

Aeropalynological survey of airborne pollen grains at different sites in Rohtak city.

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ABSTRACT

Over 20–30% of people worldwide are known to have one or more allergy conditions, including atopic dermatitis, allergic rhinitis and bronchial asthma. The main culprits are dust mites, pollen grains, fungal spores, insect waste and various plant fragments and food items. To effectively diagnose and treat allergy illnesses, a thorough understanding of the seasonal variations in various bioparticulates in the atmosphere is necessary. An aerobiological investigation for airborne pollen grains was carried out for a year (March 2023- Feb 2024) at human height in order to determine the aerial concentration at four distinct locations inside the city of Rohtak. To sample the air, a Burkard Personal Volumetric Sampler for slide exposures was utilised. A total 34 different species of pollen have been identified with simultaneous slide exposure. The largest contributors to the thirty-four pollen types that were recorded include Poaceae, *Cannabis*, *Morus*, *Parthenium*, *Chenopod/Amaranth*, *Artemisia*, Myrtaceae and *Achyranthes*. Pollen grains were observed throughout the year at low frequencies, although two main pollen seasons were noted (March–April and July–October). There were variations among the sites as well, with the sites with lush vegetation surrounding them exhibiting higher pollen loads. The project will give local allergologists preliminary but useful data to assist diagnose and treat respiratory allergy diseases effectively.

1. Introduction

Pollen and other bioparticles in the atmosphere are the subject of an aerobiological survey. Microbial propagules, sometimes referred to as air spora, are always present in the surrounding air and are never completely eliminated (Magyar et al., 2016). Geographical location, local vegetation, and climate affect the amount and make-up of atmospheric pollen flora. All around the world, particularly developing nations like India, the prevalence of allergic illnesses such bronchial asthma, allergic rhinitis, and atopic dermatitis is rapidly rising. Currently, it is estimated that over 30% of people have one or more allergies. The main culprits that have been identified are dust mites, pollen grains, animal epithelia, fungus spores, insect debris, and more. A thorough understanding of the kind and quantity of airborne pollen is necessary for effective management of various illnesses. Consequently, research on aeropalynology is crucial for comprehending the pollen spectrum of various regions (Quamar et al., 2018). The aerial concentration and seasonality of pollen grains have been determined by a number of aerobiological experiments carried out across the country. Temperate countries have produced a wealth of research on the varieties of airborne pollen; in tropical and subtropical regions, however, the topic has received comparatively little attention. India features many geoclimatic zones with noticeable seasonal variations in temperature and relative humidity in addition to being a subcontinent with a rich biodiversity. Therefore, studies of the airborne microflora of various geographic regions must be conducted, as the richness of the local flora and the prevailing climatic conditions impact the prevalence of pollen (Mandal et al. 2008). Additionally, to have a more comprehensive understanding of the pollen spectrum in that location, spatial variations within the same geographical region

need to be assessed as well (Ahlawat et al., 2013). The "All India Coordinated Project on Aeroallergens and Human Health" was started in 1992 with the goal of determining the prevalence of aerosols, both quantitatively and qualitatively, at various locations throughout the country (Kumar et al., 2015). It was believed that pollen was the cause of "Summer Catarrh," or hay fever (Morappanavar et al., 2019). Eventually, Blackley (1959) proved that pollen grains are a major cause of allergies and hay fever (Gupta and Anand, 2023). The United States' Scheppegegrell placed a strong focus on field research and aerial mapping to identify "aeroallergens" in the atmosphere (Singh et al., 2017). Pollen grains were found to be the cause of respiratory allergy diseases in later research conducted by several researchers worldwide (Holomquist et al., 2005).

