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Seasonal variations in airborne pollen concentration in Rohtak city, Haryana, India.

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Abstract

One of the major bioparticles responsible for allergic reactions in humans is believed to be pollen grains. Therefore, understanding the season and the frequency of the airborne allergens that patients are exposed to is essential for both diagnosis and treatment of patients with allergic illnesses. An aerobiological survey was conducted from March 2023 to February 2024 in order to determine the qualitative and quantitative changes in airborne pollen concentrations of Rohtak city. Air samples were taken at weekly interval, at human height (1.8 meters), using by personal volumetric glass slide sampler. Total 34 different pollen types were identified, with Poaceae, *Cannabis, Morus, Parthenium, Chenopod/Amaranth, Artemisia*, Myrtaceae and *Achyranthes* being the main contributors. Ninety percent of the overall pollen load came from ten different pollen types. There were two main pollen seasons observed annually (March–April and July–October) however, pollen grains were identified at low frequencies throughout the entire year. There were also differences in sites with the sites bordered by dense vegetation showing higher pollen burdens. For the purpose of accurately diagnosing and treating respiratory allergic illnesses, the study will provide local allergologists preliminary but helpful data.

Keywords: Pollen, Aerobiological, Allergens, Survey, Allergic ailments.

1. Introduction

Air contains large amount of bioparticles like pollen, fungal spores dust mites which are responsible for triggering the allergic disorder like allergic rhinitis, bronchial asthma, atopic dermatitis in hypersensitive patient (Roubelat et al., 2020). Various types of allergies are caused by airborne pollen grains from a variety of plant species. It is generally present in pollen grains and fragments carried by the wind within the size range of 10 to 50 µm. Numerous studies were carried out to determine the probable allergenic pollen species since allergic rhinitis has grown to be a severe respiratory disease (Ajikah et al., 2021). Certain proteins and glycoproteins included in these allergenic particles are

released when they come in contact with the human respiratory system, releasing specific chemicals that trigger an allergic reaction in the body.

Knowing the seasonal variations of pollen types in the air enables allergists to identify the pollen allergens of a specific period in the atmosphere and treat patients with various hypersensitive allergy illnesses (Albaradie et al., 2013). To improve knowledge of the variety of allergenic species and the seasonal patterns of their distribution in local vegetation, aerobiological studies are carried out (Agashe et al., 2021). The effects of climate change on pollen variation and spatiotemporal distribution can also be examined with this data, and pollen-related public health concerns can be addressed. A crucial aspect of studies on pollination ecology is determining the origin of the pollen. A large portion of the flora is made up of the pollen grains that are released by wind-pollinated. the amount and make-up of air pollen flora are affected by local vegetation, climate, and geographical location. Numerous kinds of biocomponents are present in the atmosphere, according to aerobiological studies. Since airborne pollens are the primary cause of respiratory allergies, allergologists placed significant importance on a thorough analysis of the pollen spectrum in a particular location's atmosphere. John Bostock (1819) was first to suspect pollen to be the causative agent of allergic rhinitis (Hay fever) (Rauer et al., 2021). Blackley (1873) also reported grass pollen to be responsible for Hay fever in U.K. Scheppegrell (1916) from USA laid emphasis on the aerial survey for recording aeroallergens from the atmosphere (Singh & Mathur, 2017). Since then, a lot of studies have been carried out in different parts of the world and pollen are established to be the major causative agents of respiratory allergy (Green et al., 2004).

In world population, 20-30% population is suffering from one or other allergic disorders such as bronchial asthma, rhinitis and atopic dermatitis (Kochar et al., 2014). In different parts of the country, aerobiological survey has been carried out to find out the concentration and seasonality of pollen grains during last fifty years (Dahiya et al., 2008). According to “Aeroallergens and Human Health” has revealed the presence of aerosols at different locations. Peak season were March-May and August-October. Due to the climatic changes’ variation in vegetation and pollen production occur. In Italy, from this study it has revealed that variation in pollen spectrum composition and seasonal timings for the allergy detection and management during 20 year (1989-2008) (Cristofori et al., 2010).

In Trento, Italy, pollen was collected by means of Hirst- type spore trap. Pollen concentration data and variations in pollen data revealed that main pollen season for a particular- taxa spread allergic disorders in local representatives. This study also shows that out of 63 pollen taxa ,40 taxa belong to tree and shrub and 23 to herbs that causes allergic ailments. Mainly pollen production from woody species due to variation in temperature. Pollen spectrum of highly allergic in Italy belongs to Urticaceae, Gramineae (Matavulj et al., 2022).

In Calcutta, the research was conducted to find out the frequencies of airborne pollen grains and leading taxa spreading allergic disorders (Mandal et al., 2008). Some of the dominant pollen grains in Calcutta accounted for *Trema* (19%), Poaceae (12.98%), *Casuarina* (5.76%), *Cocos* (5.7%), *Azadirachta* (4.65%), Cyperaceae (3.68%). In Berhampore town, part of West Bengal, a study was conducted to determine the airborne pollen grains allergising potential. Poaceae (grasses) and Cyperaceae, *Cassia sp.* etc showed maximum pollen frequency (Boral et al., 2000).

