Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268
(Print copies up to 2016)
e-ISSN: 2395-3454

Vol. 21 | No. 4 | pp. 1775-1781 | 2022

Original Research Paper

https://doi.org/10.46488/NEPT.2022.v21i04.033

Open Access Journal

# Aeropalynology of *Parthenium hysterophorus* L. in Relation to Meteorological Parameters from Srinagar Valley of Garhwal Himalaya, Uttarakhand

**Shikha Arya*, Prabhawati Tiwari *†, Alok Sagar Gautam** and Manish Sharma*****
*Department of Botany & Microbiology, HNB Garhwal University, Srinagar (Garhwal)-246174, Uttarakhand, India
**Department of Physics, HNB Garhwal University, Srinagar (Garhwal)-246174, Uttarakhand, India
***School of Science and Technology, Himgiri Zee University, Dehradun-248197, Uttarakhand, India
†Corresponding author: P. Tiwari; ptiwari29@rediffmail.com

**Nat. Env. & Poll. Tech.**
**Website: www.neptjournal.com**

*Received:* 03-01-2022
*Revised:* 08-03-2022
*Accepted:* 11-03-2022

**Key Words:**
*Parthenium hysterophorus*
Aeroallergens
Pollen grains
Rotarod sampler
Meteorological parameters
Back trajectory analysis

## ABSTRACT

*Parthenium hysterophorus* (congress grass) is a harmful weed and its pollen grains are important allergens. Due to its minute size and allergenic activity, this particular type of pollen is selected for the study. The aeropalynological survey was conducted for the year 2019 at Chauras Campus, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand. It is located on the right bank of the Alaknanda river (30°13'35.81"N & 78°48'11.05"E; 560 m amsl). A Rotarod sampler was used for air sampling. The maximum pollen count was observed in July. To evaluate the correlation matrix in R software, correlations (Pearson's and Spearsman's) between pollen count and meteorological parameters have been calculated. Back trajectory analysis has also been done using NOAA HYSPLIT MODEL.

## INTRODUCTION

Pollen grains are one of the important biological materials that are ubiquitous and inhaled by humans. The main purpose of pollen grains is to bring about fertilization but these also cause allergies. (Nair et al. 1986, Leuscher et al. 2000, Shukla & Shukla 2010). In several studies, pollen grains from different plants have been reported as aeroallergens (Subiza et al. 1994, Mari et al. 1996, Asturias et al. 2002).

*Parthenium hysterophorus* L. commonly known as congress grass is designated as a major allergenic plant by many workers from different parts of the world (Sohi et al. 1979, Wedner et al. 1989, Handa et al. 2001, Wiesner et al. 2007). Taxonomically, the plant is categorized under the family Asteraceae and was introduced in India along with food grains (Kohli & Rani 1994). The flowering period of *P. hysterophorus* is almost throughout the year (Nayar et al. 1990). Studies have shown the harmful effect of *P. hysterophorus* pollen on human beings, animals, crops, etc. (Khosla & Sobti 1981, Gupta et al. 1995, Yadav et al. 2010, Sharma et al. 2013). The meteorological parameters influence the dispersion and transport of pollen grains (Cour et al. 1999, Galán et al. 2000, Gioulekas et al. 2004) and play an important role in the pollen concentration in air (Piotrowska 2006, Iglesias et al. 2007).

The present work aims to find out the concentration of *P. hystrophorus* pollen and the effect of meteorological factors on pollen concentration in the area. Back-trajectory analysis helps to locate the origin of airborne biological particles at any selected sampling point. The HYSPLIT model is used in the present study to investigate airborne pollen concentrations. It has been used earlier by many workers (Cecchi et al. 2007, Mahura et al. 2007). It is highly effective in studies emphasizing defining the pathway and possible long-range transport of air pollutants (Sa´nchez-Ccoyllo et al. 2006, Davis et al. 2010). The main objective of the back-trajectory analysis was to establish the relationship between the movements of air mass and pollen counts of *P. hysterophorus* pollen counts in the valley Srinagar of Garhwal Himalaya.

