DISCUSSION

Vegetable markets are important source, substrates and sinks of fungal and bacterial growth because markets of these commodities are found in congested and crowded localities having shops of eatables, grocery, temporary vendors and residences. Such markets or areas have enough dust and to keep vegetables away from desication, sprinkling of water on them is a common practice of sellers in tropical countries like India which offer excellent atmosphere for the growth of an array of microorganisms which cause:

1. Bio-pollution
2. Deteriorating agents
3. Spoilage microflora and as
4. Source of inoculum to standing crops and vice versa.

Consequently, scanning of these microbes especially airborne fungi and incidence of market disease has gained importance due to their diverse applications in triggering allergy and allied aspects of environmental, agricultural microbiology (Walker, 1957; Chupp and Sherf, 1960; Agarwal and Shivpuri, 1974; Kurup, 2000; Chandel, 2001; Verma, 2003; Lohare et al., 2009; Prester, 2011; Grishan et al., 2012).

With the view of the foregoing and the objectives delineated in the study, experimental results, emanating from the present
investigation entitled “Aeromycoflora of selected environments at Hapur” have been presented and analyzed in the light of findings of earlier studies. Selected microphotographs of the fungi are presented in support of results.

The number and types of spores in the air of areas under reference depend not only upon the substrate involved but also on weather variables, storage conditions degree of disturbance, packing materials and conditions, particulate matter, biopollution, agricultural and marketing stages and processes, building and biozone conditions (Chakrevorty and Nandi, 1972; Sarma and Bora, 1996; Raha and Bhattacharya, 1997; Singh et al., 1999; Bansal, 2002). Aeromycoflora over the markets of vegetables is dependent on a variety of factors like meteorological factors, particulate matter, biozones, water sources, vegetation decomposition and exhibits fluctuations and relationship between fungal spores in time and space between site to site, season to season, day to day, year to year and hour to hour, apart from sampling methods, time to exposure, incubation, temperature and media (Joshi, 2002; Singh, 2005).

During present investigation, the ecological niches studied for airborne mycospora near Garh Road, Chandi Road area of vegetable markets formed different biozones, conditions and crowdedness. Fungal catches from these areas were at variance as analysed in the results. Earlier, site to site, variations have been reported by
several authors like Kakde et al. (2001), Bansal (2002). Singh et al. (2005) found site to site variation in the aeromycoflora of Mawana while Sahney and Purwar (2002) reported on the aeromycoflora from the residential and crowed area of Allahabad, Kotwal et al. (2010) reported on the aeromycoflora from residential area of Nashik, Reddy et al. (2011) reported aeromycoflora in an area of Visakhapatanam, Nafis and Sharma (2012) reported on the aeromycoflora from crowed area of Chawri Bazar metro railway station, Delhi. Similarly, Joshi et al. (2005) observed differences in the medical stores of Meerut at various sites and Gola et al. (2005) found such differences to occur at various sites at Nainital.

The scanning and evaluation of aeromycospora like an other airspora is known to be dependent on methods of fungal isolation, media used, conditions operating on the media and its incubation (Singh amd Vats, 2006). There is general opinion that different methods often produce different results (Mishra and Sinha, 1987; Madan, 2000).

It is expected that sampling method should take following aspects into account :

1. Temporal variance
2. Location of sampling
3. Differences in spore shapes and sizes
4. Viability of the spores
5. Value of the air to be sampled (Markanday, 2002)
AEROMYCOSPORA IS FLUCTUATING AND DYNAMIC

According to Das (1992) in depth study of nature/environment clearly indicates that all biota remain embedded in their environment constituting a very well knit and interacting system governed by the laws of nature. It is this environment (soil, water or air) which stands as the life support system for individuals population, community, ecosystem and biosphere embedded there. In any case, air-quality is important for man, who has common future (Anonymous, 1987; Mishra, 1989 and Das, 1992).

SAMPLING OF AIRBORNE

There are broadly two patronized techniques for the identification and population measurement of aerial fungal spores:

1. Visual counting Method (VC) including Durham’s gravity sampler

(2) Settling plate technique or culture method.

None of these techniques however, addresses all the requirements of sampling without assumptions. Besides these techniques, a whole range of sampling devices are now well used and fungal spores may be collected on sticky surface slides, petridishes, filters, gravimetric sampling or sedimentation apart from volumetric samples like Burkard, Rotorod and Anderson (Singh and Vats, 2006). Therefore, in the present investigation, two complimentary techniques of fungal isolation have been used and their merits and demerits are as follows:
A. LIMITATIONS OF GRAVITY SLIDE EXPOSURE METHOD

1. Spores of several fungi being morphologically similar are very difficult to be identified on slides eg. *Aspergillus*, *Mucor*, *Penicillium* spores.

2. Spores of some fungi being either very small or hyaline do not possess sufficient diagnostic features that can be used as means of identification eg. Yeasts, *Phoma*, *Candida* spores etc.

3. Sometimes the material trapped on slides may get washed away by rain or blown by strong winds.

B. LIMITATIONS OF CULTURE PLATE METHOD

1. As this technique is expected to give the frequency of the spores only for the duration of exposure, it may not yield a representative sample of the fungal spores present during the entire 24 hours.

