Plant Archives Vol. 14 No. 1, 2014 pp. 177-184 ***ISSN 0972-5210***

RISK OF POLLEN ALLERGY IN ROHTAK CITY (HARYANA), INDIA : A POLLEN CALENDAR

Manisha Ahlawat and Pushpa Dahiya*

Department of Botany, Maharshi Dayanand University, Rohtak, Haryana-124001.

Abstract

Pollen grains are known as one of the important bioparticles causing allergic manifestation in human beings. Hence, knowledge of season and prevalence of the airborne allergens to which the patients are exposed is a prerequisite for the diagnosis and treatment of patients suffering from allergic disorders. Keeping this in view, aeropalynological study was carried out in the atmosphere of Rohtak city for two consecutive years (July, 2007–June, 2009), using a volumetric spore trap. A total of 31 pollen types were recorded during the survey period. In the two years of study, March–April and July – October, were identified as the pollen seasons for Rohtak city. Average annual pollen catch of 59,750 grains was obtained with 80–85% of pollen recorded from February to May**.** The highest monthly counts were recorded in the month of September and July for the first and second year, respectively. The principal pollen producers were *Cannabis sativa* (28.9%), Poaceae (20.6 %), Cheno/ Amaranth (10.5 %) and *Parthenium hysterophorus* (6.8 %). Fourteen pollen types contributing more than 2% to the total catch were represented in the form of a pollen calendar. A significant positive correlation ($p>0.001$) of total pollen count with maximum and minimum temperature was observed.

Key words : Aeropalynology, pollen calendar, meteorological parameters, allergic ailments.

Introduction

The role of a pollen grain is to fertilize the female flower to reproduce plant species. In order to perform this function, pollen grains are released from flowering plants and are carried by the wind or insects to the other plants of the same type and during this process they become airborne. Nearly ninety-eight percent of the total pollen grains in the atmosphere are from anemophile plants, whereas 2% are from entemophile plants (Mullins and Emberlin, 1997; Molina *et al*., 2001). Pollen grains that are dispersed by the wind are small, light, dry and produced in huge quantities by the plant. They are important source of allergens and causative agents of allergic disorders like allergic rhinitis, allergic conjunctivitis and allergic bronchial asthma in hypersensitive individuals (Hyde, 1969; Kang *et al*., 1979; Nair *et al*., 1986; Malik *et al*., 1991; Leuscher *et al*., 2000; Singh and Kumar, 2003; Wani *et al*., 2011).

Although, pollen grains represent only a small proportion of the aerial bioparticulate matter, they are responsible for allergic responses in susceptible individuals, pollinosis hence is a health problem worldwide. Moreover, there is an escalating trend in allergic disorders and this has developed interest in the presence and movement of pollen grains in the earth's atmosphere and their impact on human health. Therefore, it is imperative to evaluate the airborne pollen types of different ecozones as aerial pollen concentration is determined by diversity of local flora and weather conditions. Aeropalynological studies have thus been carried out in several geographical regions of the country to study the pollen spectrum (Dua and Shivpuri, 1962; Agashe *et al.*, 1983; Gopi *et al.*, 1990; Wani *et al.*, 2011).

However, not much information in this regard is available from Haryana, a northern state of India with semiarid type of vegetation. Hence, the present study was planned with an aim to study the atmospheric pollen load of Rohtak city in Haryana by elaboration of a pollen calendar of dominant pollen types. The information will be beneficial in assessing the allergenic potential of the city and will be compared with other nearby stations. Moreover, the influence exerted by the meteorological factors on total pollen catch will also be established.

****Author for correspondence :*** Email:pushpa.dahiya@hotmail.com

Materials and Methods

Sampling procedure

Atmospheric survey was carried out for recording airborne pollen types using a personal volumetric glass slide sampler (Gautam Enterprises, New Delhi) with a flow rate of 10L/min. It is a portable, compact, battery/ power operated sampler. The sampling was carried out at a fixed site once a week at human height (1.8m) in Rohtak city for two consecutive years from July 2007-June 2009. A slide coated with glycerine jelly was inserted through a slit inside the sampler and was removed after 20 minutes of exposure. The slide was brought to the laboratory carefully in a slide box to avoid any contamination.

Identification of pollen

Pollen types trapped were identified by comparing them with corresponding pollen in reference collections made during extensive and periodic field trips to various parts of the city and adjoining areas covering various seasons of the year. In addition, pollen atlases available on internet and published literature were also consulted (Singh and Babu, 1980a; Lewis *et al*., 1984; Nair *et al*., 1986). Pollen concentration was calculated by dividing the obtained pollen count with the volume of air sampled (20 min. × 10 liter/min. × 0.001m^3/liter = 0.2 m^3) and was expressed as pollen grains/m^3.