## MATERIALS AND METHODS

### Study Area

The study was conducted at Chauras Campus Hemvati Nandan Bahuguna Garhwal University (Fig. 1). It is located on the right bank of Alaknanda. The coordinates for the sampling sites were latitude 30.226522 and longitude 78.803177 with an elevation of 560 m amsl. The study site has forests with broad leaves and dry scrubs. In the research

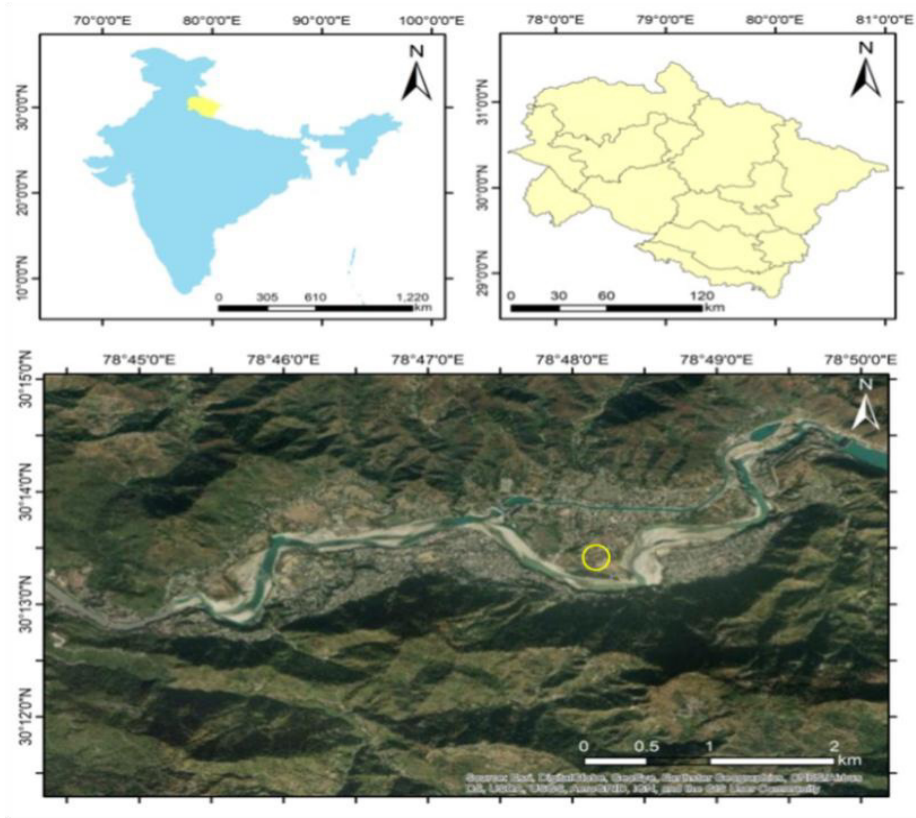


Fig. 1: Location map (yellow colored circle indicating sampling location at Chauras, Srinagar (Garhwal)).

region, *Parthenium* is an abundant weed that grows with other species like *Cannabis sativa, Erigeron, Lantana camara, Murraya koenighi,* and *Solanum* spp.

### Sampling Technique

Aerobiological sampling was carried out by Digital Rotorod pollen and Air particle collector for one year from January 2019 to December 2019. Glass slides smeared with glycerin jelly were exposed and changed after each hour of sampling. The slides were then examined under a microscope and the total number of pollen was counted by the continuous sweep method as suggested by Mandrioli et al. (1998).

Fresh pollen samples were taken directly from the plants for preparation of reference slides. The samples were then acetolyzed by the standard method (Erdtman 1960). The pollen was studied properly at the magnification of 400X under the Light microscope (Magnus Pro 3.7) and matched with the air sample. SEM image is taken with Scanning Electron Microscope Model JSM-6610 LV-JEOL, Japan. A customizable Davis Vantage Pro2 Automatic Weather Station (AWS) was used to extract Meteorological parameters like temperature, humidity, wind speed, and rainfall. The AWS data was analyzed by Special Weather Link (version 6.0.3) as well as Aroldis Software. Correlations were calculated using Hmsc (version 4.4) package for the evaluation of the correlation matrix in R software as suggested by Feng et al. (2019), Gautam et al. (2020), and Liu et al. (2020). Air Mass Back trajectory analysis is carried out using National Oceanic and Atmospheric Administration (NOAA) HYSPLIT MODEL.

