V: Remedial measures to protect crop plants from disease causing organisms through disease forecasting

Introduction

Climate-related factors can induce impact on the physiology and distribution of living organisms, such as plants and fungi. There is evidence that climate change affects pollen and spore production by plants and fungi as well as different phenological events (Cecchi, 2010). Climate changes can be considered a major threat for global health to be faced during the coming decades. Human activities and production processes are directly affecting the weather, particularly in terms of generation of gases responsible for the greenhouse effect (i.e., CO$_2$, CH$_4$ etc.). The consequent increase of global warming, associated to extreme weather conditions, affects human health in different ways. Among these, we need to underline the increase of allergic problems, and the worsening of previous diseases, since there is a strong correlation between the climate change and the pollen, fungal spore production, the atmospheric concentration and allergic sensitivity. The pollens and fungal seasonality and, the geographical distributions of plants are related to pollen and fungal spore production (Ridolo et al., 2013) and human allergic disorders.

Mechanisms are needed to adopt the response to the impact of current and future climate scenario. In the field of allergology, study of aerobiology is necessary, in particular, to implement a careful monitoring of pollen and fungal species, both are known as immerging, area of research, thereby improving the forecasts on the annual
pollen and fungal concentration in the atmosphere and also by providing appropriate education to allergic patients to deal with the effects that climate change is going to have and will increasingly have the impact on the allergic disease.

Abnormal changes in air, temperature and rainfall increased intensity of storms, drought and flooding, which are currently concern to Indian agriculture and agro-industries. Climate patterns change has been thought to affect spatial distribution of agro-ecological zones, habitants, distribution patterns of plant diseases and pests, which can have significant impacts on the food production. Disease monitoring and forecasting have become immediate necessity to cater long term or short term climate change adaptation measures.

Meteorological conditions clearly have profound influences on the production, dispersal and deposition of fungal spores (Li et al., 1994). Rain, wind speed, wind direction, humidity, temperature and flora and fauna in the testing area are among the major factors which affect the concentration of airborne fungal spores (Al –Doory et al., 1980, Singh, 1992). Aerobiological studies enable us to ascertain the concentration of the fungal spores present in the atmosphere and give better understanding of the relationship between their concentrations and the weather parameters (Gofron and Bosiacka, 2015).

Keeping the above in view some observations on the aerobiological studies to make a fungal spore calendar was undertaken in the present work.
Materials and Methods

Meteorological parameters such as temperature, relative humidity, rainfall and wind speed of Moreh area were recorded from ICAR complex Lamphelpat, Imphal and compared with the occurrence of fungal spores in the atmosphere of Moreh, Manipur.

Result and Discussion

Aerobiological methods can be widely used for different purposes (Jedryczka et al., 2008). The most widespread monitoring of pollen grains and fungal spore concentration in the air samples are used as an advisory tool for allergic patients. Sampling of air can also help in monitoring the airborne inoculums of damaging pathogens of agricultural crops.

The fungal forecast was done with the primary consideration of the fungal diseases of crops and allergenicity for the allergy sufferers. There was difference in the number of fungal spores in the atmosphere of residential and open area of Moreh during spring and rainy seasons (Table: 5.1, 5.2, 5.3 and 5.4). 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 and maximum temperature was 11.1°C and 28.7°C and relative humidity was 77% and 62.1% respectively, whereas minimum number of spores were isolated in
the month of May, 2012, when minimum and maximum temperature was 18.6°C and 32.7°C, respectively and relative humidity were 62.1% (Fig. 5.1 and 5.2). While for open area (near market) the maximum spores were observed in the month of September, 2013 (Figure: 3.3 & 3.4), when minimum and maximum temperature was 21.3°C and 30.3°C and relative humidity was 75.2% Whereas minimum number of spores were recorded in the month of December, 2012, when minimum and maximum temperature was 4.9°C and 22.8°C and relative humidity was 56.2% and 88.7%, respectively (Fig.5.3 and 5.4). Seasonal and diurnal aermycoflora in and around Moreh, Manipur was found to be related with the variation of the climatic conditions.

