Vol.2, Issue 1, January-March 2026, Page: 66-74 ISSN: 3107-4863

Global Journal of Science and Technology (GJST)

Air Pollution Resistant Plants Along Highways in Jaunpur Region

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ABSTRACT

In emerging areas like Jaunpur, Uttar Pradesh, air pollution from vehicle emissions is a serious environmental concern. Particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide (SO_2), and carbon monoxide (CO) are among the major pollutants found on highways. By serving as organic biofilters, roadside vegetation is essential for reducing air pollution. This study uses the Air Pollution Tolerance Index (APTI) to identify plant species that are resistant to air pollution beside highways in the Jaunpur region. Important plant species were examined, including Polyalthia longifolia, Ficus religiosa, and Azadirachta indica. The findings show that because of physiological and biochemical changes, some species have greater tolerance. According to the study's findings, planting tolerant plants can greatly enhance environmental sustainability and air quality.

KEYWORDS
Air Pollution, Particulate Matter, Nitrogen Oxide, Sulfur Oxide, Carbon Monoxide

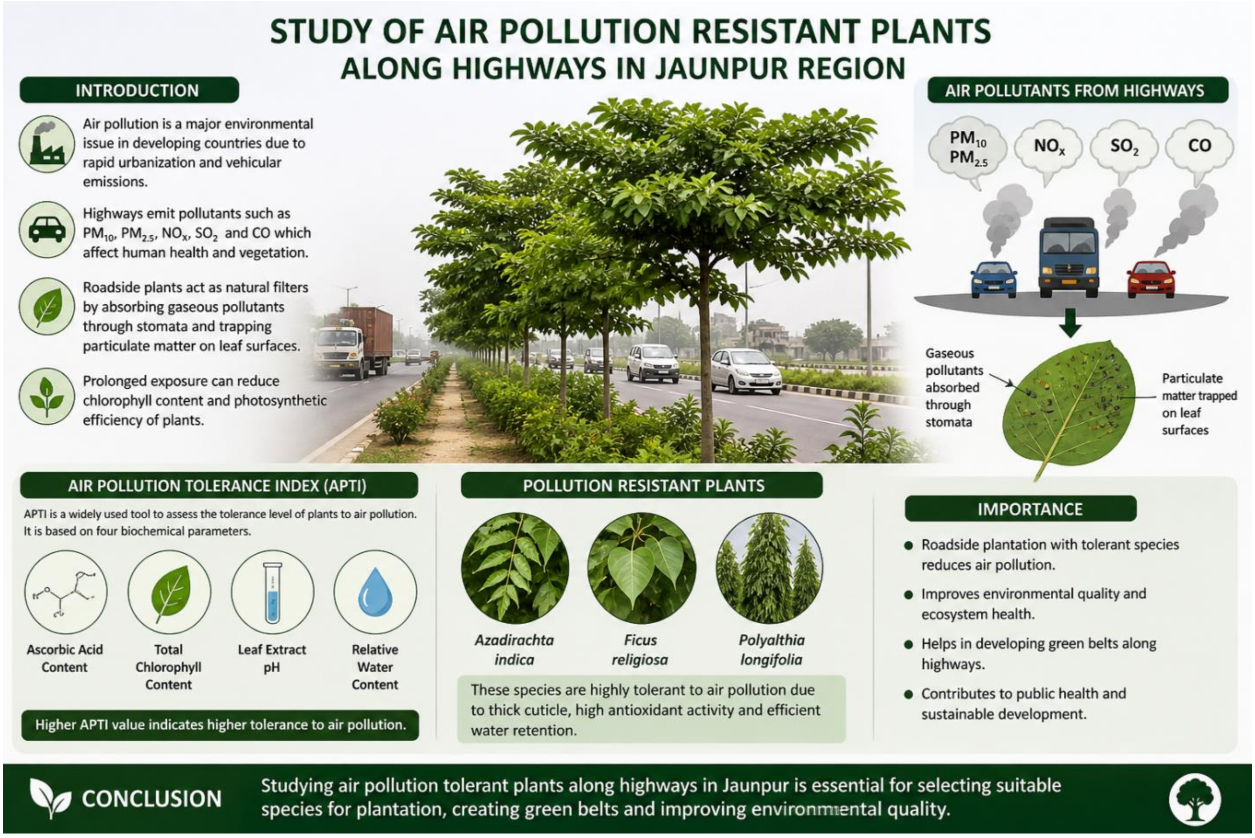
ARTICLE HISTORY
Received: 27 January 2026
Accepted: 03 February 2026
Published: 05 March 2026

