.5	2.2	1.7	0.8
Zygomycotina	1.8	1.1	1.0	0.9
Ascomycotina	13.2	11.4	10.7	11.5
Basidiomycotina	2.6	3.6	5.1	6.3
Deuteromycotina	70.0	72.9	73.0	69.2
Other types	9.9	8.8	8.5	11.3
Total	100	100	100	100

concentration (686/m^3 of air) during month of February and minimum monthly mean contribution (224/m^3 of air) during month of December. Pollen grains play important role in nasobronchial allergy (Verma 1995). Singh (1987) reported pollen grains in causing allergy and human health hazards. People working in agricultural fields often suffer from various allergic ailments like agricultural asthma, repeated cold and sneezing. Fungal aerobiopollutants, pollen grains, insect scales and hyphal fragments affect the human health and cause allergy (Shivpuri 1980, Khandelwal 2002).

Aerobiopollutants showed considerable fluctuation throughout the study period, and were controlled by the meteorological factors. It was found that moderate temperature and relative humidity could harbour maximum biopollutants in the air over maize fields. Presence of many fungal spores may be related to the abundance of parasitic and saprophytic forms in and around the vicinity of the sampling site. Majority of the biopollutants are aeroallergens which are potential source of allergy and their inhalation may cause respiratory allergic diseases in human beings. The collected information in this study may provide basic data to the clinicians for the treatment of sensitive patients suffering from allergy. It will also help in avoidance and management of aeroallergens.

The abundance of aeroallergens in the ambient air over agricultural fields may cause health problems like asthma, allergy, pulmonary disorders, rhinitis, repeated cold, sneezing, mycoses, breathlessness and skin diseases. Similar findings were reported by Husanian (1985), Karne (2008) and Shivpuri (1982). Thus, it can be stated that there is no fungal spore free period in the environment, and these studies in relation to allergy and phytopathology will bring forth many useful and meaningful results for implementing cheaper and better preventive measures of crop plant disease management and allergy avoidance.

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