Meteorological data analysis

The meteorological parameters taken into account for assessing the effect of meteorological conditions on the airborne pollen grains trapped were: rainfall (mm), relative humidity (%), maximum temperature (°C), minimum temperature (°C) and wind speed (Km/hr). The meteorological data for the days on which sampling was performed during the survey period was obtained from Regional Meteorology Centre, New Delhi. The relationship between the meteorological parameters and total pollen concentration obtained was calculated using Spearman's correlation coefficient. Statistical analysis was undertaken with SPSS version 11.5 and values of $p< 0.001$ were considered statistically significant.

Results

Of the total pollen types obtained during the survey period, pollen grains from herbaceous vegetation dominated the air spectrum (79.43%); the most important being *Cannabis sativa*, Poaceae and Cheno/Amaranth. Pollen grains from trees contributed 16.71% to the total catch followed by shrubs (figure 1). Pollen grains of *Morus alba*, *Cassia* sp. and family Myrtaceae were

Table 1 : Pollen types recorded in the atmosphere of Rohtak city (July 2007-June 2009) and their average percent contribution.

Pollen type	Family	Average percent contribution
Achyranthes sp.	Amaranthaceae	2.67
Acacia sp.	Mimosaceae	0.08
Aerva sp.	Amaranthaceae	0.13
Ageratum sp.	Asteraceae	2.10
Albizia sp.	Mimosaceae	0.14
Argemone mexicana	Papaveraceae	0.10
Artemisia sp.	Asteraceae	4.03
Azadirachta indica	Meliaceae	2.34
Bauhinia sp.	Caesalpiniaceae	0.02
Boerrhavia sp.	Nyctaginaceae	0.05
Brassica sp.	Brassicaceae	2.62
Cannabis sativa	Cannabinaceae	28.90
Cassia sp.	Caesalpiniaceae	2.15
Cheno/Amaranth	Chenopodiaceae/ Amaranthaceae	10.56
Croton sp.	Euphorbiaceae	0.15
Cyperus sp.	Cyperaceae	3.20
Delonix regia	Caesalpiniaceae	0.12
Ipomea sp.	Convolvulaceae	0.02
Liliaceae		0.10
Mangifera indica	Anacardiaceae	0.20
Morus alba	Moraceae	6.15
Myrtaceae		3.70
Parthenium hysterophorus	Asteraceae	6.80
Poaceae		20.65
Polyalthia sp.	Annonaceae	0.12
Pongamia sp.	Papilionaceae	0.10
Prosopis sp.	Fabaceae	0.15
Ricinus communis	Euphorbiaceae	2.00
Salvadora sp.	Salvadoraceae	0.07
Xanthium strumarium	Asteraceae	0.06
Zizyphus sp.	Rhamnaceae	0.02

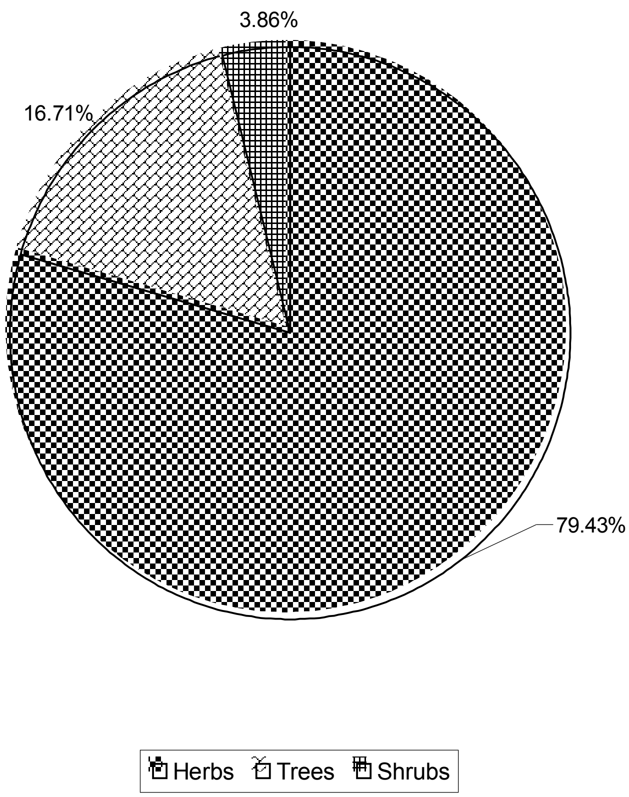

Fig. 1 : Percent contribution of herbs, shrubs and trees to total pollen load.