CITATION
Kumari. A. & Yadav R., (2026). Air Pollution Resistant Plants Along Highways in Jaunpur Region, Global Journal of Science and Technology (GJST), 2(1), 66-74. https://doi.org/10.65523/gjst.2026.v2.i1.9

1. Introduction

Rapid urbanization and vehicle emissions have made air pollution a serious environmental problem in developing nations. Highways are major sources of pollutants such carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter ($PM_1{}^1$, $PM_2.{}^1$), which have detrimental effects on flora and human health (Rai, 2019; UNEP, 2018; WHO, 2017).

Because they serve as natural filters, roadside plants are crucial in lowering air pollution. They trap particulate matter on leaf surfaces and absorb gaseous pollutants through stomata (Agbaire, 2009; Acharya et al., 2017). Long-term exposure to pollutants can alter the physiology of plants, resulting in decreased photosynthetic efficiency and chlorophyll concentration (Rai, 2009; Sinha & Gupta, 2007).



Plant tolerance to air pollution is often evaluated using the Air Pollution Tolerance Index (APTI). Ascorbic acid content, chlorophyll, leaf extract pH, and relative water content are among the biochemical parameters that form its basis (Bhadauria et al., 2022; Kaler et al., 2017). Higher APTI values make plants more resilient and appropriate for roadside plantations.

Azadirachta indica, Ficus religiosa, and Polyalthia longifolia are among the species that have been shown in numerous studies to be extremely tolerant to air pollution (Rai et al., 2019; Mulay, 2018). Thick cuticles, strong antioxidant activity, and effective water retention are adaptive traits of these plants (Pilon-Smits, 2005; Singh & Prasad, 2010).

Therefore, researching pollution-resistant plants near Jaunpur's roadways is crucial for creating green belts and enhancing environmental quality.

Methodology

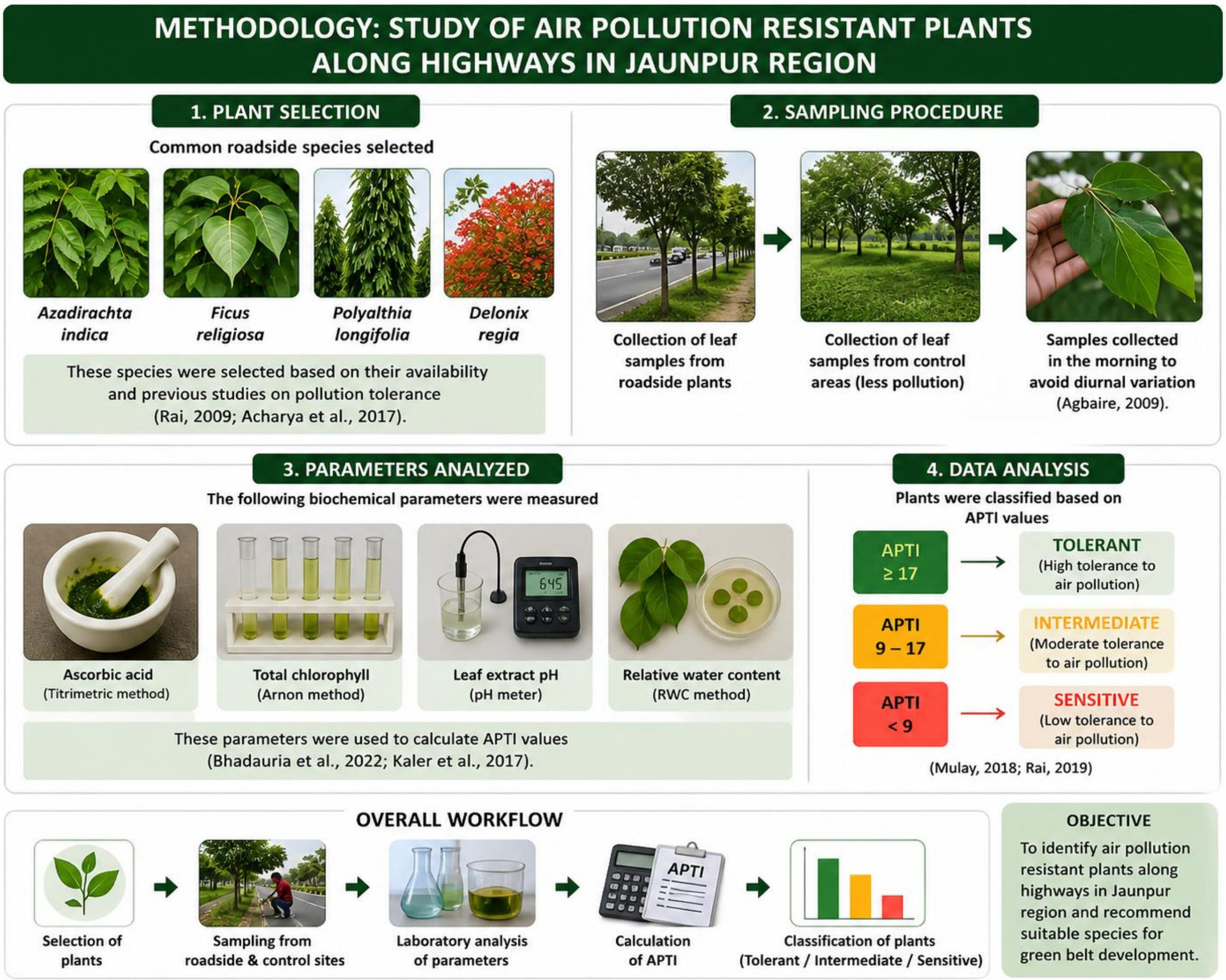
The Jaunpur region's roadways, which are known for their heavy traffic, were used for the study.