In addition, there is an increasing prevalence in allergy problems, which led to concern about pollen grains' existence, migration through the environment, and effects on human health. Since the variety of the local flora and weather influence aerial pollen concentration, it is crucial to assess the airborne pollen kinds of various ecozones. Thus, to investigate the pollen spectrum, aeropalynological researches have been conducted throughout the country (Wani et al., 2011). Delhi and Jaipur in India were the beginning destinations for atmospheric surveys on airborne pollen (Verma et al., 2022). Other researchers in different parts of the country have periodically continued the investigations (Shukla and Shukla 2010). Cunningham, who originated in Calcutta (now known as Kolkata), was the first to connect aerosols to illnesses referred to as "zymotic diseases" (Singh and Mathur, 2021). After two significant centres in Jaipur and Delhi began doing aerobiological research, there was a nearly fifty-year gap in Indian aerobiological research (Singh and Mathur, 2017). Chanda and his students recommenced aerobiological experiments at the Bose Institute in Kolkata, preparing pollination calendars for Kolkata, Falta, and Kalyani (Singh and Mathur, 2021). Haryana, a landlocked state in northern India with a semi-arid climate, does not, however, provide sufficient data. The current study was conducted to track the pollen grains in the atmosphere of Rohtak, Haryana, at four distinct locations. Since the majority of people are exposed to pollen at lower height, it was thought relevant to investigate the pollen load at 1.8m (i.e. human height) for local residents' allergy disorders diagnosis and treatment.

2. Materials and Methods

2.1 Survey area

The investigation was carried out in the Rohtak city, Haryana (India). The sampling sites for this study were chosen to provide an in-depth investigation of the city's pollen spectrum. Two sites were located at densely populated areas of the city and the 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 20minutes. 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/m³ of air.

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.

3.2 Site to Site variations

Throughout the survey period, there were site to site differences observed in five different types of dominant pollen. Although pollen grains were seen in Rohtak City throughout the year. In March 2023, Site I recorded the highest pollen catch (12185 pollen/m³), while Site II recorded the highest pollen catch (10585 pollen/m³). However, the highest pollen concentration (35350 pollen/m³ and 31445 pollen/m³) from sites III and IV was also reported in 2023 during the survey period, as seen in (Fig. 1).

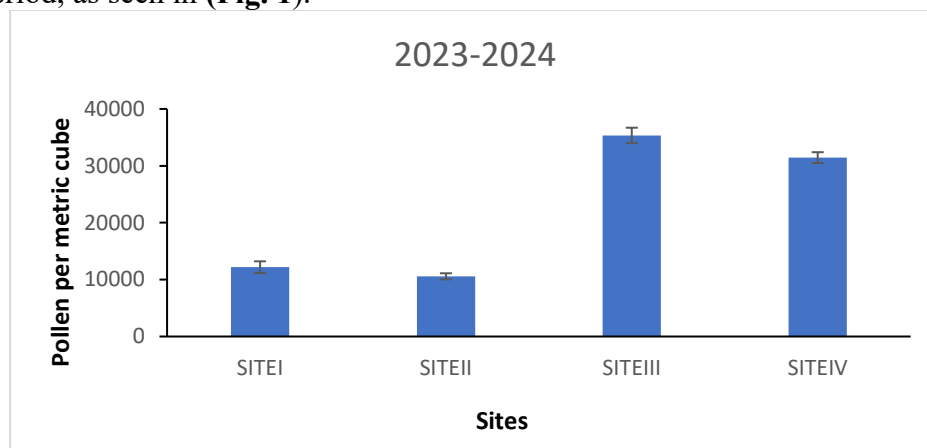


Fig. 1 Site to Site Variation of total pollen types

3.2.1 Poaceae

On analysing the pollen counts recovered from four sites, it was observed that Poaceae pollen concentration was markedly higher at sites III and IV in 2023-2024 year. In this year, site III, IV encountered (18520, 16305 pollen /m³) while counts at site I and II were (1830, 1750 pollen/m³), respectively (Fig. 2).