for two years are illustrated in figure 2. During the first year, peak concentration of 1920 pollen/m^3 was observed in fourth week (July, 2007). Two more peaks were also observed in ninth week (August 2007) and fifty second week (June, 2008) of this year with a concentration of 1685 pollen/m^3 and 1045 pollen/m^3, respectively. Minimum concentration of 95 pollen/m^3 was observed in twenty ninth week (January, 2008). In the second year, two peaks were observed in seventeenth (November, 2008) and seventh (July, 2008) week with a pollen count of 995 pollen/m^3 and 680 pollen/m^3, respectively. The lowest concentration (85 pollen/m^3) was recorded in sixth week (August 2008) during the second year of investigation.

In the present study, March–April and July – October were identified as the pollen seasons for Rohtak city although pollen grains were recorded throughout the year (figure 3). Major contributors to the first season were *Morus alba, Achyranthes* sp., Myrtaceae and *Brassica* sp. while predominant types of second season were *Cannabis sativa*, Poaceae, Cheno/Amaranth and *Parthenium hysterophorus*. During the first year, maximum pollen concentration was obtained in the month of July 2007 (4120 pollen/m^3) and minimum in January 2008 (515 pollen/m^3). In the next year, maximum pollen catch of 7550 pollen/ m^3 was recorded in September, 2008 and lowest concentration of 350 pollen /m^3 was recorded in February, 2009.

Table 2 : Correlation between pollen concentration and meteorological factors.

Meteorological factors versus total pollen	Maximum temperature	Minimum temperature	Rainfall	Wind speed	Relative humidity
Spearman's correlation coefficient	0.426*	0.450*	-0.016**	-0.005**	-0.044**
p- value	0.000	0.000	0.823	0.948	0.527

*Correlation is significant at the 0.001 level (2-tailed)
** ns – not significant.

dominant contributors from tree taxa while shrubs were dominated by *Artemisia* sp., *Achyranthes* sp., *Parthenium hysterophorus* and *Brassica* sp.

Aerial pollen diversity

A total of 31 pollen types belonging to 23 angiospermic families were registered during the two years of survey. The average percent contribution of different pollen types to the atmospheric pollen load is presented in table 1. Fourteen predominant pollen types comprised about 97.87% of the total pollen catch. *Cannabis sativa* pollen was predominant (28.90%) followed by Poaceae (20.65%) and Cheno/Amaranth (10.5%). *Parthenium hysterophorus* and *Morus alba* contributed about 6% followed by *Artemisia, Cyperus* and Myrtaceae.

The average weekly counts of total types together

A pollen calendar was designed for fourteen dominant pollen types in a pictogram form where columns of increasing height represented pollen concentrations of individual pollen types in different months (figure 4). In the pollen calendar, the different taxa follow the order in which the maximum peaks appear and only those taxa that showed more than 2% contribution to the total pollen catch were included. The yearly pollen concentration of each taxon showed marked seasonality, although *Cannabis sativa*, Poaceae and *Parthenium hysterophorus* occur year round. Apart from these, pollen of Cheno/Amaranth, *Cyperus* sp. and *Achyranthes* sp. were also sporadically recorded throughout the year. Major season for *Cannabis sativa* pollen was from May

