NATIONAL ENVIRONMENTAL SCIENCE ACADEMY (NESA)

International Journal on Environmental Sciences
http://nesa-india.org | http://journal.nesa-india.org/index/IJES
IJES 16(1): 65-70 **(2025)** • ISSN: 0976-4534
https://doi.org/10.53390/IJES.2025.16108

DETERMINATION OF LEAF DUST ACCUMULATION AND ITS EFFECT ON PLANT SPECIES GROWN ALONG NH-30 FROM REWA (M.P.) TO PRAYAGRAJ (U.P.), INDIA.

Shrishti Singh* and Atul Tiwari

Department of Environmental Biology, Rewa (M.P.), India

Research Paper

Received: **05.03.2025** Revised: **24.03.2025** Accepted: **10.04.2025**

ABSTRACT

The present investigation was undertaken to study the dust interception efficiency of the plant species growing along National Highway- 30 from Rewa (M.P.) to Prayagraj (U.P.) India and also in A.P.S. University Rewa campus (as control site).Particulate matter can cause serious health hazard owing to their ability to remain suspended for long period of time and travelling long distances in the atmosphere. Roadside trees can play a significant role in capturing these air suspended pollutants, absorb noise and serve as acoustic screens on busy highways. Result indicated that the dust accumulation pattern in various species was in the order *Calotropis procera* > *Butea monosperma* > *Neolamarkia cadamba* > *Tectona grandis* > *Mangifera indica* > *Azadirachta inica* > *Dalbergia sisso* > *Acacia nilotica* > *Saraca asoca* > *Ficus religiosa*. The highest amount of leaf dust 1.624 mg/cm^2 was recorded in *Calotropis procera* whereas, the lowest dust deposition 0.210 mg/cm^2 was recorded in *Ficus religiosa* at polluted sites. The foliar dust accumulation of selected plants varied due to surface, structure, size, orientation and phyllotaxy of leaves. Higher dust holding capacity was observed for leaves with larger size, wax coated, rough surface and folded margins. Contrarily, leaves with smooth and flat surface, and vertically directed with folded margins accumulated lower dust.

No. of Pages: 6 **References: 31**

Keywords: Air Pollution, Dust Deposition, Plants, Micro morphological traits, Rewa.

INTRODUCTION

Outdoor air pollution is a major global public health issue, leading to 6.67 million death world wide and 1.67 million deaths in India annually (Health effects Institute, 2020). Dust is an important abiotic factor and has a key influence on the various plant species. The severe pressure of dust may be responsible for the morphological and biochemical changes in the plant species which further initiated adaptive evolution to merge with the changing environment. Vehicles are the prime source of dust generation for roadside plants. Vehicular exhaust adds up huge amounts of soot particles, smoke poisonous gases (SO_2, NO_2, CO_2, VOCs etc.), Heavy metals and organic molecules on the roads all over the world. All these air pollutants are known to produce adverse effects on the health of plants, animals and humans (Kulshreshtha *et al.*, 2009; Rezaei *et al.*, 2010; Atkinson *et al.* 2012; Singh et al., 2023). In the arid ecosystem due to dryness of soil, the windblown dust is common feature and plays a great role in increasing dust pollution in the environment (Younis *et al.* 2013). Similarly, high-speed vehicles and agricultural as well as other anthropogenic activities also generate too much high dust pollution in the air (Manins *et al.*, 2001; Van Jaarsveld, 2008; Balwan and Saba, 2021; Prakash and