## RESULTS

### Plant and Pollen Description

The plant is annual, much branched and grows luxuriantly all around the year (Fig. 2 a). It reaches up to about 1.5 m or long. Each plant has several capitula. Each capitulum has several florets of which only five are female and the rest are male. The flowering occurs from July to November. Although heavy flowering occurs in the rainy season, the plant continues to flower and fruit till the environmental conditions favor it. The life cycle of *P. hysterophorus* is usually 9-10 months but can extend beyond it. *P. hysterophorus* is seed propagated. New plants grow as soon as the seed disperses. The plant can be seen in the fruiting, flowering, and vegeta-

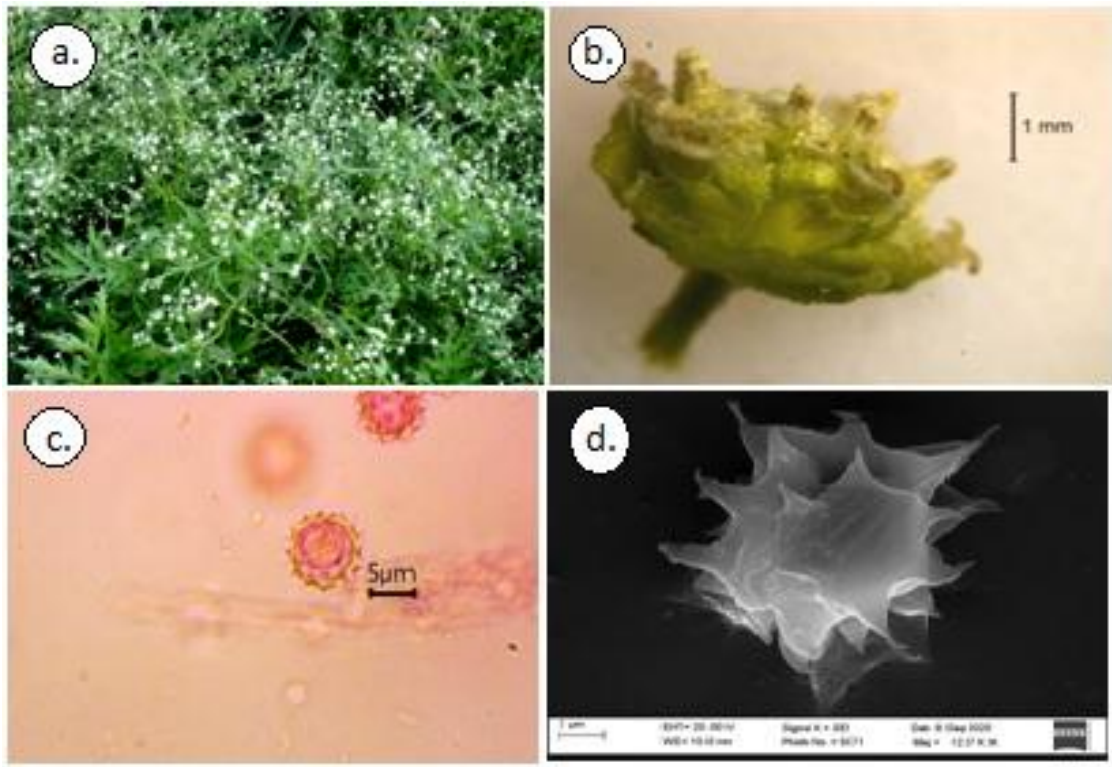


Fig 2: a. Plant habit (Lax panicle) b. Inflorescence (Single capitulum or head) c. Pollen grain (LM) d. SEM image of grain.

tive phase simultaneously. In a study in our laboratory, we germinated *P. hysterophorus* seeds and observed 38% seeds germination rate.

The inflorescence is the capitulum (head) on a lax panicle, white (Fig. 2 b). Each capitulum has ray and disc florets. Five ray florets are located at its periphery. These are narrowly ovate with puberuolus bracts, white, ligulate, truncate, and zygomorphic with a well-developed female part. The ovary is unilocular with a basal ovule. The ovule is attached to the style with two arms. The remaining flowers of the capitulum are disc florets which are actinomorphic and white. The Corolla of the disc florets form a tube towards the base ends in a four-lobed apex. Stamens are four, epipetalous, and are fused near the base of the flower. Anthers are basifixed and dithecous. The pistil present in the disc floret is non-functional.

The Amb of the pollen is circular with three zonal colpi having a length of ~ 2.78 µm. The grain is radially symmetrical (Fig. 2 c, d). The shape class of the pollen is spheroidal with a 100 P/E ratio and the size of the pollen is minute ranging from 14.80±1.92 × 14.11±0.48µm, the surface of the grain is spinulate with pointed spines of <3 µm length. The exine width of the pollen grain is very thin (~ 0.93 µ).