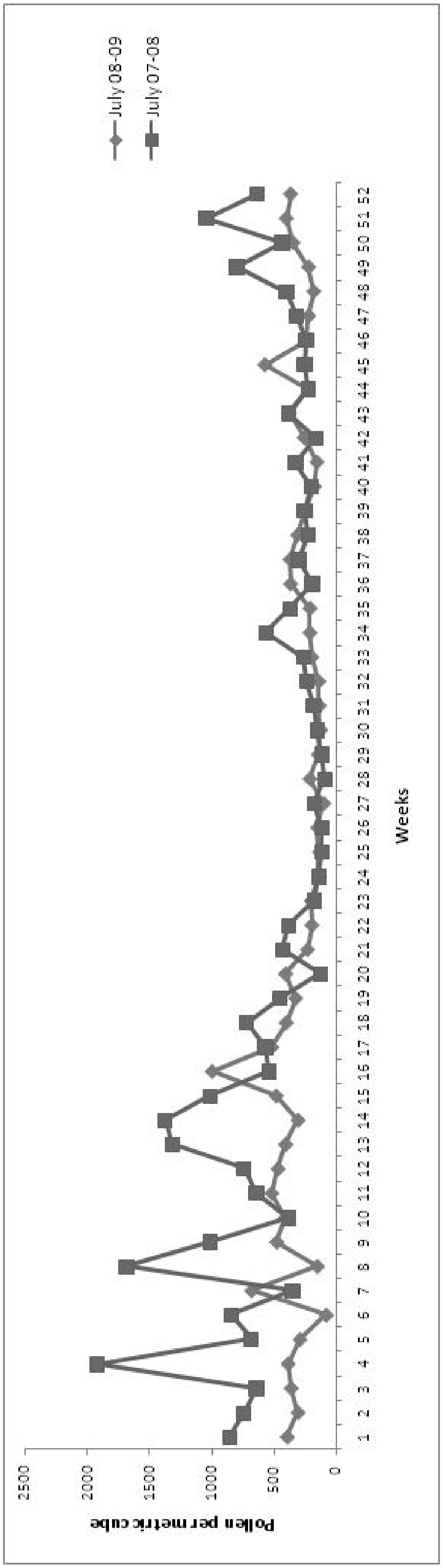

Fig. 2 : Mean weekly variations of total pollen during the two years of atmospheric survey.

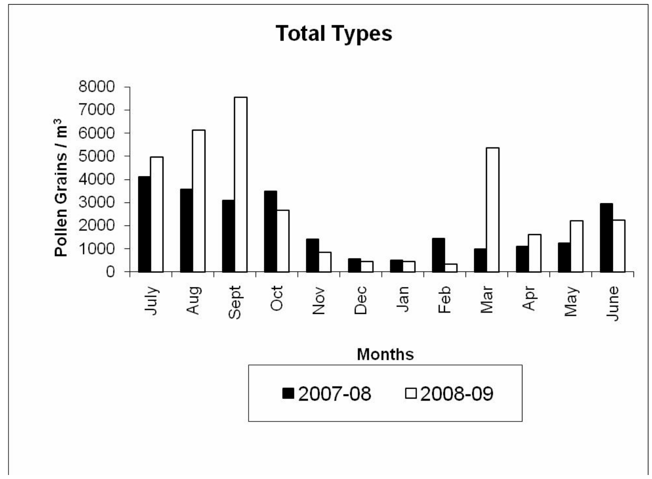

Fig. 3 : Histogram showing total monthly pollen counts during each year of survey.

to September while Poaceae pollen exhibited two peaks *i.e*. February- April and August - October. *Parthenium hysterophorus* and Myrtaceae revealed a peak from May to September and January to April, respectively. Pollen of *Morus alba* showed a very short and precise pollen season with remarkably high concentration in the month of March.

Statistical analysis

Spearman's Correlation coefficient was used to determine meteorological factors that influence the aerial prevalence of pollen (table 2). Total pollen count showed a highly significant positive correlation ($p<0.001$) with maximum and minimum temperature, whereas a non significant correlation was observed with rainfall, windspeed and humidity.

Discussion

This paper presents first qualitative and quantitative analysis of aerial spectrum with respect to pollen grains (pollen calendar) for Rohtak city. As a result of aeropalynological investigation carried out, 31 pollen types belonging to 21 families were identified. Apart from this, identity of a small fraction (0.5%) could not be established due to their distorted nature as a result they were grouped as 'Unidentified'. *Cannabis sativa* was the major contributor to the pollen load followed by Poaceae, Cheno/ Amaranth, *Parthenium hysterophorus*, *Morus alba*, *Artemisia* sp., *Cyperus* sp., Myrtaceae, *Achyranthes* sp. and *Brassica* sp. These types are expected because of the semi arid type of vegetative and pronounced seasons, both of which, to a large extent, determine qualitative composition of the airspora.

The pollen types recorded are broadly comparable with those reported from a nearby station like Delhi and