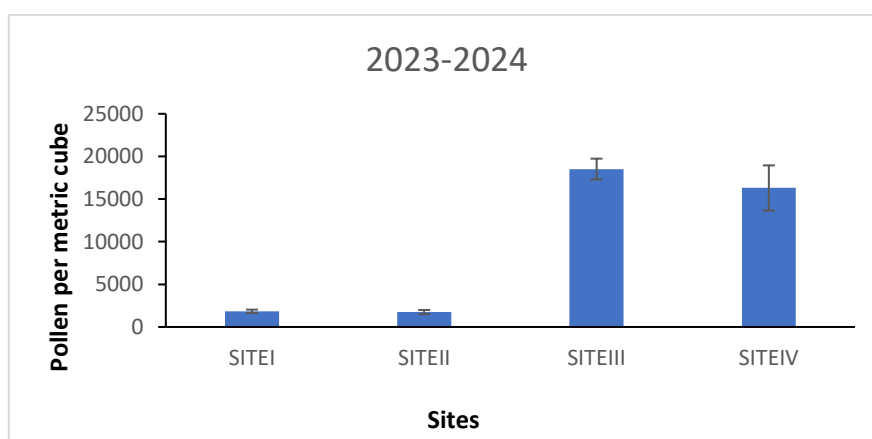


Fig. 2 Site to Site Variation of dominant pollen Poaceae

3.2.2 Cannabis sativa

On analyzing the pollen counts recovered from two sites, it was observed that *Cannabis sativa* pollen showed very less difference in its concentration at site I, II (5270, 5485 pollen/m³) and site III, IV (5240, 5285 pollen/m³) (Fig. 3).

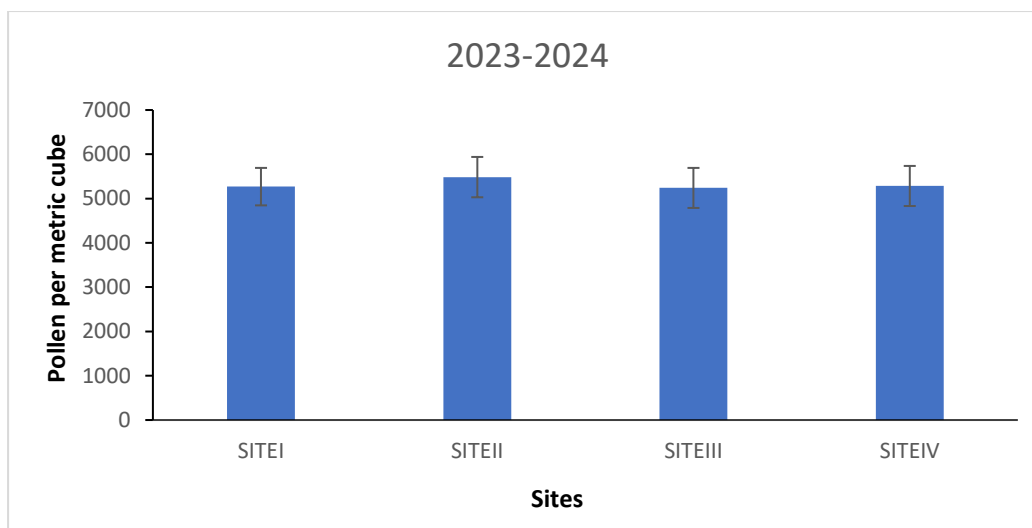


Fig. 3 Site to Site Variation of *Cannabis sativa*

3.2.3 *Morus alba*

Site III, IV encountered a higher pollen concentration as compared to site I, II. Interestingly, *Morus* pollen exhibited remarkable difference in its concentration at the four sites during the first year with (1735, 1535 pollen/m³) at site I, II and (5215, 5315 pollen/m³) at site III, IV (**Fig. 4**).