2. As the spores of some biotrophic fungi like rusts and facultative parasites like smuts and some non-viable fungal spores do not grow on nutrient media, these can not be identified in culture plates.

3. In petridishes, an individual spore or a group of spores of *Alternaria* and *Cladosporium* and the like will produce only one colony this sometimes may not give the correct quantitative representation of the spores in an unit area of atmosphere.
C. MERITS OF SLIDE EXPOSURE TECHNIQUE

1. This technique gives the approximate representative frequency of 24 hours.

2. Rusts and smuts (do not culture on media) can be identified on slides to some extent.

3. The spores which usually occur in groups can easily be counted on slides (cf. culture plates).

D. MERITS OF CULTURE PLATE METHOD

1. Most of the viable spores grow on media in petridishes.

2. The spores of Aspergillus, Candida, Penicillium, Mucor, Rhizopus, Trichoderma and Paecilomyces can be identified even upto their specific species level after they have grown on the culture media.

3. Viable fungal hyphae which grow on/in nutrient media can be identified.

The results of present study supports the above observation and the contention of Agarwal (1970). Hence, simultaneous use of above two methods is useful. But, petri exposure method, which is generally used when volumetric spore trap method facilities are lacking, has serious limitations, as a very few fungal colonies can grow to the size where they can be identified, because of the possibility of the over growth and mutual interference of adjacent colonies. In addition, fungi are also less responsive to serial dilution plating (cf. Priyanka Bansal, 2002).
ADVANTAGE OF A VARIETY OF MEDIA

It would be advantageous if the catches can be diluted or split between a variety of culture media (Chanda, 1992).

USE OF SELECTIVE CULTURE MEDIA IN AEROMYCOLOGICAL SCANNING

To overcome difficulties (ecophysiological of culture media), selective media have been developed and used. These are of kinds:

(a) Media for general mycological surveys, and
(b) Media for studying specific aeromycospora. Tuite (1969) and Tsao (1970) have described selective media used for isolation of pathogenic fungi. Bell and Crawford (1967) used Botran media for isolation of *Aspergillus flavus* from soil and peanuts while Rao *et al.* (1970) used potato dextrose agar (PDA) with sodium chloride (60 %). Sodium tairo-glycochlarate (0.1 %) and streptomycin (0.01 %) for investigating seed borne fungi of cotton seed. Earlier, Raper and Fennel (1965) have suggested the use of My-40 for the enumeration of airborne *Aspergillus*. Bansal (2002) also observed that selective media gave good isolation of *Aspergillus*. Rose Bengal-streptomycin agar was found to be good selective medium by Rogerson (1958) and Bansal (2002) for the isolation of *Aspergillus*. Earlier, Hudson (1969), Chute and Barden (1964) and Stallybrass (1961) also used selective media for the isolation of *Aspergillus* and used it with malt extract Agar Difco Tryptose agar.
and with sabourand agar. In the later two streptomycin was added to the plates to inhibit bacterial colonies likewise Rati and Ramalingam (1974) used 12 media to choose a medium for the selective enumeration *Aspergillus flavus*. These included PDA, MA, Rose Bengal, agar, Banana extract agar, V8 juice agar, Coconut meal agar, Kita’s basal Aspergine agar, Coo-oo agar, Corn meal agar (CA), Beelarvae extract agar and Malt yeast extract agar.

**EFFECT OF INCUBATION ON MYCOFLORA**

Fungi can grow over a wide temperature range (0-45°C) but optimum growth normally occurs between 20-30°C. *Cladosporium* can be restricted if incubated at 32°C and can be completely inhibited at 34°C. Likewise, temperature has an effect on *Aspergillus fumigatus*. Chakravarthy and Nandi (1972) reported that the incubated temperature affects isolation of *Cladosporium herbarum*.

**EFFECT OF TIME OF EXPOSURE ON MYCOFLORA**

Time of exposure on mycoflora is also important in the census of aeromycospora. Generally it ranges from 2 minutes to 10 minutes and should be repeated thrice to demonstrate diurnal periodicity.

Monitoring meteorological data, circadian and diurnal periodicities and climate changes and their effect on the distribution-quality and quantum of aeromycospora is an important upcoming aspect. Seasonal, circadian and diurnal variations in aeromycospora like present investigation have earlier been reported
by several workers like Mishra and Kamal (1971), Kumar and Gupta
(1976), Verma et al. (1981), Verma and Kamal (1982), Nayhak and
Behera (1996), Singh et al. (2004), Singh et al. (2005) and Singh
et al. (2005) lending full support to the present study.