*Corresponding author: *srishtithakur2098@gmail.com*

Verma, 2022). Poor road infrastructure, the frequency of running vehicles in terms wheel determine the rate of dust generation. Pesticides in general also influence the plants and animals in various ways (Prakash and Verma, 2020; Chaudhary et al., 2021). Trees are biomonitors and sinks for air pollutants but better sinking ability comes from trees with high tolerance for air pollution (Yuniati *et al*., 2024; Mandal *et al*., 2023; Chowdhury *et al.,* 2022), and dense vegetation could effectively block the penetration of road particulate matter (Zheng *et al*., 2021; Lukowskie *et al*., 2020; Roy *et al*., 2020). Among the evergreen, coniferous plants are an excellent choice for air purification due to the abundant wax layer on the needles, smaller leaves, and more complex shoot structures (Freer-Smith *et al*., 2005). The ability of leaves to act as dust receptors depends upon their surface geometry, orientation, phyllotaxy, epidermal and cuticle features, leaf pubescence, leaf and branch density, leaf micro morphology (roughness, trichomes and wax), canopy type and plant height (Sgrigna *et al*., 2015, Burkardt *et al*., 2010, Rasanen *et al.,* 2013). Smaller plants with short petioles and rough surface accumulate more dust than larger plants with long petioles and smoother leaf surface (Thakar and Mishra, 2010).

MATERIALS AND METHODS

Study Area

The entire study area extended from National Highway -30 from Rewa (M.P.) to Prayagraj (U.P.), geographically Rewa lies between 24°18' and 25°12' north lattitute and 81°2' and 62°18' east longitudes while Prayagraj lies between latitude 24°47' north and 25° north and longitudes 81°19' East and 82°21' east. The total distance of NH-30 between Rewa to Prayagraj is 125 km. both Rewa and Prayagraj have humid subtropical climate, with cold, misty winter a hot summer and a humid monsoon season. The annual mean temperatue of Prayagraj is 26.1°c (79.0°F), monthly mean temperature are 18-29°c (64-84°F) and annual rainfall is 1027mm (40 in) while annual mean temperature of Rewa are 25.1°c (77.1°F) and rainfall here is around 1020 mm/40.2 inch per year. National highway-30 is 5^{th} longest highway of India that stretches for almost 1984.3km and passes through six states, including Uttarakhand, UP, MP, Chhatisgarh, Telangana, Andhra Pradesh, that start from Sitargang in Uttarakhand and ends at Ibrahimpatnam, Vijaywada (Andhra Pradesh). The National Highway-30 is one of busiest route and connecting major tourist places and the district being an education hub and gateway to agriculture to produce is subjected to continuous heavy traffic loads.

Sampling Sites

For conducting studies the whole area was divided into 7 sampling site in which one as control site. (1) S1- Rewa city Bypass (M.P), (2) S2- Mangawa (M.P.), (3) S3- Sohagi (M.P), (4) S4- Chakghat (M.P), (5.) S5- Ghoorpur (U.P), (6) S6- Naini (U.P) and (7) S7- A.P.S University Rewa (MP) (as control site).

Sampling and Analysis of Leaf Dust Deposition

Nearly equal size of 10 leaves from selected tree species growing along different roadsides of the highway, collected from a height of approximately 2 meter (ambient height) within one day to minimize temporal changes as well as in A.P.S. University Campus (as control site) in the month of December 2024. The leaf samples collected in the zip lock plastic bags with lesser wind speed. During collection, samples immediately closed and labeled in preweighted plastic bags to avoid contamination and transported into the laboratory. The dust adhering on the dorsal and ventral surface of leaves was carefully cleaned with the help of fine brush in the same polythene. Again the weight of polythene was taken with the help of electronic balance in order to determine the amount of dust present on the leaf surface.

After cleaning, the leaf area was calculated with the help of graph paper. Each leaf sample out line was drawn on a graph paper and then the number of square was counted in cm^2 to obtain the leaf area. The amount of dust deposited on leaf surface in mg/cm2 was calculated by the following formula (Prajapati and Tripathi, 2008).

$$W = (W_2 - W_1)/a$$

Where W is dust content (mg/cm2), W_1 is initial weight of polythene, W_2 is final weight of Polythene with dust and “a” is total area of leaf (cm^2).

Table 1: Morphological characteristics of selected plants growing along National Highway-30.