**Aerpalynological Analysis**

*P. hysterophorus* pollen was collected from January 2019 to December 2019. The daily data have been converted accordingly. It was observed that the pollen number was at its peak in July with a total of 29.07% of the pollen count

Table 1: Pollen concentration per month (in percentage).

| Month | Pollen concentration (%) |
|---|---|
| January | 2.62 |
| February | 2.16 |
| March | 3.44 |
| April | 3.97 |
| May | 2.30 |
| June | 7.10 |
| July | 29.07 |
| August | 24.59 |
| September | 11.17 |
| October | 7.69 |
| November | 4.31 |
| December | 2.57 |

followed by August with 24.59%. The Main Pollen Season (MPS) can be estimated as July- August for *P. hysterophorus*. February was having a minimum of 2.16% pollen during the whole month (Table 1). The presence and distribution of pollen are throughout the year. The sudden increase in pollen concentration can be seen in July and August (Table 1). The monthly concentration of the *P. hysterophorus* pollen along with meteorological parameters is shown in the graphs below (Fig. 3).

## Correlation Analysis

It has been observed that there is some relation between the pollen count and the meteorological factors. To find out the relationship between pollen count and metrological parameters Spearman's and Pearson's correlation is calculated (Table 2). Analyzing Pearson's correlation shows a positive significant correlation between pollen count and rainfall ($p<0.05$). The correlation is non-significant by analyzing Spearman's correlation.

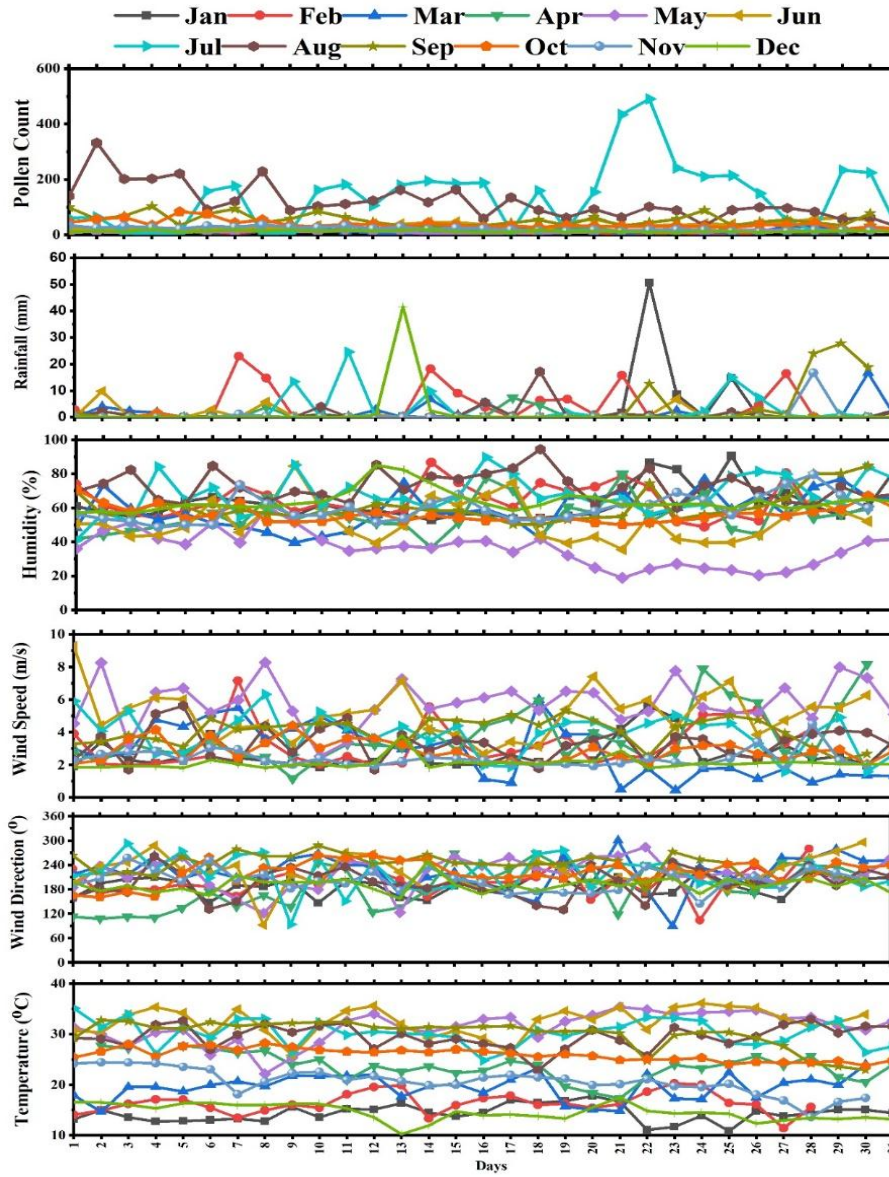


Fig 3: The monthly concentration of *P. hysterophorus* pollen grain along with meteorological parameters.