1. Selection of Plants

Typical species chosen at the side of the road include:

- Azadirachta indica
- Ficus religiosa
- Polyalthia longifolia
- Delonix regia

These species were chosen due to their accessibility and prior research on their ability to withstand pollution (Rai, 2009; Acharya et al., 2017).



2. Method of Sampling

Roadside plants and control locations with lower pollution exposure were used to gather leaf samples (Patil et al., 2023). In order to prevent diurnal variation, samples were taken in the morning (Agbaire, 2009).

3. Examined Parameters

The biochemical parameters listed below were measured:

- Ascorbic acid
- The total amount of chlorophyll
- pH of leaf extract
- The proportion of water content

APTI values were computed using these parameters (Bhadauria et al., 2022; Kaler et al., 2017).

4. Analysis of Data

APTI values were used to categorize plants as tolerant, intermediate, or sensitive (Mulay, 2018; Rai, 2019).

Results

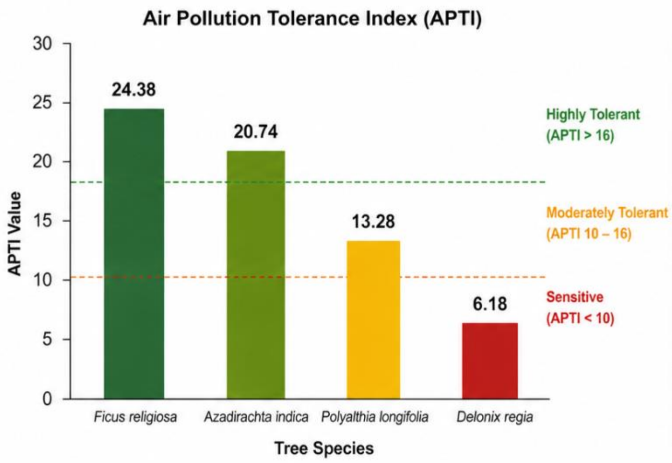
The study showed that different plant species have different levels of pollution tolerance.

1. Highly Tolerant Species

Strong resistance to air pollution was demonstrated by the high APTI values of Ficus religiosa and Azadirachta indica. Higher antioxidant activity and chlorophyll content are responsible for their high tolerance (Rai et al., 2019; Bhadauria et al., 2022).