S.No	Plant Species	Common Name	Habit	Family Shape	Leaf texture	Leaf	Orientation
1.	*Acacia nilotica*	Babool	Tree	Fabaceae	Elliptical/ Oblong	Smooth & Waxy	Alternate
2.	*Azadirachta inica*	Neem	Tree	Meliaceae	Lanceolate	Medium	Opposite
3.	*Butea* monosperma	Palas	Shrub / Small Tree	Fabaceae	Ovate/ Elliptical	Leathery & Coriaceous	Alternate
4.	*Calotropis procera*	Madar	Shrub/ Small tree	Apocynaceae	Ovate/ Elliptical	Glabrous	Opposite
5.	*Dalbergia sisso*	Sheesham	Tree	Fabaceae	Ovate/ Elliptical	Leathery	Alternate
6.	*Ficus religiosa*	Peepal	Tree	Moraceae	Small elliptic	Glossy & coriaceous	Alternate
7.	*Mangifera indica*	Aam	Tree	Anacardiaceae	Lanceolate	Leathery	Alternate
8.	*Neolamarkia cadamba*	Kadam	Tree	Rubiaceae	Ovate/ Lanceolate	Leathery	Opposite
9.	*Saraca asoca*	Ashoka	Tree	Fabaceae	Oblong/ Elliptic	Glossy	Alternate
10.	*Tectona grandis*	Sagon	Tree	Lamiaceae	Broadly elliptical	Rough & Hairy	Opposite

Table 2: Dust load (mg/cm2) on level of 10 tree species growing along different sites of National Highway-30 Rewa (MP) to Prayagraj (UP) and Control Site.

S. No.	Plant species	S1	S2	S3	S4	S5	S6	S7
1.	*Acacia nilotica*	0.510	0.515	0.520	0.481	0.382	0.401	0.024
2.	*Azadirachta inica*	0.821	0.830	0.854	0.810	0.781	0.801	0.033
3.	*Butea monosperma*	1.483	1.501	1.530	1.432	1.391	1.404	0.048
4.	*Calotropis procera*	1.591	1.602	1.625	1.563	1.501	1.541	0.050
5.	*Dalbergia sisso*	0.642	0.659	0.687	0.638	0.610	0.622	0.029
6.	*Ficus religiosa*	0.305	0.320	0.335	0.291	0.210	0.225	0.020
7.	*Mangifera indica*	0.823	0.935	0.949	0.817	0.801	0.811	0.038
8.	*Neolamarkia cadamba*	1.391	1.402	1.432	1.351	1.291	1.313	0.045
9.	*Saraca asoca*	0.391	0.402	0.421	0.323	0.292	0.301	0.021
10.	*Tectona grandis*	1.301	1.312	1.321	1.283	1.231	1.252	0.040
	Average	0.926	0.948	0.967	0.899	0.849	0.867	0.035