### Back-Trajectory Analysis

Back- trajectory analysis has been carried out using NOVA HYSPLIT MODEL (Stein et al. 2015) on the height of 1000m above ground level (Fig. 4). The trajectory presented here is for a single pollen episode, 31st July; at 2 pm (highest pollen concentration). The diurnal variation shows a peak at 2 pm. The trajectory indicates that the movement of air mass is from the sampling site (Uttarakhand) to Eastern India, then turn south from the Bay of Bengal. This path shows that with air mass, the pollen from *P. hysterophorus* can travel along and can cause allergic diseases to the individuals living in these areas.

## DISCUSSION

*P. hysterophorus* is a noxious weed and its pollen is known for causing dermatitis (Gunaseelan 1987, Towers & Subba Rao 1992, Morin et al. 2009) and is sensitive to rhinitis patients (Rao et al. 1985). A novel hydroxyproline-rich glycoprotein is identified as the major allergen in P. *hysterophorus* pollen by Gupta et al. (1996). Kumar et al. 2012 were the first who studied to immunologically characterize patients with *P. hysterophorus* sensitive atopic dermatitis.

The plant *P. hysterophorus* blooms throughout the year. Each plant has several capitula. Each capitulum has 5 female ray florets and numerous male disc florets. Four anthers are present in the disc florets. Each anther lobe produces a large number of pollen grains. Nayar et al. (1990) reported that *P. hysterophorus* produces 1.7 million pollen per plant.

By analyzing the meteorological data has been observed that despite heavy rains total number of *P. hysterophorus* pollen was highest in July. These findings are quite similar to some previous studies on *P. hysterophorus* pollen incidence in the aerospora. The frequency of *P. hysterophorus* pollen has been observed highest from June to August by Seetharamaiah et al. (1981) from Bangalore. Tilak & Patil (1983) also observed the maximum pollen count in July. Lalita and Ashok (2018) reported that this plant can produce flowers at any time of the year, but flowering occurs commonly in the rainy season. Additionally, we discovered that 38% of *P. hyterophorus* seeds germinated in the lab. It suggests that it germinates and grows generously when there is the highest level of air humidity. This might be the cause of the high pollen grain count in July.

*P. hysterophorus* is an invasive alien plant species and grow abundantly in the bare lands, roadsides, barren places, and dumping sites of the Srinagar valley (Rawat et al. 2017). Although the pollen from the plant has mainly entemophilous characters it still contributes a prominent amount of pollen in the atmosphere, thus, it can be called anemophilous as well and categorized as amphiphilic.

The back trajectory analysis suggested the travel path of the airborne pollen grain along with the air parcels. Similar studies were conducted earlier by Satch et al. (2007).

## CONCLUSION

The present study leads us to the conclusion that though there is some relation between the meteorological factors and the pollen counts, the flowering season of plants is also important. It can also be concluded that the ornamentation on the surface of *P. hyterophorus* pollen is also responsible for allergies. As the surface has fine spines on it, these spines can irritate the skin, nasal cavity, or throat when inhaled with air. July is considered the main pollen season as the number was maximum during this month. The track of the air mass shows the possible areas in which pollen can find and can cause allergies.

## ACKNOWLEDGEMENTS

The authors acknowledge the Head, Department of Botany and Microbiology, HNB Garhwal University, Srinagar (Garhwal), Uttarakhand for providing facilities to conduct the study. The authors are also thankful to the Department of Physics, HNB Garhwal University, Srinagar (Garhwal), and the Department of Physics, School of Basic Sciences, Bahra University, Shimla, Himachal Pradesh, India for their assistance in trajectory analysis and for providing

Table 2: Correlation between pollen count and meteorological parameters.

| Met parameters | Pearson's correlation | | Spearman correlation | |
|---|---|---|---|---|
| | R-value | P value | R-value | P value |
| Temperature | 0.399 | 0 | 0.153 | 2.660 |
| Humidity | 0.240 | 0.001 | 0.172 | 3.420 |
| Wind speed | 0.090 | 0.002 | 0.159 | 0.865 |
| Wind direction | 0.070 | 0.001 | 0.174 | 0.181 |
| Rainfall | 0.015 | 0.396 | 0.047 | 0.782 |