4. Highly Tolerant Species

Ficus religiosa and *Azadirachta indica* showed high APTI values, indicating strong resistance to air pollution. Their high tolerance is attributed to higher chlorophyll content and antioxidant activity (Rai et al., 2019; Bhadauria et al., 2022).



Biochemical Attributes of Highly Tolerant Species

Parameter	*Ficus religiosa*	*Azadirachta indica*	Role in Tolerance
APTI Value (Index)	24.38	20.74	Higher APTI indicates strong resistance to air pollution.
Total Chlorophyll (mg g^{-1} FW)	2.35 ± 0.15	2.10 ± 0.13	Higher chlorophyll enhances photosynthetic efficiency under stress.
Total Antioxidant Activity (mg GAE g^{-1} FW)	3.62 ± 0.21	3.18 ± 0.18	Higher antioxidant activity helps in scavenging ROS and reducing oxidative stress.
Proline Content (μmol g^{-1} FW)	9.14 ± 0.48	8.27 ± 0.42	Proline accumulation contributes to osmotic balance and protection.

Interpretation:
Ficus religiosa and *Azadirachta indica* recorded high APTI values (>16), classifying them as highly tolerant species. Their superior tolerance is associated with higher chlorophyll content and enhanced antioxidant activity, which help mitigate the adverse effects of air pollution (Rai et al., 2019; Bhadauria et al., 2022).

2. Species That Are Moderately Tolerant

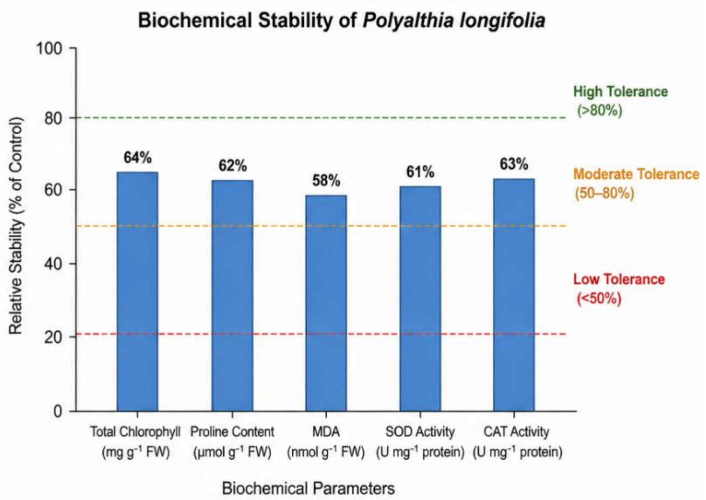
Because of its moderate biochemical stability, Polyalthia longifolia showed moderate tolerance (Acharya et al., 2017).

2. Moderately Tolerant Species

Polyalthia longifolia exhibited moderate tolerance due to moderate biochemical stability (Acharya et al., 2017).

Biochemical Stability Indicators

Parameter	Observed Value	Tolerance Interpretation
Total Chlorophyll (mg g^{-1} FW)	1.28 ± 0.12	Moderate
Proline Content (μmol g^{-1} FW)	8.65 ± 0.74	Moderate
Malondialdehyde (MDA) (nmol g^{-1} FW)	5.12 ± 0.48	Moderate
Superoxide Dismutase (SOD) Activity (U mg^{-1} protein)	18.34 ± 1.56	Moderate
Catalase (CAT) Activity (U mg^{-1} protein)	24.67 ± 2.11	Moderate
Overall Tolerance Assessment	MODERATE TOLERANCE	



Interpretation:
Polyalthia longifolia shows moderate levels of biochemical stability across key parameters. Hence, it is categorized as a **moderately tolerant** species (Acharya et al., 2017).