Asthma and hay fever allergies are prevalent health issues globally (Mortimer et al., 2022). Precise knowledge of the variations in the seasons in airborne pollen grains is crucial for an efficient diagnosis and treatment of pollinosis. Assessing the effectiveness of pollen antigen-based immunotherapy in patients with respiratory allergies can be greatly aided by a long-term study of the airborne pollen of a particular area. Moreover Urbanisation, industrialisation increasing pollution in lifestyle are the main

causes of the rise in pollen allergy (Sharma et al., 2009). Although the varieties of airborne pollen from temperate countries are widely known, tropical and subtropical regions have seen comparatively less study on the subject of pollen. In addition to being a subcontinent with a wealth of biodiversity, India is habitat to several different geoclimatic zones with notable seasonal variations in relative humidity and temperature (Ahlawat et al., 2013). Therefore, studies of the airborne microflora of various geographical areas must be undertaken, as the richness of the local flora and the prevailing climatic conditions impact the prevalence of pollen (Damialis et al., 2019). In addition, it is important to evaluate spatial variations within the same geographic area to obtain a more comprehensive understanding of the pollen spectrum in that location (Mandal et al., 2006).

During the past thirty years, a number of atmospheric surveys for airborne pollen have been conducted to determine qualitative and, in certain circumstances, quantitative alterations (Patel et al., 2023). According to recent investigations, pollen grains also act as bio-aerosols carrying COVID 19 infection (Damialis et al., 2021). According to (Singh et al., 2012), pollen grains, often referred to as aeroallergens, are well-established worldwide and are a known cause of pollinosis. In India, the capital city Delhi (Gill et al., 2016) and Jaipur (Verma et al., 2022) saw the establishment of atmospheric surveys on airborne pollen. Occasionally, other researchers in different regions of the world have continued the investigations (Shukla and Shukla, 2010). A thorough understanding of the kind and quantity of airborne pollen is necessary for the efficient treatment of various illnesses. For this reason, research on aeropalynology is crucial to comprehending the pollen spectrum of various regions (Quamar et al., 2018). To determine the qualitative and quantitative variations in the concentrations of airborne pollen in Rohtak, Haryana, India, a survey was conducted for this study.

2. Materials and Methods

2.1 Survey area

The investigation was carried out in the Indian state of Haryana, in the city of Rohtak. The sampling sites for this study were chosen to provide an in-depth investigation of the city's pollen spectrum across various directions. Two sites were located at densely populated areas of the city and other two sites at the outskirts of the study area where urban expansion has recently occurred.

2.2 Qualitative and Quantitative changes on pollen

Qualitative and quantitative variations in the composition of atmospheric pollen were analysed.

2.3 Sampling technique

In Rohtak city, atmospheric survey of the concentration of airborne pollen was carried out for one year (March 2023–Feb 2024) using a personal volumetric glass slide sampler, mounted at human height (1.8 m). This portable sampler has a flow rate of 10 L/min and can be operated by battery. Microslides smeared with glycerine jelly (50g gelatin, 50g glycerine, and 175ml distilled water and 7g phenol) will be inserted in the sampler and exposed for 20minute. Airborne particles get deposited in the form of a streak.

2.4 Pollen Identification

Pollen grains was identified with the assistance of published floras and reference slides prepared with the pollen of recognised taxa. The pollen counts were expressed as number/m^3 of air.

2.5 Seasonal variations

Seasonal variations in the concentration of dominant pollen grains were analysed throughout the sampling period (March2023- Feb2024).

3. Results

3.1 Atmospheric pollen diversity

During the survey period, 34 different types of pollen were captured. They were identified up to the family, genus, or species level based on their physical characteristics.

3.1 Seasonal variations

Seasonal disparities during the survey period, eight predominant pollen types were encountered altogether. Pollen grains were observed all year around in Rohtak City; however, two distinct pollen seasons were identified: (1) March–April; and (2) July–October. The largest amount pollen from Site I catches (3,380 pollen/m^3), site II, maximum pollen catches (3115 pollen/m^3) in the month of March 2023. But from site III, IV also highest pollen concentration (3595 pollen /m3, 7705 Pollen/m3) was recorded in the month of September 2023 during the survey period as shown in **(Fig. 1).**