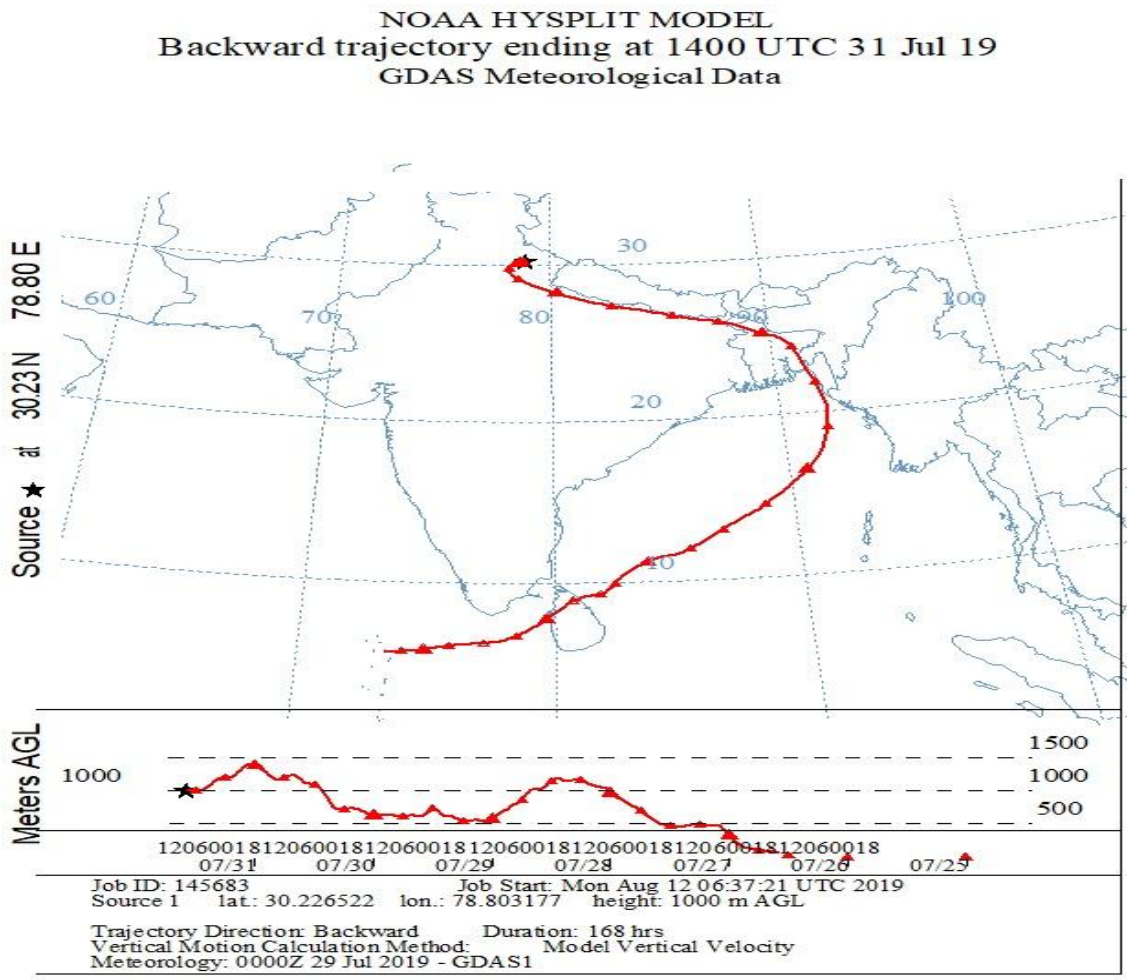


Fig 4: Back trajectory analysis.

meteorological data. SA is grateful to the University Grants Commission (UGC), New Delhi for granting a fellowship during the study period.

## REFERENCES

Asturias, J.A., Ibarrola, I., Bartolome, B., Ojeda, I., Malet, A. and Martinez, A. 2002. Purification and characterization of Pla a 1, a major allergen from Platanus acerifolia pollen. Allergy, 57(3): 221-227.

Cecchi, L., Malaspina, T.T. and Albertini, R. 2007. The contribution of long-distance transport to the presence of Ambrosia pollen in central northern Italy. Aerobiologia, 23: 145-151.