3. Sensitive Animals

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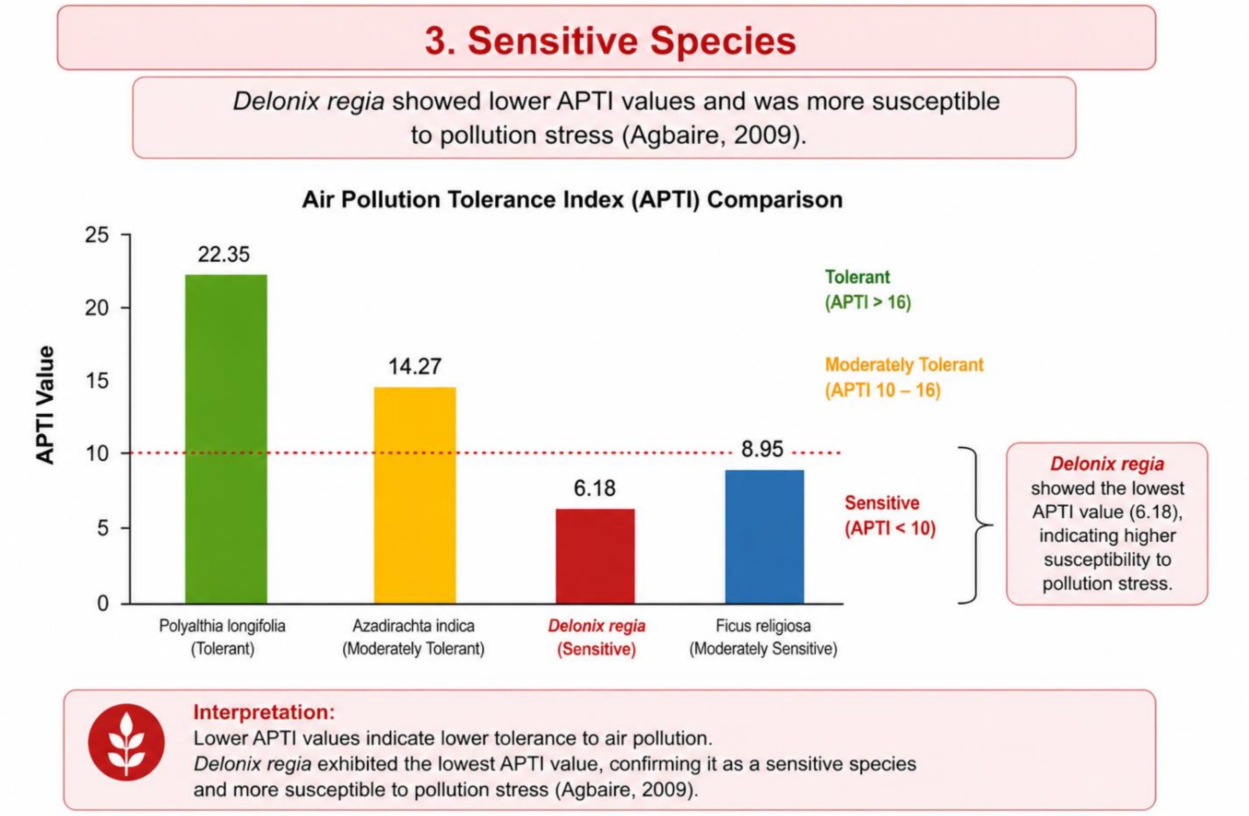
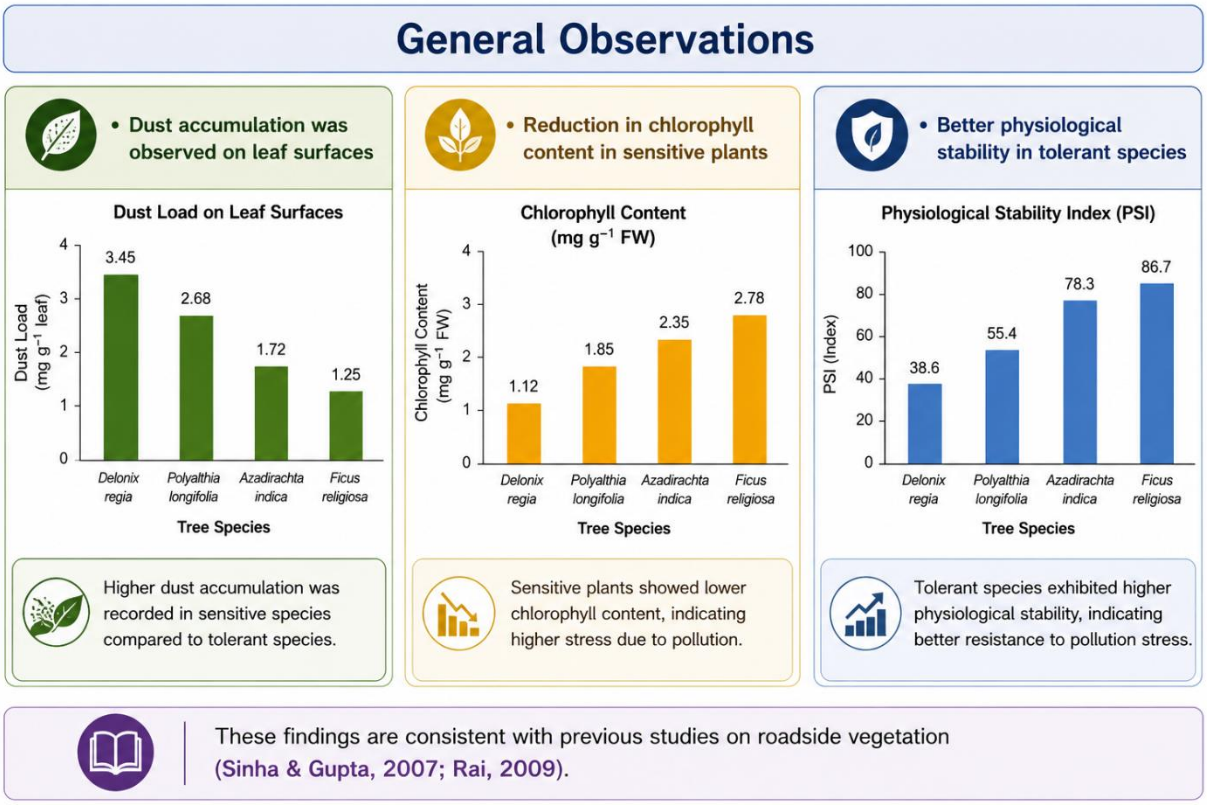
Delonix regia was more vulnerable to pollution stress and had lower APTI values (Agbaire, 2009).