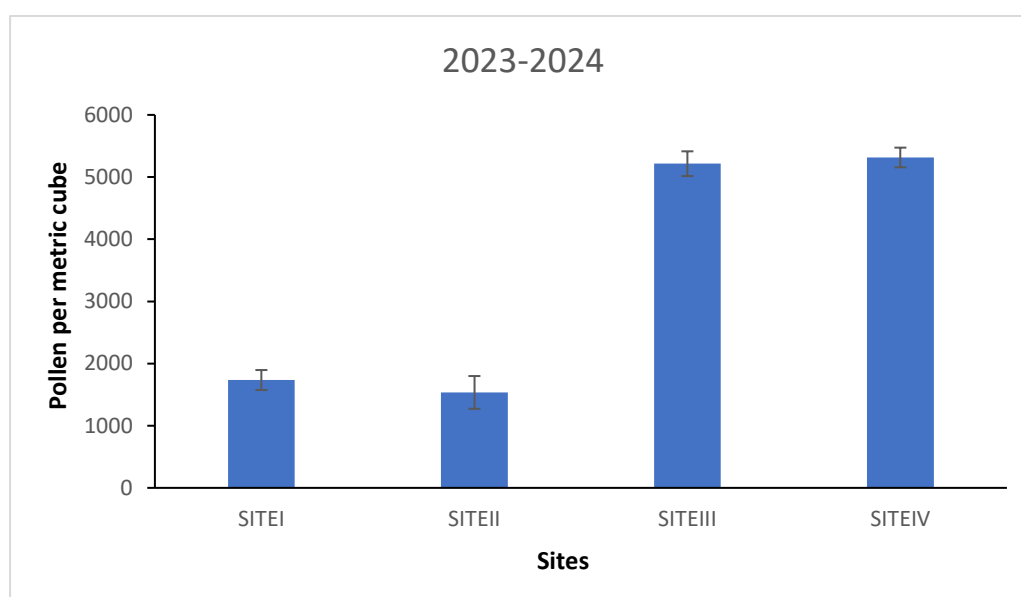


Fig. 4 Site to Site Variation of *Morus alba*

3.2.4 *Parthenium hysterophorus*

In 2023–2024-year, site I, II (2040, 1760 pollen/m³) encountered higher catch. Pollen count at site III, IV during this year was (910, 820 pollen/m³). However, Pollen grains of *Parthenium hysterophorus* were regularly monitored during the study year (**Fig. 5**).

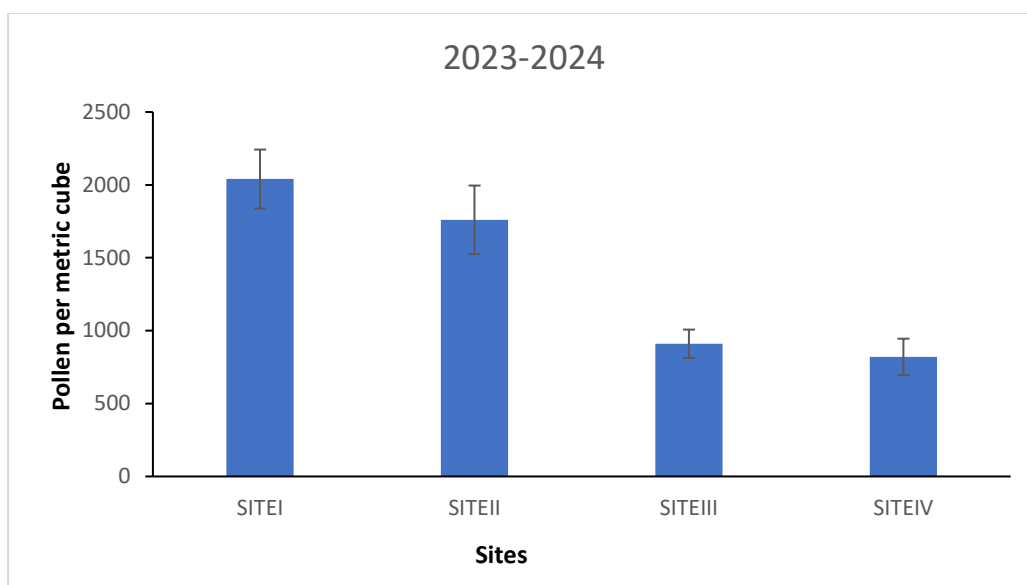


Fig. 5 Site to Site Variation of *Parthenium hysterophorus*

3.2.5 *Cheno/Amaranthus*

Pollen concentration of *Cheno/Amaranth* group was a little higher at site I and II (2075 pollen/m³) in this year. But pollen count at site I, II were (2095, 2140 pollen/m³) while site III, IV showed little lesser catch (1555, 1635 pollen/m³) (The pollen of *cheno/amaranth* was noticed frequently throughout the year, reaching its peak in September and November (**Fig. 6**)).