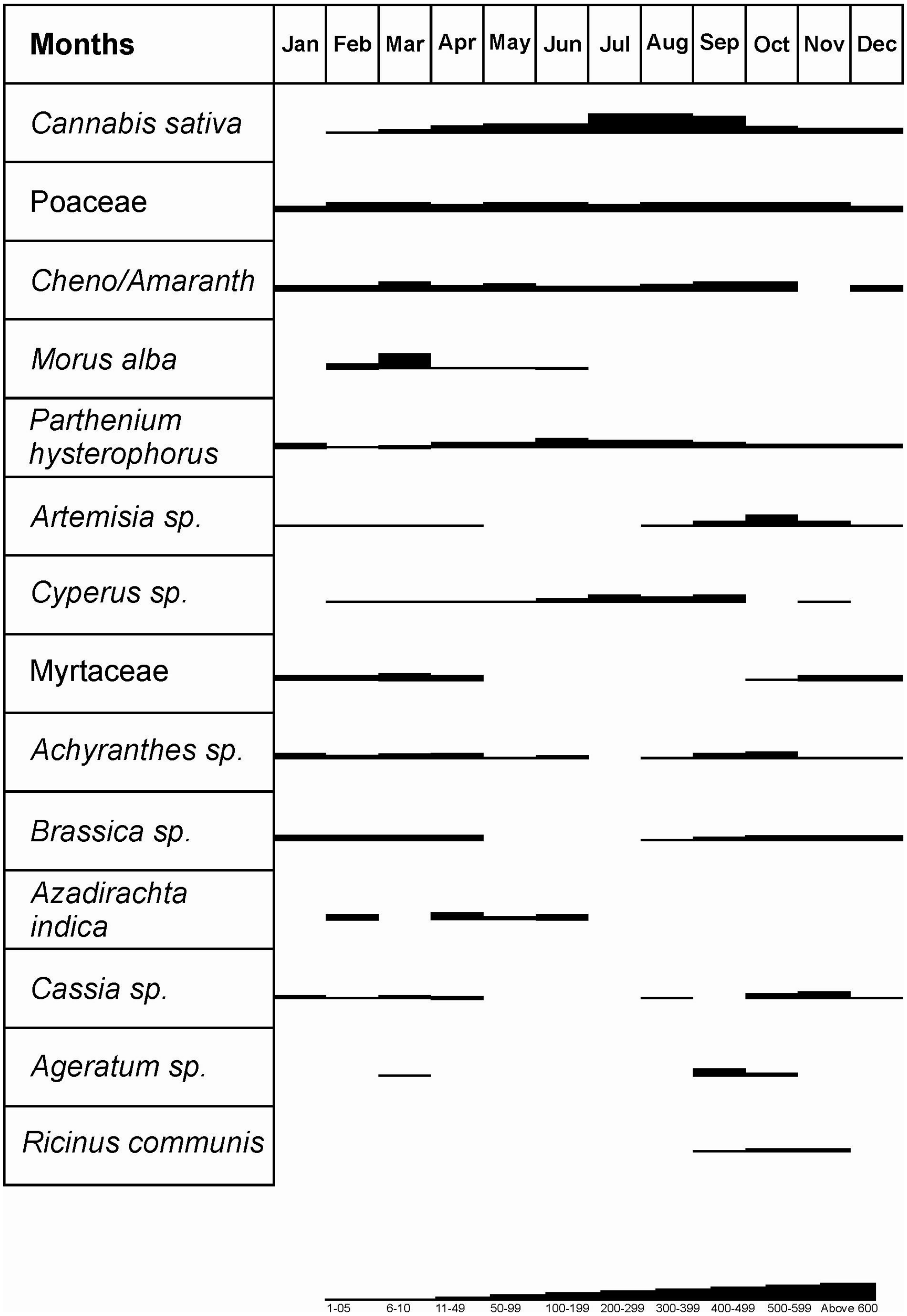

Fig. 4 : Pollen calendar of Rohtak city based on average monthly counts obtained from July 2007-June 2009.

Agra (Malik *et al*., 1991 ; Singh *et al*., 2003; Chauhan and Goyal, 2006). However, some pollen types like *Clerodendron, Holoptelea integrifolia*, *Nerium indicum*, *Taraxacum officinalis* and *Tecoma indica* reported from the above stations were not encountered in the present study; probably these trees are not abundant in the vegetation of the city. However, some pollen types like *Acacia* sp., and *Albizia* sp encountered in the present study are not reported by them. The heterogeneity observed by various workers can be attributed to the fact that the pollen types trapped are influenced by vegetation of the area, mode of sampling and the height at which samples are collected.

The wind pollinated taxa (anemophilous) belonging to grasses, weeds, cultigens and trees were the major contributor to airborne pollen load as they produce large number of small size pollen grains, which are mainly smooth, dry and buoyant. However, entomophilous taxa like *Brassica* sp. and members of Myrtaceae family also contributed to total pollen catch. This is probably because *Brassica* sp. is predominantly grown in surrounding cultivated fields and trees of Myrtaceae family like *Callistemon* sp. and *Eucalyptus* sp. are a part of urban planning. Similar contribution of the pollen from entomophilous plants to the airspora has also been reported by Dutta and Jain (1992) from Gwalior and Sharma *et al.* (2009) from Assam.