An individual’s sensitivity is specific to that individual only, therefore, the level of outdoor allergens may not reflect the potential of allergic reactions. This is due to the predominance of one or more specific species of pollen or spore, the possibility of multiple allergies, cross- reactivity between allergens or any combination of these. Allergies are very individual and reports on outdoor allergens have to be used in conjunction with the person’s reaction by the medical professionals. There are records of thousands of species of fungal spores trapped through air samplers, thus differentiating and understanding as to what they mean or what role they play in allergies needs to be worked out through research.

Blast disease was recorded in the air over rice field at Moreh, Manipur. The minimum number of fungal spores were recorded in the month of July, 2013. The corresponding meteorological data presents the minimum temperature of 22.6°C,
maximum temperature of 30.8°C, Relative humidity of 75.6% and average rainfall of 8.2mm, whereas the maximum number of spores were recorded in the month of September, 2012. The corresponding meteorological data shows the minimum temperature of 21.7°C and maximum temperature of 29.8°C, Relative humidity of 70.9% and average rainfall of 6.0mm (Fig.5.5 and 5.6). The spores of *Pyricularia oryzae* appeared in the air 3 to 6 days prior to the first onset of disease incidence and disease intensity index is closely related to the percentage of *Pyricularia* spores in the atmosphere (Singh and Singh, 1987).

Similarly, the comparative study of two year meteorological data revealed that the spore of *Gliocladium penicilloides* was abundantly recorded during 2012 and 2013 cropping season. Where the minimum number of spores were recorded in the month of June, 2013. The corresponding meteorological data was minimum temperature of 22.0°C and maximum temperature of 30.6°C, Relative humidity of 70.3% and rainfall 4.5mm while the maximum numbers of spores were recorded in the month of March, 2012. The corresponding meteorological data was minimum temperature of 11.1°C, maximum temperature of 28.7°C, relative humidity of 79.8% and rainfall of 2.4mm respectively (Fig. 5.7 and 5.8). Earlier workers also had predicted the plant diseases based on the weather parameters (Bahous *et al*., 2003; Krisnaveni *et al*., 2008; Singh *et al*., 2014).

During the study period many well known allergenic fungal spores were observed which contributed a major portion of the total aeromycoflora of the area viz., *Aspergillus fumigatus, Aspergillus niger, Aspergillus flavus, Cladosporium* sp., *Mucor* sp., *Fusarium*
moniliforms, *Alternaria* sp. etc. According to (Pastuszka *et al.*, 2000) *Cladosporium* sp., *Alternaria* sp. and *Aspergillus* sp. represent the main group of airborne moulds to which children may be sensitized and which may caused allergic symptoms. *Alternaria* sp. and *Cladosporium* sp. are considered to be the most important allergens in the outdoor air, as well as the cause of mycotoxin production and mycotoxicosis in humans (Novakovic, 2013).
Fig. 5.1. Metrological data in relation to the occurrence of airborne fungal spores (%)

for residential site at Moreh, Chandel District, Manipur during 2012
Fig. 5.2. Metrological data in relation to the occurrence of airborne fungal spores (% for residential site at Moreh, Chandel District, Manipur during 2013
Fig. 5.3. Metrological data in relation to the occurrence of airborne fungal spores (%) for open area (near market) at Moreh, Chandel District, Manipur during 2012
Fig. 5.4. Metrological data in relation to the occurrence of airborne fungal spores (% for open area (near market) at Moreh, Chandel District, Manipur during 2013
Fig. 5.5. Metrological data in relation to the occurrence of airborne fungal spores (%)

(%) over the rice field at Moreh, Chandel District, Manipur during 2012
Fig. 5.6. Metrological data in relation to the occurrence of airborne fungal spores (% over the rice field at Moreh, Chandel District, Manipur during 2013
Fig. 5.7. Metrological data in relation to the occurrence of airborne fungal spores (%), over the cabbage field at Moreh, Chandel District, Manipur during 2012.
Fig. 5.8. Metrological data in relation to the occurrence of airborne fungal spores (%)

  over the cabbage field at Moreh, Chandel District, Manipur during 2013
Conclusion

The air sampling can help to achieve monitoring of airborne inoculums of pathogens for damaging agricultural crops. The result obtained from the present studies would be helpful for developing disease forecasting system of crop fields in Moreh area, Manipur. Constant air monitoring of the well known allergenic fungal spores will also provide valuable information for the timely diagnosis and therapy of allergic diseases.