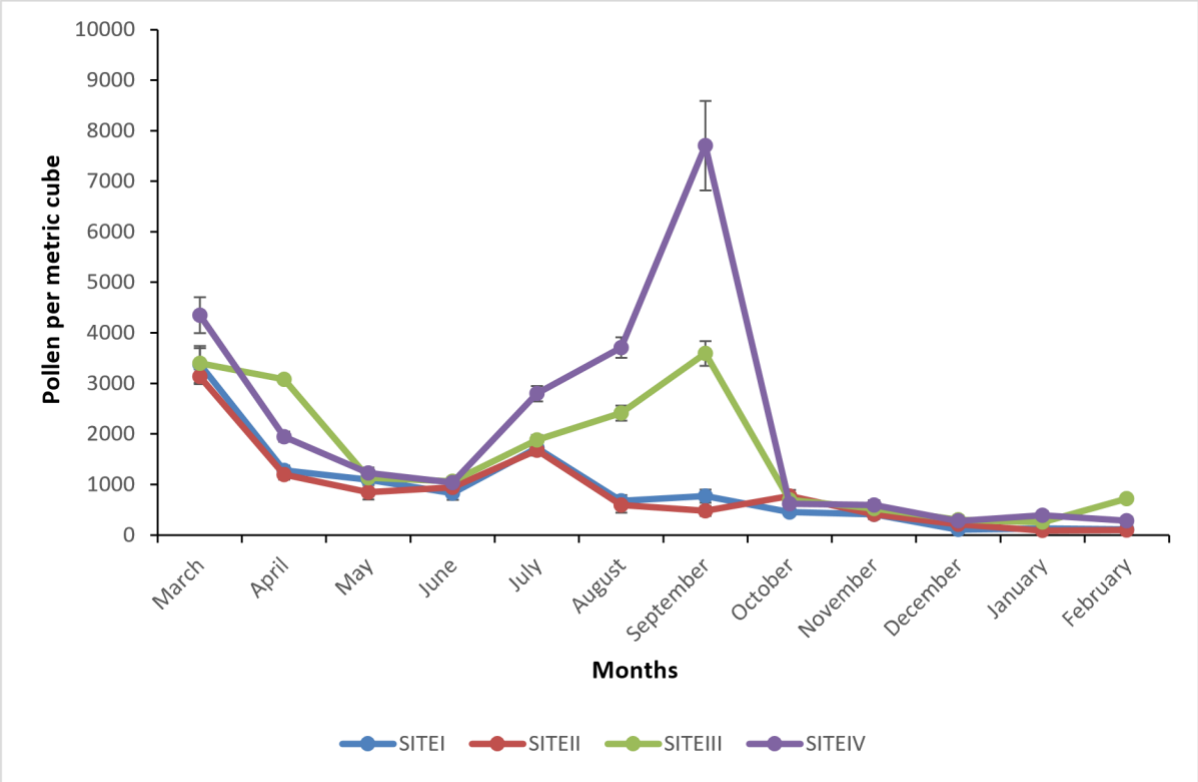

Fig. 1 Seasonal variations of total pollen types

3.2.1 Poaceae

Poaceae pollen were captured in all months at varying concentrations, but it reached its peak in March–April and September–October. Throughout the survey (2023–2024), the highest (985, 870 pollen/m^3) and lowest (86, 75 pollen/m^3) concentrations from Site I, II were noted. Nonetheless, from Site III, IV, the highest concentration (4465, 6130 pollen/m^3) and lowest (420, 399 pollen/m^3) were noted in June and July of 2023, respectively **(Fig. 2).**

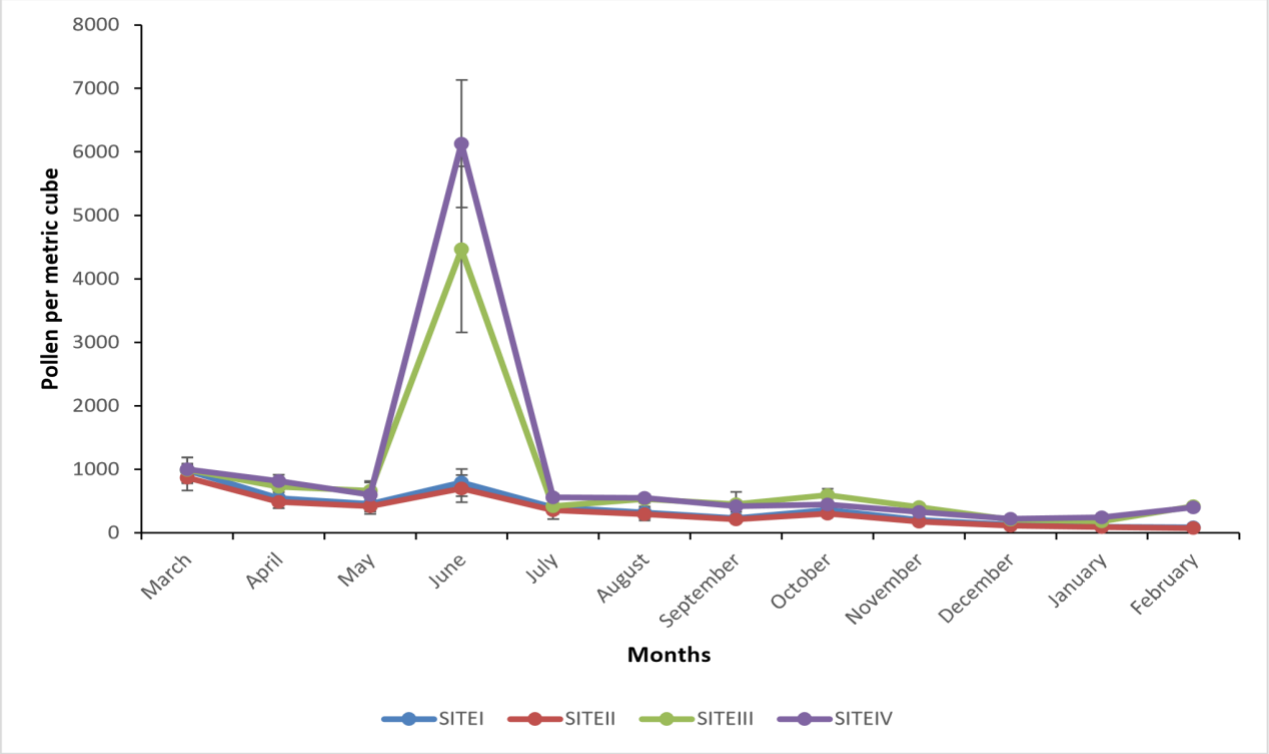

Fig. 2 Seasonal variation of dominant pollen Poaceae

3.2.2 *Cannabis sativa*

May to August was the main cannabis pollen season. During the study, August had the highest pollen capture during the study from Site I, II. However, from Site III, IV, the maximum concentration was recorded in the months of July and August, with 2520, 3280, and 3770, 3985 pollen/m^3, respectively **(Fig. 3).**