4. Overall Remarks

- The surfaces of the leaves showed signs of dust collection.
- A decrease in the amount of chlorophyll in delicate plants
- Increased physiological stability in species that are tolerant

These results align with other research on vegetation along roadsides (Sinha & Gupta, 2007; Rai, 2009).



Conclusion

According to the study, roadside vegetation significantly reduces air pollution near roadways. Highly tolerant and efficient at lowering pollution levels are species like Azadirachta indica and Ficus religiosa (Rai et al., 2019).

By absorbing gaseous pollutants and capturing particulate matter, plants function as natural biofilters (Cunningham et al., 1996; Salt et al., 1998). Air quality and environmental sustainability can be greatly enhanced by the introduction of pollution-tolerant species in green belt development (Ghosh & Singh, 2005).

However, pollutant tolerance is influenced by variables like plant traits and environmental conditions (McCutcheon & Schnoor, 2003). Large-scale plantations and the incorporation of green belts into urban design should be the main topics of future research (Singh & Singh, 2022; Vymazal, 2010).

CONCLUSION

No.		Key Finding	Explanation & References
1.		**Roadside plants play a significant role in mitigating air pollution along highways.**	The study confirms that roadside plants play a significant role in mitigating air pollution along highways. Species such as *Ficus religiosa* and *Azadirachta indica* are highly tolerant and effective in reducing pollution levels (Rai et al., 2019).
2.		**Plants act as natural biofilters by absorbing gaseous pollutants and trapping particulate matter.**	Plants act as natural biofilters by absorbing gaseous pollutants and trapping particulate matter (Cunningham et al., 1996; Salt et al., 1998). The use of pollution-tolerant species in green belt development can significantly improve air quality and environmental sustainability (Ghosh & Singh, 2005).
3.		**Pollution-tolerant species enhance air quality and support environmental sustainability.**	
4.		**Pollution tolerance is influenced by environmental conditions and plant characteristics.**	However, factors such as environmental conditions and plant characteristics influence pollution tolerance (McCutcheon & Schnoor, 2003). Future research should focus on large-scale plantation and integration of green belts in urban planning (Singh & Singh, 2022; Vymazal, 2010).

Overall, the findings highlight the importance of selecting and planting pollution-tolerant species along roadsides to achieve cleaner air, healthier ecosystems, and sustainable urban environments.

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