In general, two peaks for airborne pollen of Rohtak city were observed; first in March-April and a second in July-October. December and June were the months with least pollen catch at both the sites due to poor vegetation and scanty pollination during this time. During the first season, pollen of grasses, weeds and tree taxa like *Morus alba*, Myrtaceae, *Cassia* sp., *Prosopis* sp. were prevalent. The second season is dominated mainly by pollen of grasses and weeds. These results are expected because the pollination period of tree like *Cassia* sp., *Eucalyptus* sp. and *Morus alba* and few grasses and weeds coincide with March- April pollen season, whereas the pollination period of monsoon annual and perennial grasses (*Cynodon dactylon*, *Imperata* sp., *Cenchrus* sp., *Eragrostis* sp.) and weedy taxa (*Cannabis sativa*, Cheno/Amaranth, *Parthenium hysterophorus, Artemisia* sp., *Xanthium* sp.) coincide with the July–October pollen season. Similar to our observation, two peak seasons *i.e.* March- April and July- October were also reported from nearby areas like Delhi (Dua and Shivpuri, 1962; Malik *et al.,* 1991; Singh *et al.*, 2003) and Agra (Sharma and Dharke, 1995).

When the fourteen pollen types represented in the pollen calendar were related with their allergic effects, it was found that they are reported to be important aeroallergens from different geographical areas of India (Shivpuri *et al*., 1960; Tilak and Vishwanathan, 1980; Singh and Babu, 1980 b; Singh and Babu, 1982; Singh and Kumar, 2003; Mandal *et al*., 2008).

Of these, the presence of pollen of Poaceae family has great significance as it has been reported to have strong allergic effect, especially on patients with hay fever (Chapman, 1986). Poaceae pollen have also been reported to be the cause of pollinosis from different parts of the world (Stem and Timmermans, 1989; Hirsch *et al.,* 2000). Pollen of *Cannabis sativa*, Cheno/Amaranth and *Parthenium hysterophorus* can also be considered as an important source of aeroallergens in the study area due to their high aerial prevalence. Moreover, allergenicity of these pollen types has been established from different parts of the country (Chauhan and Goyal, 2006; Singh *et al*., 2003; Mandal *et al*., 2008).

Pollen calendars are very useful for clinicians as well as allergic patients to establish chronologic correlation between the concentration of pollen in air and seasonal allergic symptoms. Keeping this in view, pollen calendar of Rohtak city was constructed for the first time for 14 dominant types. This will provide preliminary but useful data to allergologists for diagnosis and management of allergic ailments. This information will be beneficial for the hypersensitive individuals in managing their routine activities so as to minimize their contact with allergens and improve the quality of life. Likewise, pollen calendars of different geographical regions have also been constructed by workers around the globe (Leuschner, 1974; Nilsson *et al*., 1977; Nilsson and Palmberg-Gotthard, 1982; Emberlin *et al*., 1990; Ong *et al*., 1995; Lorenzoni *et al*., 1998; Weryszko-Chmielewska and Pitrowska *et al*., 2001; Celent and Bicakci, 2005; Chauhan and Goyal, 2006; Recio *et al*., 2006; Mandal *et al*., 2008; Pasha and Hossain, 2009; Altunoglu, 2010; Ceter *et al*., 2011).

In the present study, a highly significant positive correlation was observed between total pollen catch and maximum and minimum temperature. It is well established that temperature is a major factor that influences the release of pollen into the atmosphere (Iglesias *et al*., 2003). Positive correlation of maximum and minimum temperature with pollen load in the study could be attributed to the fact that temperature dehydrate the anthers and cause them to burst and release pollen into the air (Ong *et al*., 2011). Results consistent to the present finding have been reported from India and all around the world (Rutherford *et al*., 1997; Agashe and Alfadil, 1989; Mishra *et al*., 2002; Stennett and Beggs, 2004; Mandal *et al*., 2008). However, contrary to our findings, Mishra *et al.* (2002) from Jabalpur observed a negative correlation between temperature and pollen count. However, the correlation was non significant. Similar results were also encountered by Sahney and Chaurasia (2008) from Allahabad.

It is well established that wind speed, relative humidity and rainfall plays an important role in the dispersal of pollen grains and hence their prevalence in air. However, no significant correlation was observed between total pollen catch and these parameters. This is probably because it is quite complicated to separate the influence of individual meteorological factors. Moreover, it seems that from such short term studies it is difficult to achieve concrete conclusions thus necessitating the need of continuous long term monitoring of airspora for analysing the effect of meteorological parameters.