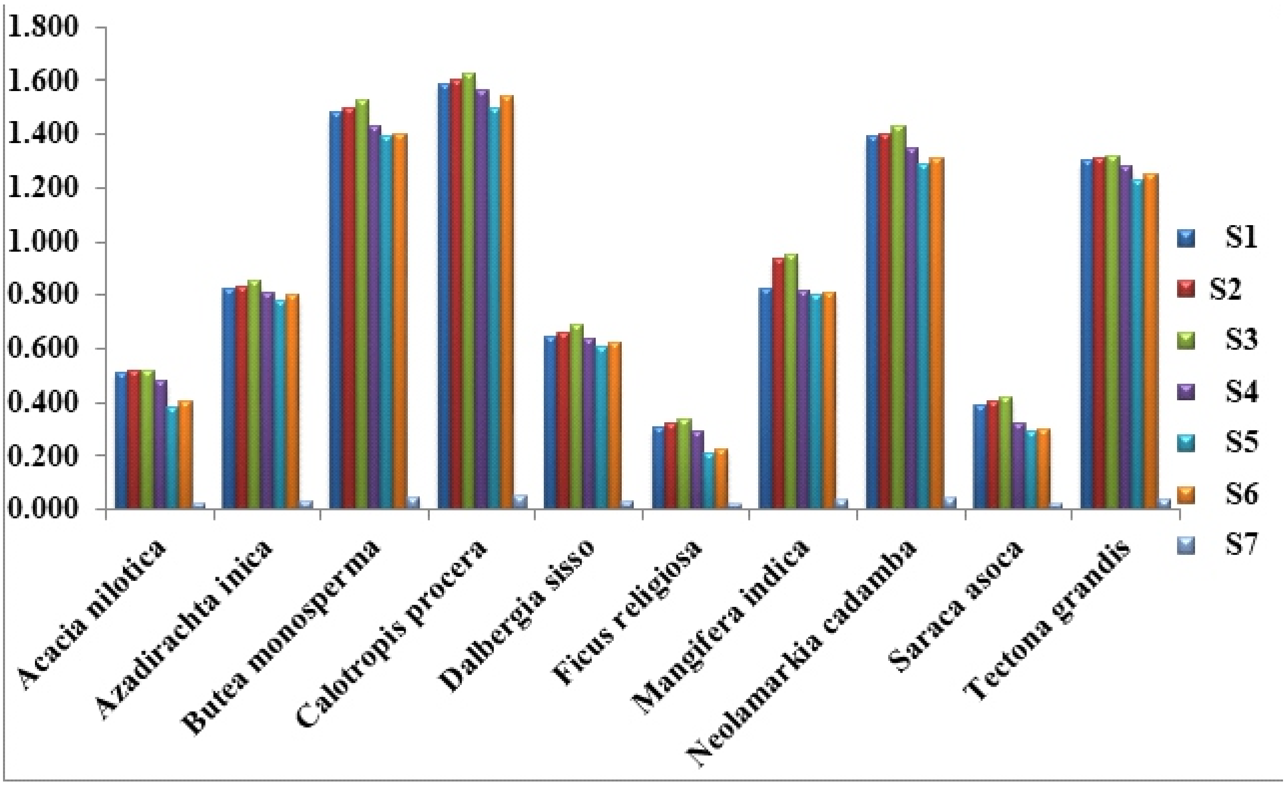

Figure 2: Dust deposition on leaves of selected plant species of sampling sites.

RESULT AND DISCUSSION

Dust deposition on leaves of selected 10 plant species growing along National highway-30 as well as control site are given in Table1. The average maximum dust deposition was observed on the leaf of *Calotropis procera* (1.571 mg/cm^2) growing at polluted sites followed by *Butea monosperma* (1.457mg/cm^2), *Neolamarkia cadamba* (1.363 mg/cm^2), *Tectona grandis* (1.283 mg/cm^2), *Mangifera indica* (0.856 mg/cm^2), *Azadirachta inica* (0.816 mg/cm^2), *Dalbergia sisso* (0.643 mg/cm^2), *Acacia nilotica* (0.468 mg/cm^2), *Saraca asoca* (0.355 mg/cm^2). *Ficus religiosa* (0.281 mg/cm^2) showed lowest average dust deposition on leaves. Result revealed that greater accumulation of dust on leaf of plant species growing along NH-30 of sampling sites maximum at Sohagi (S3)> Mangawan (S2) > Rewa Bypass (S1) > Chakghat (S4) > Naini (S6) > Ghoorpur (S5) as compared to their respective plant of control site (APSU campus). The average dust load was found at S1 (0.926 mg/cm^2), S2 (0.048 mg/cm^2), S3 (0.967 mg/cm^2), S4 (0.899 mg/cm^2), S5 (0.849 mg/cm^2), S6 (0.867 mg/cm^2) and S7 (0.035 mg/cm^2) – control site respectively (Table2). The observed deposition on the plant leaves has provided the information of particulate ambient air pollution in the sampled sites as compared to control site of APSU campus (Figure 2).