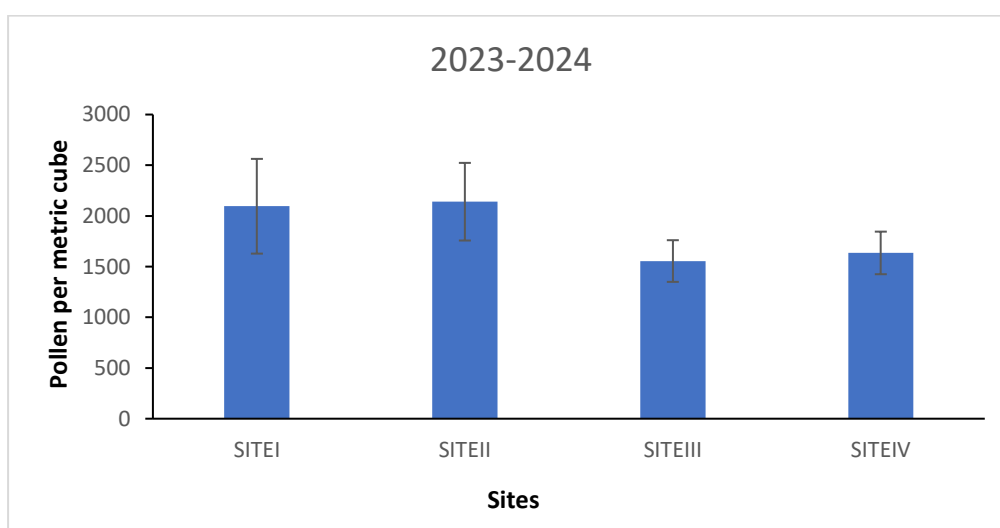


Fig. 6 site to site Variation of *Cheno/Amaranthus*

3.2.6 *Artemisia*

Artemisia pollen showed higher concentration at site III, IV for 2023-2024 year with (1050, 1095 pollen/m³). However, Site I, II encountered pollen (575, 595 pollen/m³) in the first year (**Fig. 7**).

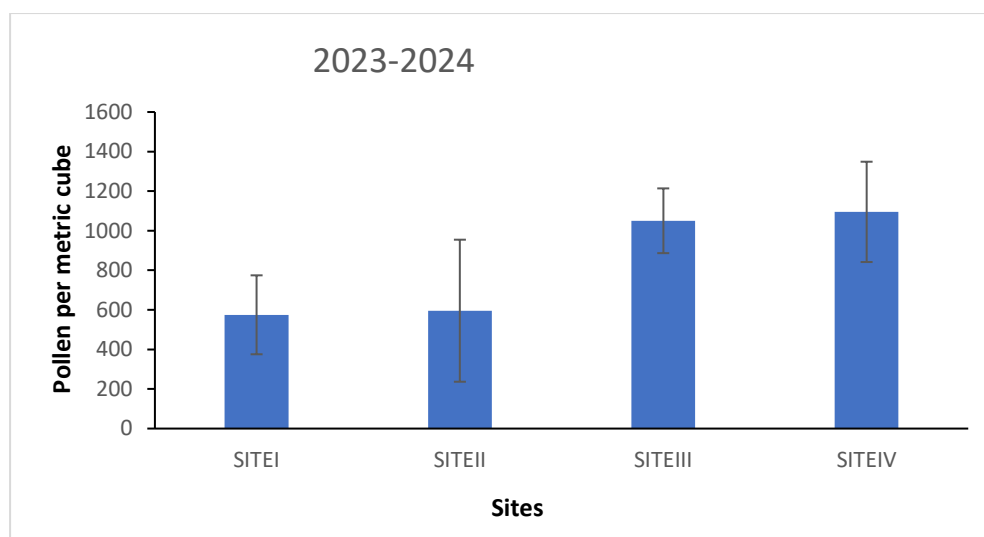


Fig. 7 Site to Site Variation of *Artemisia*

3.2.7 Myrtaceae

Myrtaceae pollen counts were higher at site I, II (755, 620 pollen/m³) during this year. But Pollen concentration at site III, IV during the first year was (920, 935 pollen/m³) (**Fig. 8**).