References

Agashe, S. N. and A. G. Alfadil (1989). Atmospheric biopollutants monitoring in relation to meteorological parameters. *Grana,* **28** : 97-104.

Agashe, S. N., P. Anand, K. Manjunath and J. N. Abraham (1983). Airborne pollen survey at Bangalore city (A preliminary study). *Asp. Allergy Appl. Immunol.,* **16** : 53.

Altunoglu, M. F., E. Toraman, M. Temel, B. Adam and M. Kargioglu (2010). Analysis of airborne pollen grains in Konya, Turkey. *Pak. J. Bot.*, **42 (2)** : 765 – 774.

Celink, S. and A. Bicakci (2005). Aerobiological investigation in Bitlis, turkey. *Annals of Agricultural and Environmental Medicine*, **12(1)** : 87-93.

Ceter, T., N. M. Pinar, K. Guney, A. Yildiz, B. Asci and M. Smith (2011). A 2- year aeropalynological survey of allergenic pollen in the atmosphere of Kastamonu, Turkey. *Aerobiologia*, DOI 10.1007/s10453-011-9240-0.

Chapman, J. A. (1986). Aeroallergens of Southeastern Missouri, USA. *Grana*, **25** : 235-246.

Chauhan, S. V. S. and R. Goyal (2006). Pollen calendar of Agra city with special reference to allergenic significance. *Journal of Environmental Biology*, **27(2)** : 275-281.

Dua, K. L. and D. N. Shivpuri (1962). Atmospheric pollen studies in Delhi area in 1958-59. *J. Allergy*, **33** : 507-512.

Dutta, T. R. and A. R. Jain (1992). Studies in the aerobiology of Gwalior- pollen grains. *Ind. Bot. Soc.*, **71** : 221-224.

Emberlin, J., J. Norris-Hill and R. H. Bryant (1990). A tree pollen calendar for London. *Grana*, **29** : 301-309.

Gopi, T. V., R. P. Kumar, P. Ravindran and P. K. K. Nair (1990). Comparative analysis of airspora of two urban localities in Kerela. *Ind. J. Aerobiol.*, **3** : 39-44.

Hirsch, T., V. Neumeter, E. von Hut, D. Hirsch and H. Grafe (2000). Traffic exposure and allergic sensitization against latex in children. *J Allergy Clin Immunol.*, **106(3)** : 573-8.

Hyde, H. A. (1969). Aeropalynology in Britain-an outline. *New Phytologist,* **6** : 579-590.

Iglesias, I., J. Mendez and P. Comotis (2003). Aerobiological survey of Alnus pollen in Ourense (N. W. Iberian Peninsula), 1993 – 2000. *Grana*, **42** : 112 – 120.

Kang, B., D. Vellody, H. Homburger and J. W. Yunginger (1979). Cockroach cause of allergic asthma. Its specificity and immunologic profile. *J. Allergy Clin. Immunol.*, **63** : 80-86.

Leuscher, R. M., H. Christen, P. Jordan and R. Vonthein (2000). 30 years of studies of grass pollen in Basel (Switzerland). *Aerobiologia*, **16**: 381 - 391.

Leuschner, R. M. (1974). Investigation on airborne pollen in Basel and Davos (Switzerland) in connection with pollinosis. *Grana* (Abst.), **14** : 40.

Lewis, W. H., P. Vinay and V. E. Zenger (1984). Airborne and allergenic pollen of North America. The John Hopkins University Press. U. S. A.

Lorenzoni, F. C., M. Giorato and G. Marcer (1998). Phenological and aerobiological monitoring of allergic flora in Pauda (Italy). Preliminary data. *Aerobiologia,* **14** : 285-289.

Malik, P., A. B. Singh, C. R. Babu and S. V. S. Gangal (1990). Atmospheric concentration of pollen grains at human height. *Grana*, **30** : 129-135.

Mandal, J., P. Chakraborty and I. Roy (2008). Prevalence of allergic pollen grains in the aerosol of the city of Calcutta, India : a two year study. *Aerobiologia*, **24** : 151-164.

Mishra, R. P., B. Singh and M. Oommachan (2002). Airborne pollen flora of Jabalpur- the central India. *Aerobiologia*, **18** : 73-81.

Molina, R. T., I. S. Palacios, A. F. M. Rodriguez, J. T. Munoz and A. M. Corchero (2001). Environmental factors affecting airborne pollen concentration in anemofil species of *Plantago*. *Ann Bot*., **87** : 1–8.

Mullins, J. and J. Emberlin (1997). Sampling pollens. *J Aeresol Sci.,* **28** : 365–370.