Cour, P., Zheng, Z., Duzer, D., Calleja, M. and Yao, Z. 1999. Vegetational and climatic significance of modern pollen rain in northwestern Tibet. Rev. Paleobot. Palynol., 104: 183-204.

Davis, R.E., Normile, C.P., Sitka, L., Hondula, D.M., Knight, D.B., Gawtry, S.P. and Stenger, P.J. 2010. A comparison of trajectory and air mass approaches to examine ozone variability. Atmos. Environ., 44(1): 64-74.

Erdtman, G. 1960. Acetolysis method, A revised description. *Sven. Bot. Tidskr*. 54: 561-564.

Feng, W., Zhu, Q., Zhuang, J. and Yu, S. 2019. An expert recommendation algorithm based on Pearson correlation coefficient and FP-growth. Cluster Computing, 22: 7401-7412.

Galán, C., Alcázar, P., Cariñanos, P., Garcia, H. and Domínguez-Vilches, E. 2000. Meteorological factors affecting daily Urticaceae pollen counts in southwest Spain. Int. J. Biometeorol., 43(4): 191-195.

Gautam, A.S., Joshi, A., Kumar, S., Shinde, M., Singh, K. and Nautiyal, A. 2020. Variation of atmosphere parameters and dependent nature of Covid-19 pendemic in India during the lockdown period. Journal of Critical Review, 7(19): 2445-2453.

Gioulekas, D., Balafoutis, C., Damialis, A., Papakosta, D, Giioulekas, G. and Patakas, D. 2004. Fifteen years' record of airborne allergenic pollen and meteorological parameters in Thessaloniki, Greece. Int. J. Biometeorol., 48:128-136.

Gunaseelan V. N. 1987. *Parthenium* is addictive to cattle manure in biogas production. Biol. waste, 21:195-202.

Gupta, N., Martin, B.M., Metcalfe, D.D., and Rao, P.S. 1996. Identification of a novel hydroxyproline-rich glycoprotein as the major allergen in *Parthenium* pollen. J. Allergy Clin. Immunol., 98(5): 903-912.

Gupta, N., Sriramarao, P., Kori, R. and Rao, P.S. 1995. Immunochemical characterization of rapid and slowly released allergens from the pollen

of *Parthenium hysterophorus*. Int. Arch. Allergy Immunol., 107(4): 557-565.

Handa, S., Sahoo, B. and Sharma, V.K. 2001. Oral hyposensitization in patients with contact dermatitis from *Parthenium hysterophorus*. Contact Derm., 44: 279-282.

Iglesias, I., Rodriguez-Rajo, F.J. and Mendez, J. 2007. The behavior of *Platanus hispanica* pollen, an important spring aeroallergen in northwestern Spain. J. Investig. Allergol Clin. Immunol., 17(3), 145-156.

Khosla, S.N. and Sobti, S.N. 1981. Effective control of *Parthenium hysterophorus* L. Pesticides, 15(4): 18-19.

Kohli, R.K. and Rani, D. 1994. *Parthenium hysterophorus*: A review. Res. Bull. Sci. Punjab Univ., 44: 105-109.

Kumar, S., Khandpu, S., Rao, D.N., Wahaab, S., and Khanna, N. 2012. Immunological Response to *Parthenium hysterophorus* in Indian Patients with *Parthenium* Sensitive Atopic Dermatitis. Immunological Investigations, Informa Healthcare, USA, Inc. pp. 75-8.

Lalita, R. and Kumar, A. 2018. Review on a weed *Parthenium hysterophorus* (L.). Int. J. Curr. Res. Rev., 10(17): 23-32.

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

Liu, Y., Mu, Y., Chen, K., Li, Y. and Gou, J. 2020. Daily activity feature selection in smart homes based on Pearson correlation coefficient. Neural Processing Letters, 51(2): 1771-1787.

Mahura, A.G., Korsholm, U.S. and Baklanov, A.A. 2007. Elevated birch pollen episodes in Denmark: Contributions from remote sources. Aerobiologia, 23: 171.

Mandrioli, P., Comtois, P. and Levizzani, V. 1998. Methods in Aerobiology. Pitagora Editrice Bologna, Italy.

Mari, A., Di Felice, G., Afferni, C., Barletta, B., Tinghino, R., Sallusto, F. and Pini, C. 1996. Assessment of skin prick test and serum-specific IgE detection in the diagnosis of Cupressaceae pollinosis. J. Allergy Clin. Immunol., 98: 21-31.