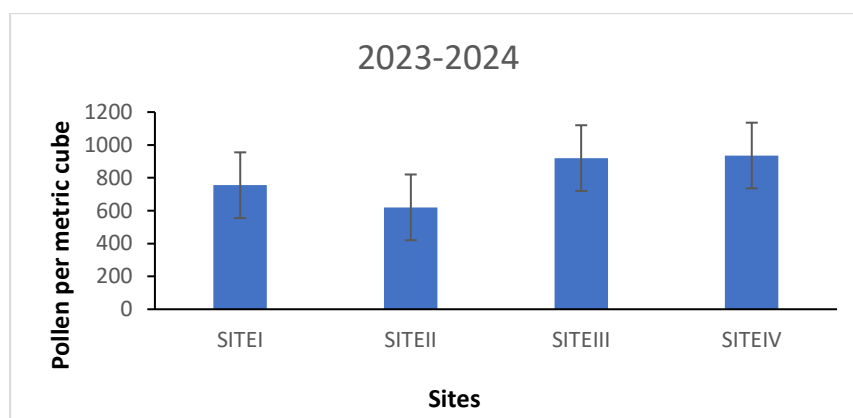


Fig. 8 Site to Site Variation of Myrtaceae

3.2.8 *Achyranthes*

On analyzing site to site variations of *Achyranthes* pollen at four sites, it was observed that pollen counts were higher at site III, IV during this year. Pollen concentrations observed at site I, II, III, IV was (485, 645, 740, 765 pollen/m³) in the first year, respectively (**Fig. 9**).

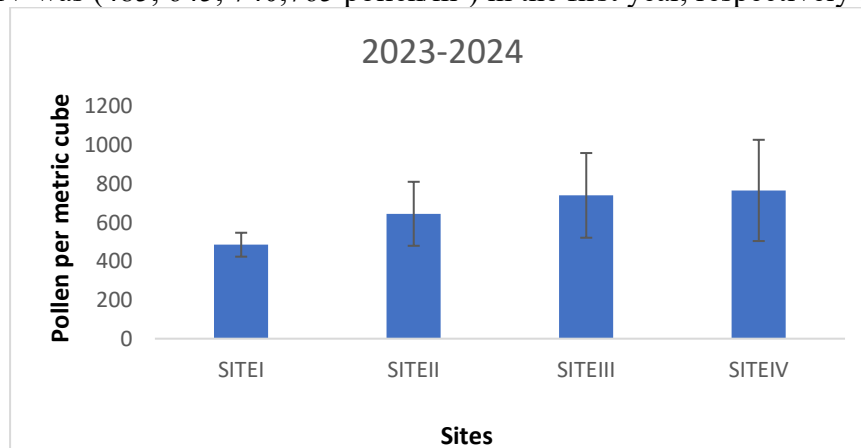


Fig. 9 Site to Site Variation of *Achyranthes*

4. Discussion

As a result of aeropalynological investigation carried out, 34 pollen types were identified. Pollen of Poaceae, *Cannabis*, *Morus*, *Parthenium*, *Chenopod/Amaranth*, *Artemisia*, Myrtaceae and *Achyranthes* were observed in the atmosphere of Rohtak city. Of these, all the eight dominant pollen types analysed are reported aeroallergens from different geographical areas of India (Mandal et al., 2008). The present study exhibited dominance of pollen from herbaceous vegetation. Predominance of these pollen types was also reported by workers from different geographical regions in India (Sahney and Chaurasia, 2008). Low contribution of pollen from trees and shrubs could be due to their low frequency of occurrence and short flowering season of some plants belonging to these groups. The height at which sampling was carried out might also be responsible for low pollen catch from tree species (Malik et al., 1991).