Nair, P. K. K., A. P. Joshi and S. V. S. Gangal (1986). Airborne pollen, spores and other plant materials of India- A survey. CSIR Centre for Biochemicals, Delhi and National Botanical Research Institute, Lucknow.

Nilsson, S. and J. Palmberg- Gotthard (1982). Pollen Calendar of Huddinge (Sweden) 1977- 1981. *Grana*, **21** : 183-185.

Nilsson, S., J. Praglowski and N. Nilsson (1977). Atlas of Airborne Pollen Grains and Spores in Northern Europe. Almquist and wiksell International, Stockholm, Sweden. Ong, E.K., M.B. Singh and R.B. Knox (1995). Grass pollen in the atmosphere of Melbourne: seasonal distribution over nine years. *Grana,* **34** : 58-63.

Ong, T. C., S. H. Lim, X. Chen, S. D. Mohd Dali, H. T. Wah Tan, B. W. Lee and F. T. Chew (2011). Fern spore and pollen airspora profile of Singapore. *Aerobiologia,* DOI 10.1007/s10453-011-9217-z.

Pasha, M. K. and M. S. Hossain (2009). Airborne pollen grains at Chittogong University Campus, Bangladesh. *Bangladesh J. Bot*., **38(1)** : 34 – 46.

Recio, M., M. Del Mar Trigo, F. Toro, S. Docampo, J. Garcia – Gonzalez and B. Cabezudo (2006). A three year aeropalynological study in Estepona (Southern Spain). *Ann. Agric. Environ. Med*., **13(2)** : 201 – 7.

Rutherford, S., J. A. K. Owen and R. W. Simpson (1997). Survey of airspora in Brisbane, Queensland, Australia. *Grana*, **36** : 114-121.

Sahney, M. and C. Chaurasia (2008). Seasonal variations of airborne pollen in Allahabad, India. *Ann Agric Environ Med*., **15** : 287-293.

Sharma, A. K. and J. S. Dharke (1995). Flora of Agra District. Publ. Botanical survey of India.

Sharma, D., B. K. Dutta and A. B. Singh (2009). Biochemical and immunological studies on eight pollen types from South Assam, India. *Iran J. Allergy Asthma Immunol*., **8 (4)** : 185-192.

Shivpuri, D. N., R. Viswanathan and K.L. Dua (1960). Studies on pollen allergy in Delhi area I-pollination calendar. *Ind. J. Med Res*., **48** : 15-20.

Singh, A. B., T. Pandit and P. Dahiya (2003). Changes in airborne pollen concentrations in Delhi, India. *Grana*, **42** : 168-177.

Singh, A. B. and C. R. Babu (1980b). Pollen types in atmosphere of Delhi. *Phytomorphology*, **30** : 180 – 189.

Singh, A. B. and C. R. Babu (1982). Survey of atmospheric pollen allergens in Delhi : Seasonal periodicity. *Ann. Allergy*, **48** : 115 – 122.

Singh, A. B. and C. R. Babu (1980a). Studies on pollen allergy Delhi: Diurnal periodicity of common allergenic pollen. *Allergy*, **35** : 311 – 317.

Singh, A. B. and P. Kumar (2003). Aeroallergens in clinical practice of allergy in India. An overview. *Ann. Agric. Environ. Med*., **10** : 131-136.

Stem, J. and A. Timmermans (1989). The diagnosis of IgE-mediated allergy of the upper airways. *Ned Tijdschr Geneeskd*., **133(35)** : 1759-60.

Stennett, P.J. and P.J. Beggs (2004). Pollen in the atmosphere of Sydney, Australia and its relationship with meteorological parameters. *Grana*, **43** : 209-216.

Tilak, S. T. and D. B. Vishwanathan (1980). Aeroallergenic pollen at Aurangabad.- In: Advances in pollen – spore research. No. 5-7 (ed. PKK Nair, M Nagaraj SN Agashe), pp. 145-150- Today and Tomorrow's Pr. Publ., New Delhi.

Wani, N. A., A. H. Munshi, Z. A. Shah, R. Rasool and M. Hameed (2010). Specific Immunoglobulin E (IgE) and Skin Prick Test (SPT) responses against battery of pollen antigens in allergic subjects of Kashmir- India. *African Journal of Basic & Applied Sciences*, **2(1-2)** : 30-32.

Weryszko- Chmielewska, E., M. Puc and P. Rapiejko (2001). Comparative analysis of pollen counts of *Corylus, Alnus* and *Betula* in Szezecin, Warsaw and Lublin (2000-2001). *Ann. Agric. Environ. Med.*, **8** : 235-240.