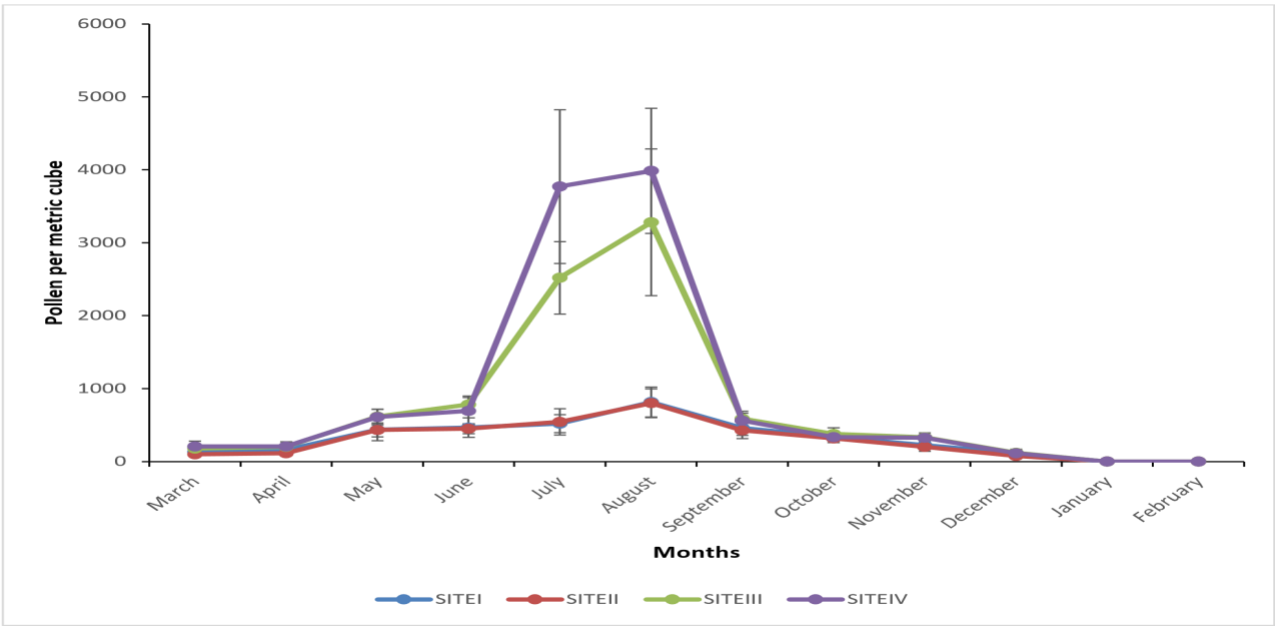

Fig. 3 Seasonal variation of *Cannabis sativa*

3.2.3 *Morus alba*

The season for *Morus alba* pollen grains was quite short, spanning from February to March. The maximum pollen concentrations were found in March 2023 at sites I, II, III, and IV (1360, 1320, 4035, and 3845 pollen/m^3), respectively **(Fig. 4).** But from August to September, no pollen was captured.

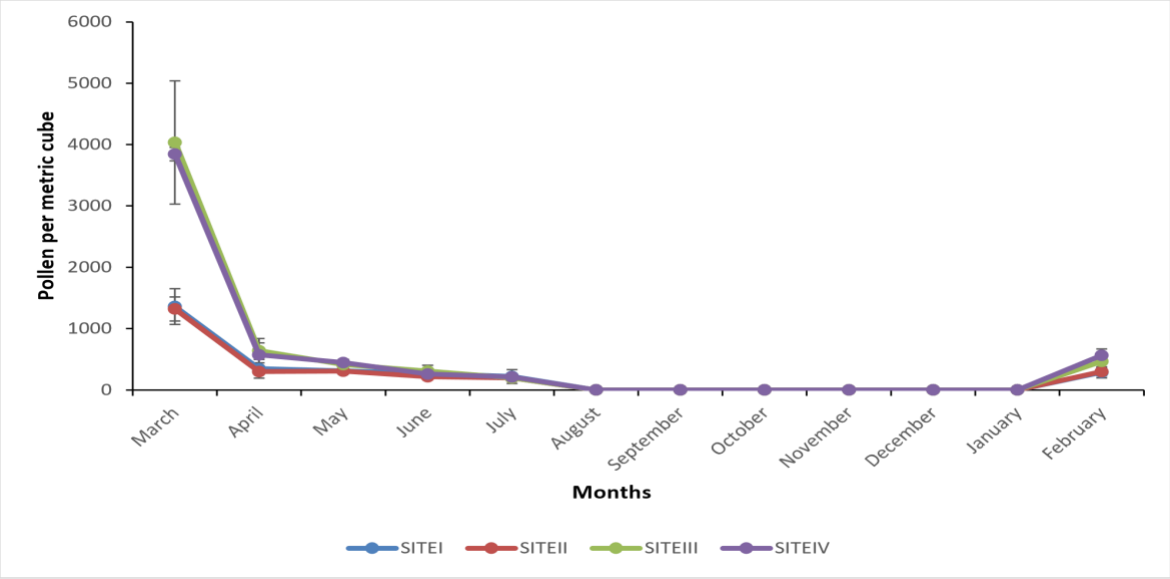

Fig. 4 Seasonal variation of *Morus alba*

3.2.4 *Parthenium hysterophorus*

Parthenium hysterophorus pollen grains were observed frequently during the study year. However, the pollen peak was discovered in August for sites I, II, III, and IV, respectively (715, 650,525,440 pollen /m^3) as depicted in **(Fig. 5).** No pollen was recorded at sites I, II, and III from December to January, and at site IV, from December to February.