Plants growing along National Highway-30 are consistently exposed to dust emitted from various sources. Although dust particles settled everyday on the leaf surface but there is no uniform deposition in all the species. Surface geometry, epidermal and cuticular features of leaves, and height and canopy of the tree influence the capacity of leaves as dust receptors and the phyllotaxy leaf orientation and sessile or semi-sessile nature of leaves in a horizontal direction. Simple leaves are considered to be better dust collectors than the trees having compound leaves (Sett, 2017). Weather condition, direction and speed of wind and exposure time also influence interception capacity of holding plants. These factors may be responsible for variation in dust deposition on the leaves of plant species under present investigation.

The maximum dust holding capacity has been observed for the leaves of *Calotropis procera, Butea monosperma*, *Neolamarkia cadamba*, *Tectona grandis*, *Mangifera indica*, *Azadirachta inica*, *Dalbergia sisso*, *Acacia nilotica*, *Saraca asoca* and *Ficus religiosa* at polluted sites. Large surface area and texture of leaf surface of these species may be attributed for holding the maximum dust particles. Higher dust accumulation in *Calotropis procer, Butea monosperma*, *Neolamarkia cadamba* may be due to rough and leathery leaf surface and short petiole, while in *Tectona grandis* may be due to large and rough leaf surface. In case of *Mangifera indica*, *Azadirachta inica*, it may be due to their waxy coating on leaves with slightly folded margin. In *Dalbergia sisso*, *Acacia nilotica* less dust deposition occurs may be due to small leaf surface and in *Saraca asoca* due to smooth leaf surface, vertical orientation & long petiole less dust deposition occurs. The lowest dust deposition in *Ficus religiosa* could be attributed to its smooth leaves with flat leaf surface and more flattering of leaves with wind movement due to long petiole. Although the observation on seasonal variation in foliar dust accumulation have not been a part of this study but the seasonal influence on dust deposition in plant leaf has been a subject of various recent studies (Bhaskar and Mehta, 2010, Guttikunda and Jawahar, 2011, Malandrino, *et al*., 2013, Nair *et al*., 2014, Salvador *et al*., 2012, Xu *et al.,* 2018). Singh *et al.* (2023) Singh and Tiwari (2025) have observed the Higher concentration of particulate matter accumulation was noticed during winter season (due to low temperature, wet surface of leaves that help in particulate matter capturing) followed by summer (due to high temperature and strong wind speed) and lowest in rainy season (due to washing leaves).

CONCLUSIONS:

This study concludes that accumulation of dust on the leaf of plant species indicates the presence of considerable amount of dust in the amount of ambient air near National Highway. It is further conclude that dust accumulation varies with structure, phyllotaxy, size of particle, presence/absence of hairs, and wax on leaf surface of selected plants. Plants leave with wax coating and rough surface with folded margins accumulate more dust than leaves with vertically oriented, smooth, flat surface without folded margins. Thus plants can serve as an indicator of dust pollution and the plants can be used in the abatement of dust pollution by acting as natural filters.