Trends of fungal dominance were also variable at different
place and seasons. For instance Verma and Georde (1995) found
Cladosporium>Aspergillus>Alternaria>Curvularia and Nigrospora to
be dominant in decreasing order at Jabalpur while Joshi et al.
(2005) found the following order in medical stores at Meerut :
Aspergillus>Alternaria>Curvularia>Cladosporium. Similar results
were obtained by Deepanjali Gogo and Hazarika (2002) in Assam.
Gaur and Kasana (1981) and Teotia (1991) found the similar trend
at Modinagar and Meerut on the fruits and seeds of Carica papaya.
Anjali et al. (2005) found the following trend : Alternaria>
Aspergillus>Colletotrichum=Fusarium which varied on different
growth stages and varieties place and isolation media. On the other
hand, Chaudhury (2005) observed variable dominance trend of air
borne fungi in different dump yards as follows :

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Sites</th>
<th>Trends</th>
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<tbody>
<tr>
<td>1.</td>
<td>Abudrain garbage</td>
<td>Asp&gt;Alt&gt;Cur&gt;Clad</td>
</tr>
<tr>
<td>2.</td>
<td>Vegetable &amp; fruit</td>
<td>Asp&gt;Clad&gt;Peni&gt;Fus</td>
</tr>
<tr>
<td>3.</td>
<td>Modipuram potato country store</td>
<td>Asp&gt;Clad&gt;Drech&gt;Fus</td>
</tr>
<tr>
<td>4.</td>
<td>Landfills</td>
<td>Asp&gt;Clad&gt;Alt&gt;Cur</td>
</tr>
<tr>
<td>5.</td>
<td>Biomedical wastes</td>
<td>Asp&gt;Alt&gt;Clad&gt;Cur</td>
</tr>
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</table>
But, the general trend of dominance was $Asp > Alt > Cur > Clad$. In any case these four fungi were dominant air fungi with variations.

Aeromycology of vegetable markets has gained importance due to its relevance to market aerobiology and disease incidence to human diseases (Ray et al., 1992). The presence of fungal spores on vegetables and fruits assume significant source domain to airborne infection and disease (Verma and Sheorey, 1994). Hence, only scanty sporadic work has been undertaken on the market diseases and aeromycospora of fruit and vegetable markets with conceptual approach for minimal national standards for environmental hygiene but literature review shows that such work done so far in vegetable markets comprises at Agra (Kulshrstra and Chauhan, 2002), Allahabad (Sohney and Purwar, 2002), Bangalore (Narayan et al., 1982; Sullia and Khan, 1980), Bhagalpur (Ghani, 1996), Bombay (Rao, 1994), Guwahata (Sarma and Bora, 1996), Gulbarga (Bellad and Reddy, 1989), Jabalpur (Verma and Khare, 1988; Verma and Sheorey, 1994), Lucknow (Wadhwani and Srivastava, 1985), Nainital (Bisht et al., 1997), Trivendurm (Chandel, 2001) while Bagwan and Meshram (2000) have worked on the aeromycospora over fruit store. *Aspergillus, Cladosporium, Alternaria* and *Drechslera* were trapped in good numbers followed by other types *Corynespora, Diplodia, Colletotrichum, Curvularia*
and Didymosphaeria etc. The atmosphere of the vegetable markets is bound to become a large and dynamic reservoir of inoculum due to constant built up of spore population from fungi growing on stored and dump plant material and serves as a source from where spores constantly get deposited causing damage to fresh arrivals of fruits and vegetables. Newer pathogens may also be added with plant materials with the arrival of new diseases. All put together constitute a good chunk of aeroallergens which may be of concern to vegetable and fruits handlers in particular and common man in general who need to be aware of the ill health effects of aeromycoflora (Sullia and Khan, 1980; Bellad and Reddy, 1983 and Bansal, 2002).

A high percentage of common representation of fungi both in the market atmosphere and on the market samples screened which were found to be possible incidents of vegetables (viz. Rhizopus spp, Aspergillus niger, A. flavus, Penicillium spp, Fusarium spp, Drechslera spp, Curvularia lunata, Alternaria solani, Botryodiplodia theobromae, Cladosporium spp, Choanephora spp, Geotrichum spp, Humicola spp, Mucor spp and Chaetomium spp showed a similar pattern and a definite relationship between the air fungal spore and the market diseases of vegetables. This too is in line of earlier observations.

In the present investigation, the trend of dominance was different at different sites. In vegetable market alone, the two
methods of fungi isolation showed the dominance in order
Aspergillus>Alternaria>Curvularia>Cladosporium>Fusarium.

The present investigation revealed that maximum numbers of
spores types were found in Main Garh Road vegetable market
Hapur.

Besides, material to material specificity in fungi was also
observed. For instance, Phytophthora infestans, Rhizoctonia solani
were exclusive to potato, Fusarium avenaceum, Alternaria tenuis
was specific to tomato. Likewise, Alternaria dausi specific to carrot,
Dictyoarthrinium spp and Uromyces fabae to beans, Colletotrichum
dematium to cauliflower, Colletotrichum capsici to chillies, C.
gloeosporoides to onion, C. papaya to papaya, Phytophthora
colocasiae to arbi and Alternaria melongenae to brinjal.

Thus, besides few specific pathogens, market disease and
airborne fungi were mostly either field fungi or opportunistic
saprophytes. Nevertheless, rot fungi played a great role in the
decomposition of heaps of vegetable garbage.