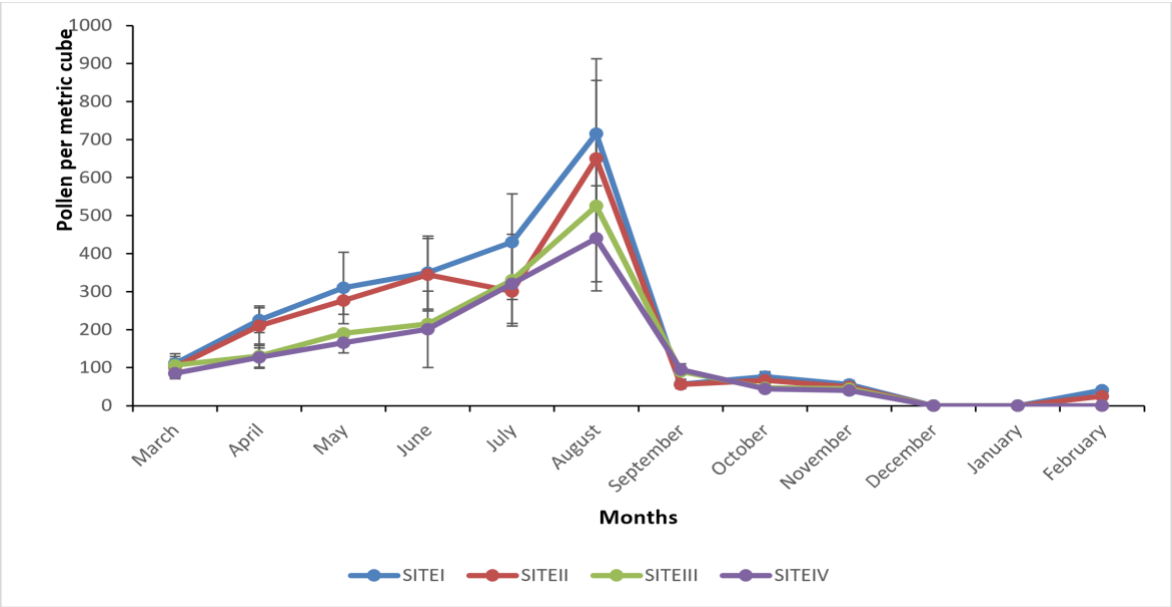

Fig. 5 Seasonal variation of *Parthenium hysterophorus*

3.2.5 *Cheno/Amaranthus*

The *Cheno/Amaranth* pollen were observed sporadically all year prolonged, peaked in September and November. September 2023 yielded the highest concentrations from Sites I, II, III, and IV, correspondingly. February had not much pollen capture from sites I, II, III, and IV as shown in **(Fig. 6).**

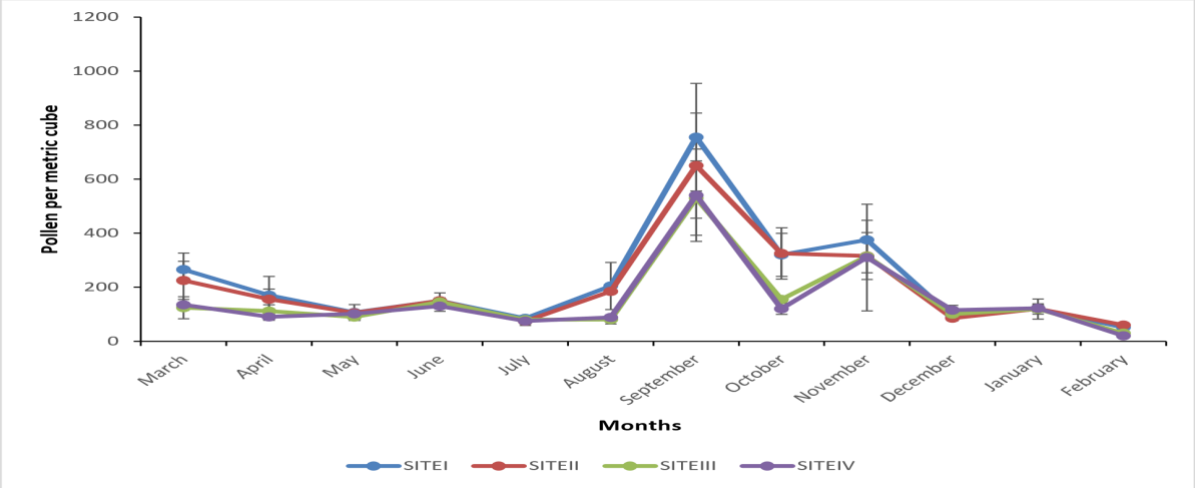

Fig. 6 Seasonal variation of *Cheno/Amaranthus*

3.2.6 *Artemisia*

Artemisia pollen season was seen in August to October. September had the highest pollen concentrations (385,295, 790, and 660 pollen/m^3) from sites I, II, III, and IV respectively. Nevertheless, all sites observed poor pollen capture from March to June depicted in **(Fig. 7).**