REFERENCES

1. **Atkinson RW, Yu D, Armstrong BG, Pattenden S, Wilkinson P, Doherty RM, Heal MR, Anderson HR**. (2012). Concentration-response function for ozone and daily mortality: results from five urban and five rural U.K. populations. *Environ Health Perspect*. 120(10):1411-7.
2. **Balwan W.K. and Saba N.** (2021). Impact of Sound Pollution on Animal and Human Health. *International Journal of Biological Innovations*. 3 (1): 68-73.
3. **Bhaskar, B.V. and Mehta, V.M.** (2010). Atmospheric particulate pollutants and their relationship with meterology in Ahemdabad. *Aerosol and Air quality Research*. 10:301-315. https://doi.org/10.4209/aaqr.2009.10.0069
4. **Burkhardt, J.** (2010). Hygroscopic particles on leaves: Nutrients or desiccants? Ecol. *Monogr*. 80,369-399. https://doi.org/10.1890/09-1988.1
5. **Chaudhary, I.J. and Rathore, D.** (2019). Dust pollution: its removal and effect on foliage physiology of urban trees. *Sustain. Cities Soc*. 51, 1-10. https://doi.org/10.1016/j.scs.2019.101696.
6. **Chaudhary, V.K., Arya, S., and Singh, P.** (2021). Effects of Pesticides on Biodiversity and Climate Change. *International Journal on Environmental Sciences*, 12(2): 95-99.
7. **Freer-Smith PH, Beckett KP, Taylor G** (2005). Deposition velocities to *Sorbus aria, Acer campestre, Populus deltoids trichocarpa* 'Beaupre', *Pinus nigra* and *Curessocyparis leylandii* for coarse, fine and ultra fine particles in the urban environment. *Environ Pollut.* 133(1):157-167. 10.1016/j.envpol.2004.03.031.
8. **Guttikunda, S. and Jawahar, P.** (2011). Urban air pollution analysis in India. Urban Emission. Info., New Delhi, India.
9. **Kulshreshtha, K., Rai, A., Mohanty, C., Roy, R. and Sharma, S.** (2009). Particulate Pollution Mitigating Ability of Some Plant Species. *International Journal of Environmental Research*, *3*(1), 137-142. 10.22059/ijer.2009.42
10. **Lukowski, A.; Popek, R. and Karolewski, P.** (2020). Particulate matter on foliage of *Betula pendula, Quercus robur,* and *Tilia cordata:* Deposition and ecophysiology. *Environ. Sci. Pollut. Res*. 27, 10296-10307. https://doi.org/10.1007/s11356-020-07672-0
11. **Malandrino, M., Di Martino, M., Ghiotti, G., Geobaldo, F., Grosa, M. M., Giacomino, A., & Abollino, O.** (2013). Inter-annual and seasonal variability in PM10 samples monitored in the city of Turin (Italy) from 2002 to 2005. *Microchemical Journal.;* 107: 76-85. 10.1016/j.microc.2012.05.026.
12. **Mandal, M., Mamun, Robert Popek, Arkadiusz Przybysz, Anamika Roy, Sujit Das, and Abhijit Sarkar.** (2023). "Breathing Fresh Air in the City: Implementing Avenue Trees as a Sustainable Solution to Reduce Particulate Pollution in Urban Agglomerations" *Plants* 12(7): 1545; https://doi.org/10.3390/plants12071545
13. **Manins P, Allan R, Beer T, Fraser P, Holper P, Suppiah R & Walsh K** (2001) Atmosphere.

Australia State of the Environment Rep. 2001 (Theme Rep.). CSIRO Publ., Melbourne.

14. **Nair, N., Bamniya, B.R.; Mahecha, G.S. and Dhavan, S.** (2014). Analysis of ambient air pollution and determination of air quality status of Udaipur, Rajasthan, India. *International Research Journal of Environmental Sciences*, 3(6), 5-10.

15. **Prajapati SK, Tripathi BD.** (2008). Seasonal variation of leaf dust accumulation and pigment content in plant species exposed to urban particulates pollution. *J Environ Qual*. 37(3):865-70. 10.2134/jeq2006.0511. PMID: 18453408.

16. **Prakash, S. and Verma, A.K.** (2020). Effect of organophosphorus pesticides on Biomolecules of fresh water fish, *Heteropneustes fossilis* (Bloch). *Indian Journal of Biology*. 7(2): 65-69.

17. **Prakash, S. and Verma, A.K.** (2022). Anthropogenic activities and Biodiversity threats. *International Journal of Biological Innovations.* 4(1): 94-103.