Morin, L., Reid, A. M., Sims-Chilton, N. M., Buckley, Y. M., Dhileepan, K., Hastwell, G. T., Nordblom T.L. and Raghu, S. 2009. Review of approaches to evaluate the effectiveness of weed biological control agents. Biol. Control, 51(1): 1-15.

Nair, P.K.K., Joshi, A.P. and Gangal, S.V. 1986. Airborne Pollen, Spores and Other plant materials of India a survey. Publ. C.S.I.R. Centre of Biochemicals, Delhi and National Botanical Research Institute, Lucknow, India. p. 224.

Nayar, J., Kumar, A. and Ramanujam, C. K. G. 1990. Monitoring of *Parthenium* pollen in the atmosphere of Hyderabad and its environs. J. Indian Inst. Sci., 70: 435-439.

Piotrowska, K. 2006. The effect of meteorological factors on the start of the grass pollen season in Lubin in the years 2001-2004. Acta Agrobot., 59(1): 365-372.

Rao, M., Prakash O. and Subba rao P. V. 1985. Reaginic allergy to *Parthenium* pollen: evaluation by skin test and RAST. Clin. Allergy, 15: 449-454.

Rawat, D.S., Ballabha, R., Suri, S., Tiwari, J.K. and Tiwari, P. 2017. Photo restoration in the debris dumping sites of a hydroelectric power project: A case study from Srinagar (Garhwal), Western Himalaya, India. Environ. Conserv. J., 18(3): 189-197.

Sa´nchez-Ccoyllo, O.R., Ynoue, R.Y., Martins, L.D. and de Fátima Andrade, M. 2006. Impacts of ozone precursor limitation and meteorological variables on ozone concentration in Sao Paulo, Brazil. Atmos. Environ., 40, 552-562.

Satch, A., Smith, M., Skjoth, A. and Brandt, J. 2007. Examining Ambrosia pollen episodes at Poznan (Poland) using back-trajectory analysis. Int. J. Biometeorol., 51: 275-286.

Seetharamaiah, M.A., Viswanath, B. and Subba Rao, P.V. 1981. Atmospheric survey of pollen of *Parthenium hysterophorus*. Ann. Allergy, 47: 192-196.

Sharma, V.K., Verma, P. and Maharaja, K. 2013. *Parthenium* dermatitis. Photochem. Photobiol. Sci., 12(1): 85-94.

Shukla, S. and Shukla, R.V. 2010. A quantitative survey of pollen flora in the atmosphere of Korba- Chattisgarh, India. Int. J. Bot., 6(4): 449-455.

Sohi, A.S., Tiwari, V.D., Lonker, A., Rangachar, S.K. and Nagasampagi, B.A. 1979. Allergic nature of *Parthenium hysterophorus*. Cont. Derm., 5: 133.

Stein, A., Draxler, R., Rolph, G., Stunder, B., Cohen, M. and Ngan, F. 2015. NOAA's HYSPLIT atmospheric transport and dispersion modeling system. Bull. Amer. Meteor. Soc., 11: 545

Subiza, J., Cabrera, M., Valdivieso, R., Subiza, J.L., Jerez, M., Jimenez, J.A., Narganes, M.J. and Subiza, E. 1994. Seasonal asthma caused by airborne Platanus pollen. Clin. Exp. Allergy, (24)12: 1123-1129.

Tilak, S.T. and Patil, B.Y. 1983. The status of *Parthenium* pollen as aeroallergen. J. Bio. Res., 3:12-15.

Towers, G.H.N. and Subba Rao, P.V. 1992. Impact of the pan-tropical weed, *Parthenium hysterophorus* L. on human affairs. In Proceedings of the First International Weed Control Congress, Weed Science Society of Victoria Melbourne, pp. 134-138.

Wedner, H.J., Wilson, P. and Lewis, W.H. 1989. Allergic reactivity to *Parthenium hysterophorus* pollen: An ELISA study of 582 sera from the United States Gulf Coast. J. Allergy Clin. Immunol., 84(2): 263-271.

Wiesner, M., Tessema, T., Hoffmann, A., Wilfried, P., Buttner, C., Mewis, I. and Ulrichs, C. 2007. Impact of the Pan-Tropical Weed *Parthenium hysterophorus* L. on Human Health in Ethiopia. Institute of Horticultural Science, Urban Horticulture, Berlin, Germany.

Yadav, N., Saha, P. and Jabeen, S. 2010. Effect of methanolic extract of *Parthenium hysterophorus* L. on hematological parameters in Wistar albino rat. Bioscan. Int. J. Life Sci., 2: 357-363.