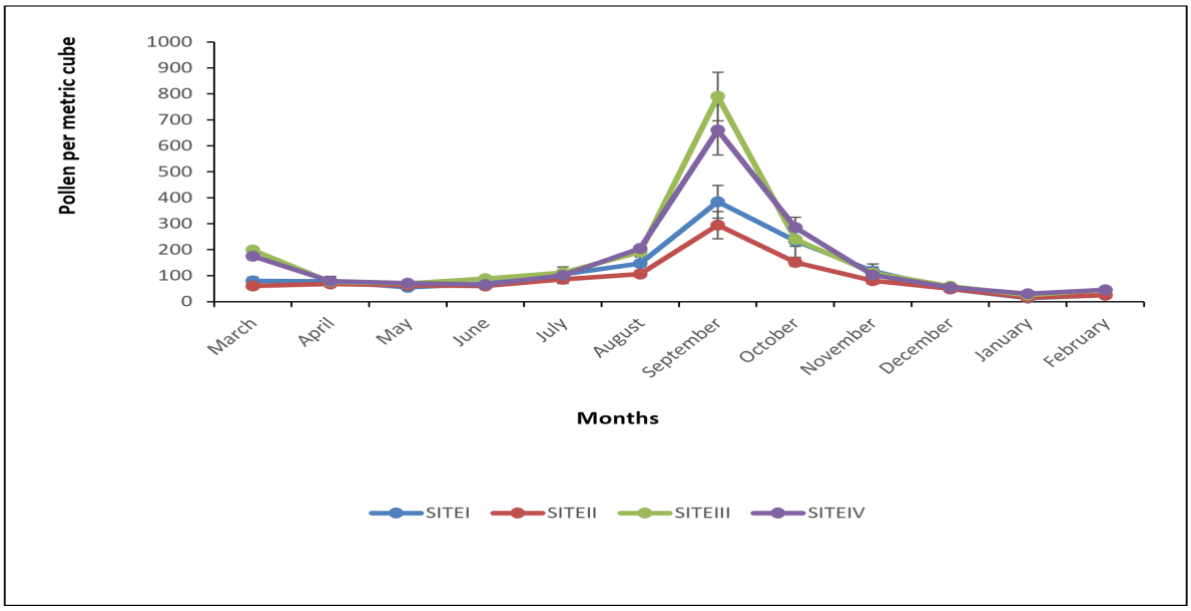

Fig.7 Seasonal variation of *Artemisia*

3.2.7 Myrtaceae

October–November was known to be the Myrtaceae pollen season. During the survey period, the sites I, II recorded pollen in April (385,345) and sites III, and IV recorded monthly pollen concentrations of 205 and 151 pollen/m^3 in March, which was the highest. Pollen capture was zero at sites I, II, and III, IV from November to December and May to September, respectively **(Fig.8).**

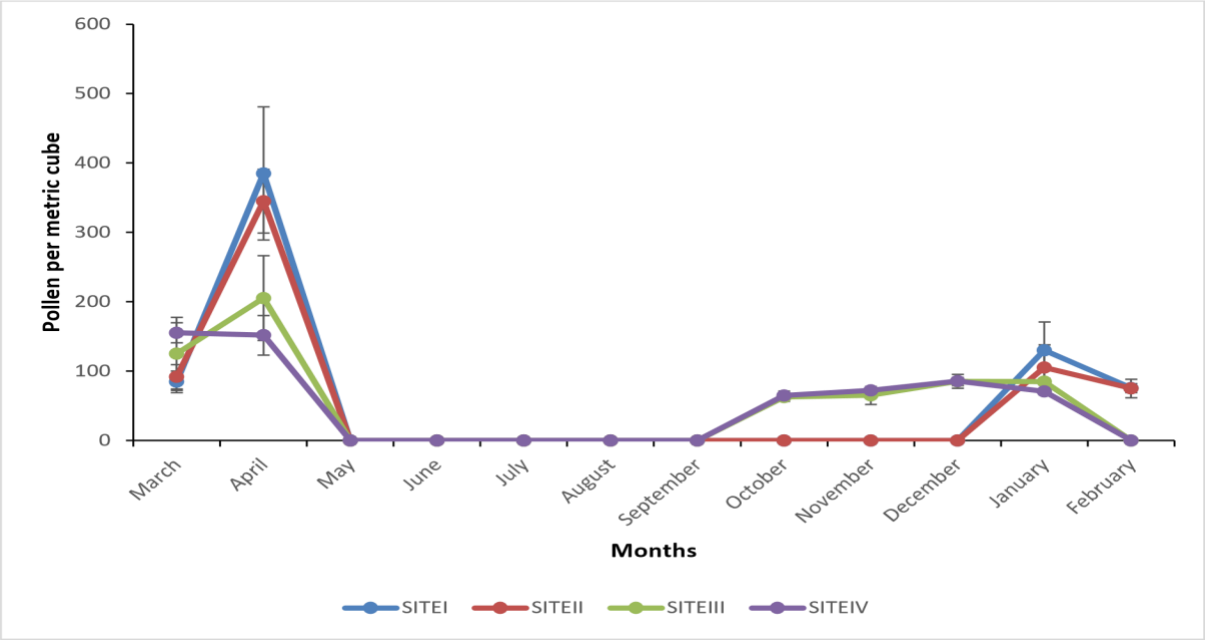

Fig. 8 Seasonal variation of Myrtaceae

3.2.8 *Achyranthes*

The month of September 2023 witnessed the highest pollen concentrations of 245and 250 pollen/m^3 for Achyranthes from sites I, II, and also a high peak of 315 and 290 pollen/m^3 from sites III and IV as well. July and November had no pollen catch as represented in **(Fig.9).**