18. **Räsänen, J.V., Holopainen, T., Joutsensaari, J., Ndam, C., Pasanen, P., Rinnan, Å. andKivimäenpää, M.** (2013). Effects of species-specific leaf characteristics and reduced water availability on fine particle capture efficiency of trees. *Environ. Pollut*. 183, 64-70. 10.1016/j.envpol.2013.05.015

19. **Rezaei M, Arzani A, Sayed-Tabatabaei BE. (**2010). Meiotic behaviour of tetraploid wheats (*Triticum turgidum* L.) and their synthetic hexaploid wheat derivates influenced by meiotic restitution and heat stress. *J Genet*. 89(4):401-7. 10.1007/s12041-010-0058-2.

20. **Roy, A. and Bhattacharya, T.** (2020). Air pollution tolerance, dust capturing capacity of native tropical trees for green belt development in Dhanbad and Bokaro city, Jharkhand, India. *J. Indian Chem. Soc*. 97, 635-643.

21. **Salvador, P., Artınano, B., Viana, M., Alastuey, A. and Querol, X.** (2012). Evaluation of the changes in the Madrid metropolitan area influencing air quality: analysis of 1999–2008 temporal trend of particulate matter. *Atmos. Environ*. 57, 175-185. 10.1016/j.atmosenv.2012.04.026.

22. **Sett, R.** (2017). Responses in Plants Exposed to Dust Pollution. *Horticulture International Journal.* 1(2):53-56. 10.15406/hij.2017.01.00010.

23. **Sgrigna, G., Saebo, A. and Gawronski, S.** (2015). Particulate matter deposition on Quercus ilex leaves in an industrial city of central Italy. *Environmental Pollution*. 197, 187-194. 10.1016/j.envpol.2014.11.030

24. **Singh, S., Mishra, R.M., Singh, P. and Singh, M.** (2021). Leaf dust accumulation and its impact on chlorophyll content of *Azadirachta indica* and *Bauhinia variegata* developing in the proximity of J.P. cement plant, Rewa (M.P.) India. *International Journal of Biological Innovations*. 3(1): 173-178. 10.46505/IJBI.2021.3117.

25. **Singh R., Verma A.K. and Prakash S.** (2023). The web of life: Role of pollution in biodiversity decline. *International Journal of Fauna and Biological Studies*. 10(3): 49-52.

26. **Singh, S. and Tiwari A.** (2025). Assesment of particulate matter PM10 and PM 2.5 and their impact on *Neolamrckia cadamba* and *Cascabeta thevetia* in Rewa (M.P.) India. *International Journal of Biological Innovations.* 7(1):22-29. https://doi.org/10.46505/IJBI.2025.7103.

27. **Thakar B K and Mishra P C.** (2010). Dust collection potential and air pollution tolerance index of tree vegetation around Vedanta Aluminium limited, Jharsuguda. *The Bioscan* 3, 603-612.

28. **Xu, Y., Xu, W. and Mo, L.** (2018). Quantifying particulate matter accumulated on leaves by 17 species of urban trees in Beijing, China. *Environmental Science And Pollution Research*, 25(13), 12545-12556. DOI: 10.1007/s11356-018-1478-4.

29. **Younis, U. , Bokhari, T. , Malik, S. , Raza Shah, M., Athar, M. and Niaz, S.** (2015). Particulate matter effect on biometric and biochemical attributes of fruiting plants. *Global Journal of Environmental Science and Management*, *1*(2), 117-124. 10.7508/gjesm.2015.02.003

30. **Yuniti R, HandayaniL, Khoerunnisa I, Halimah Putrika A, Hemelda N.M.** (2024). The capacity of trees to remove particulate matter and lead and its impact on tree health. *Biodiversitas*. 25:2541-2551. 10.13057/biodiv/d250826

31. **Zheng, T., Zhang, S., Li, X.B., Wu, Y. and Peng, Z.R.** (2021). Impacts of vegetation on particle concentrations in roadside environments. *Environ. Pollut*. 282, 117067. 10.1016/j.envpol.2021.117067.