In general, two peaks for airborne pollen of Rohtak city were observed: first in March–April and the second in July–October. The first peak was dominated by pollen of trees, whereas in the second peak, pollen from grasses and weeds was predominant. Maximum number of plants produce flowers during these periods, releasing huge amount of pollen in the atmosphere due to their anemophilous nature. This contributed to their high aerial prevalence. Our results are in concordance with earlier reports from Delhi (Gill et al., 2016). In 2014 also reported March to April to be the flowering period for trees and October for herbs from Agra city (Ahlawat and Dahiya, 2014).

Poaceae contributed more than the other pollen types and are found during peak season. The high values of Poaceae pollen in the pollen assemblages can be ascribed to its luxuriant presence in the vegetation around the sampling locations (Quamar et al., 2024). Luxuriant growth of this weed in vacant places and along road sides together with its high pollen production contributed to its dominance in the atmosphere. High concentration of Poaceae pollen at human height from Delhi was also reported by (Paliwal and Balki, 2017). Pollen belonging to *Cannabis sativa* and *Morus alba* also contributed substantially to the pollen spectrum. Wider distribution of grasses along with their long pollination period and strictly anemophilous nature was responsible for their high representation. Poaceae pollen has been reported among the dominant types by workers from different parts of India (Ghoshal and Bhattacharya, 2015).

Parthenium hysterophorus, an exotic weed and aggressive colonizer, has occupied practically every part of the city and grows almost throughout the year. The vigorous nature of this weed and aerial abundance of its pollen have also been reported from different geographical zones of India (Shukla and Shukla, 2010). High aerial prevalence of *P. hysterophorus* pollen is of great significance to the survey area as it has been reported to be an important aeroallergen from different parts of the country (Bhattacharya et al., 2006).

The high prevalence of pollen from *Cheno/Amaranth* group might be due to widespread occurrence of these weeds in the proximity of the sampling sites, especially along road sides and vacant lots. Short and precise pollen season of *M. alba* was responsible for its major contribution. This is in consensus with the observations made by earlier workers (Singh et al., 2003).

Artemisia sp. and *Cyperus sp.* pollen also dominated the pollen spectrum as semi-arid areas like the one under study favours the growth of these species. Pollen season for *Artemisia sp.* comprised from August to November, which is slightly variable from earlier reports (Singh et al., 2003).

Four individual sites revealed the spatial variations. Site III, IV encountered higher pollen load since in close vicinity vacant lands inhabited by annual and perennial weeds are found. Moreover, surrounding cultivated fields might have also contributed to higher pollen catch. Lower counts recorded from Site I, II could be due to its location in the city centre, which corresponds to poor vegetation cover. Similar correlation between pollen concentration and

surrounding vegetation has also been reported by other works (Mandal et al., 2006). Average pollen catch obtained from all the sites was higher in the morning as pollen types such as Poaceae, *C. sativa*, *M. alba*, *Parthenium hysterophorus* were prevalent during this time. Pollen of Poaceae family was encountered in high concentrations both in the morning and in the afternoon. Morning patterns for this pollen were also reported by whereas (Malik et al., 1991) observed high catch in the afternoon from different zones of Delhi. It is important to note that pollen of *P. hysterophorus* was high in the afternoon, as also reported by Malik et al. (1991).

5. Conclusion

The unique aspect of this study is that it presents preliminary findings from airborne pollen monitoring carried out in the city of Rohtak. The pollen spectrum clearly showed site to site variations. For the total pollen load, the Poaceae and *C. sativa* families contributed the majority of the pollen grains. Pollen from herbaceous plants predominated. Sites III and IV of the four chosen locations had a significant pollen burden due to their close proximity to both agricultural and uncultivated areas. The volumetric analysis of airborne pollen has improved our current understanding of the pollen grains of Rohtak, Haryana, India. The results of this study should help the allergologists in Rohtak City detect pollen allergens across the year, making diagnosis and treatment more precise. Allergy sufferers may also use this information to plan their outside activities to avoid exposure to 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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