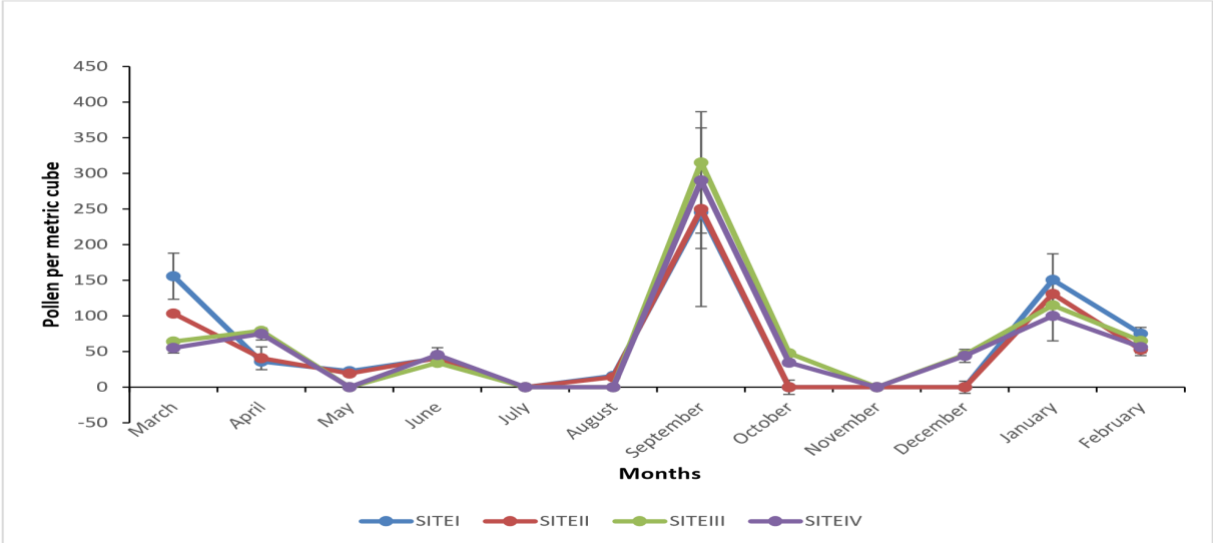

Fig. 9 Seasonal variation of *Achyranthes*

4. Discussion

The present study led to identification of 34 pollen types. According to (Ghoshal & Bhattacharya, 2015), all eight of the predominant pollen types that were examined are known aeroallergens from various parts of India. The current investigation demonstrated that pollen from herbaceous vegetation predominated. Researchers from various parts of India likewise indicated that same pollen types predominated (Kaur et al., 2024). In Eastern India, a further investigation was carried out to determine out the dominant air borne pollen grains causes allergies in tropics including India. In different families like Poaceae, Asteraceae allergenic cross reactivity has been reported (Bhattacharya et al., 2018). Some species cause diseases showed maximum percentage in eastern India such as *Cocos nucifera* (45.7%), *Phoenix sylvestris* (42.85%) and *Borassus flabellier* (38.5%). In 1873, first atmospheric survey conducted in Calcutta, India, to investigate about airborne pollen types and their concentration causes allergic disorders like bronchial asthma, allergic rhnitis, atopic dermatitis in more than 30% of population (Khaiwal et al., 2022). Some common pollen allergens are *Cynodon, Amaranthus*, Poaceae, *Artemisia, Parthenium*. In Calcutta, the research was conducted to find out the frequencies of airborne pollen grains and leading taxa spreading highly allergic disorders (Mandal et al., 2008). Some of the dominant pollen grains in Calcutta accounted for *Trema* (19%), Poaceae (12.98%), *Casuarina* (5.76%), *Cocos* (5.7%), *Azadirachta* (4.65%), Cyperaceae (3.68%).

The fact that pollen of Poaceae is the predominant type of pollen in the current study, and more abundant in the winter and spring may be the cause of the increased concentration of pollen during these seasons. March and June have the highest pollen counts, while February and July have the lowest. In general, there were two peaks for Rohtak city's airborne pollen: the first occurred in March–April, and the second occurred in July–October. Great prevalence of pollen grains in the air was influenced the local's health. Our findings are consistent with previous Delhi studies (Singh et al., 2019). Allergies to pollen and molds are very common among local residents in Islamabad (Abbas et al., 2012). A three-year study employing a volumetric spore trap at an 11-meter height was carried out to identify the kinds and concentrations of airborne pollen grains and molds that cause allergy diseases in local residents. *Cannabis sativa* and *Brussonetia papyrifera*, which were active in the March, April, and July months and the mould species *Pithomyces* and *Cladosporium,* which were active in the months of January and April and latterly detected in the months of October and November, were the two main pollen plants that contributed to allergies.

Additionally, according to (Sharma and Dharke, 1995), trees flower from March to April, and October for herbs from Agra city. Poaceae made a greater contribution because of their dense development in vacant land and by the sides of roads, which, together with their high pollen production, helped them dominate the atmosphere. Workers from various regions of India have reported Poaceae pollen as one of the predominant types (Mandal et al., 2008). In 2022, recent study in Chandigarh has been revealed that meteorological parameters and air pollutants also affects the pollen grains situated in the Indo-Gangetic plains (Ravindra et al., 2022). Due to climatic changes, pollen and air pollutants increasing the allergic diseases. In Rohtak city, Haryana, an aeropalynological survey was conducted to determine the airborne pollen grains. *Cannabis sativa* (28.9%) was the main source of pollen, following in order of predominance are the Poaceae (20.65%), *Parthenium hysterophorus* (6.80%), *Artemisia sp.* (4.03%), *Cyperus sp.* (3.20%), *Eucalyptus sp.* (3.07%) and Chenopodiaceae/Amaranthaceae (10.56%). Two major pollen seasons were identified: July through October and March through April (Ahlawat et al., 2013). For the purpose of accurately diagnosing and

treating respiratory allergy problems, this study gave local allergologists the previously mentioned but helpful data.

The *Cheno/Amaranth* group and *Cannabis sativa* made significant contributions to the pollen spectrum as well. Additionally, reports of *C. sativa* pollen from Delhi with a human height have been made (Ahlawat et al., 2013). Grass species are widely distributed, have a long pollination time, and are exclusively anemophilous, which accounts for their significant prevalence. Workers from various regions of India have reported Poaceae pollen as one of the predominant types (Mandal et al., 2008). In accordance with airborne pollen from the Poaceae family accounts for a substantial amount of the total pollen load during a day in Saudi Arabia (Alwadie et al., 2008). Since this pollen is known to cause pollinosis, especially in the summer and winter, its predominance in the atmosphere of Rohtak City (Singh and Kumar, 2003). The extensive occurrence of weeds closes to the sampling sites, especially those by roads and vacant land, might be the reason for an elevated pollen frequency from the *Cheno/Amaranth* group.

M. alba's distinctive peak in March was caused by its brief and exact pollen season. This coincides with the findings of previous investigations (Verma et al., 2024). The exotic weed *Parthenium hysterophorus* is an aggressive colonist that spreads throughout the year and has taken over a significant portion of the city.

Several Indian geographic zones have made remarks on this weed's destructive nature and the airborne abundance of its pollen (Shukla and Shukla, 2010). Due to its widespread recognition as an aeroallergen in several US regions, a high aerial prevalence of *P. hysterophorus* pollen is extremely important for the research area (Mandal et al., 2006). Similarly, *Artemisia sp.* and *Achyranthes* pollen dominated the pollen spectrum, as these pollens flourish in semi-arid regions such as the one under investigation.

The *Artemisia sp.* pollen season spanned from August to October, exhibiting a minor variation from previous studies (Singh et al., 2003). The Myrtaceae family of plants is widely planted in public avenues, which explains why the pollen of this family is so common. Spatial variations were identified in only a few individual types from four sites. Because there are wide open spaces nearby that are inhabited to both annual and perennial weeds, Site III and IV had a greater pollen load. Due to efforts of various aerobiologists lot of information is available from different schools in India in different aspects of pollen allergy from different areas like West Bengal, Delhi, Chandigarh, Bangalore, etc. But still the information is not available from many geographical regions in the country. Moreover, the sampling site selected for the present study was monitored nearly 12 years back (Ahlawat et al., 2013) and after that no published literature is available from our state creating a research gap in the field of aerobiology and allergology. Additionally, the nearby cultivated fields may have also helped to increase the amount of pollen collected. Site I and II might have had lower counts because of the location in the city centre, which is associated with less vegetation cover. According to other studies, there is a similar relationship between pollen concentration and the surrounding vegetation (Ciani et al., 2021). Additionally, showed spatial variability in the types of airborne pollen, demonstrating the significant local influence of adjacent vegetation on the airborne pollen (Katz & Batterman, 2020).

5. Conclusion

The current study is peculiar in that it provides preliminary results from aerial pollen monitoring conducted in Rohtak city. There was an obvious peak in the pollen spectrum in the autumn and spring, indicating seasonal fluctuation. Poaceae and *C. sativa* families contributed the majority of the pollen grains to the overall pollen load. Herbaceous plant pollen was more prevalent. Because of its proximity to both farmed and uncultivated areas, Site III, IV of the four selected locations witnessed a high pollen load. The present knowledge of the pollen grains of Rohtak city, Haryana, India, has been enhanced by the volumetric study of airborne pollen. It is expected that the current study's findings will give Rohtak City's allergologists valuable information for identifying pollen allergens throughout the year, facilitating accurate diagnosis and treatment. Those who suffer from allergies may additionally use this knowledge to schedule their outdoor activities so they don't come into contact with allergens.

Conflict of interest: None

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Author contributions Deepika Verma: Conceptualization, Investigation, Data curation, Formal analysis, Writing – original draft. Manisha Ahlawat and Ishu Khangwal: Conceptualization, Formal analysis, Writing – review & editing, Supervision,Validation.

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