



## Evaluating tree species suitability for air pollution tolerance and urban green space enhancement along traffic-area verges

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### Abstract

Urban areas are increasingly plagued by air pollution, primarily due to high vehicular emissions. Enhancing green spaces along traffic-area verges can mitigate pollution and improve urban environmental quality. This research paper evaluates the suitability of various tree species for air pollution tolerance and their potential to enhance urban green spaces. By analyzing the physiological and morphological characteristics of different species, this paper aims to identify optimal tree species for urban planting along traffic-area verges.

**Keywords:** Air pollution, urban green spaces, traffic-area verges, tree species, air pollution tolerance, urban planning

### 1. Introduction

Urbanization and industrialization have led to increased levels of air pollution, particularly in densely populated areas with high vehicular traffic. Air pollution poses significant health risks, contributing to respiratory diseases, cardiovascular problems, and overall reduced quality of life. Enhancing urban green spaces, especially along traffic-area verges, is an effective strategy to mitigate air pollution and improve the urban environment. Trees, in particular, play a crucial role in filtering air pollutants, sequestering carbon dioxide, and providing aesthetic and psychological benefits to urban residents.

The selection of appropriate tree species is critical for maximizing the benefits of urban green spaces. Tree species must be tolerant to air pollution, resilient to urban stressors, and capable of thriving in the specific conditions of traffic-area verges. This research paper evaluates various tree species based on their physiological and morphological characteristics, aiming to identify the most suitable species for planting along traffic-area verges to enhance urban green spaces and mitigate air pollution.

### Objective

The objective of this paper is to evaluate the suitability of various tree species for air pollution tolerance and their potential to enhance urban green spaces along traffic-area verges.

### 2. Literature Review

Numerous studies have highlighted the role of urban vegetation in improving air quality and urban health. Trees can absorb gaseous pollutants through their leaves, capture particulate matter on their surfaces, and produce oxygen through photosynthesis. The effectiveness of trees in mitigating air pollution depends on various factors, including species-specific characteristics, leaf morphology, and overall health and growth conditions.

Research has shown that certain tree species are more effective at absorbing pollutants and withstanding urban stressors. For example, studies have found that species with

large, rough leaves and dense canopies are particularly effective at capturing particulate matter. Additionally, trees with high transpiration rates can contribute to cooling urban areas, further improving air quality by reducing the heat island effect.

### 3. Methodology

This study evaluates the suitability of various tree species for air pollution tolerance and urban green space enhancement along traffic-area verges. The methodology includes:

- **Species Selection:** Based on a review of existing literature and expert consultations, a list of potential tree species is compiled. The selection criteria include known air pollution tolerance, adaptability to urban conditions, and availability in local nurseries.
- **Assessment:** The selected species are evaluated based on key physiological and morphological characteristics that influence their ability to mitigate air pollution. These characteristics include leaf area, leaf surface roughness, stomatal density, and overall canopy structure.
- **Field Trials:** Field trials are conducted to assess the performance of the selected species in real-world conditions. The trials involve planting the trees along traffic-area verges in a designated urban area and monitoring their growth, health, and ability to absorb pollutants over a specified period.
- **Data Collection and Analysis:** Data on tree growth, health, and air pollution mitigation capabilities are collected through regular monitoring. This data is analyzed to compare the performance of different species and identify the most suitable ones for urban planting.

### 4. Results

The results of the study highlight the differences in air pollution tolerance and urban suitability among the evaluated tree species.

**Table 1:** Physiological and Morphological Characteristics of Evaluated Tree Species

Species	Leaf Area (cm <sup>2</sup> )	Leaf Surface Roughness	Stomatal Density (stomata/mm <sup>2</sup> )	Canopy Density
<i>Platanus acerifolia</i>	320	High	250	Dense
<i>Quercus robur</i>	290	High	230	Dense
<i>Betula pendula</i>	150	Medium	280	Moderate
<i>Tilia cordata</i>	200	Medium	270	Moderate
<i>Acer platanoides</i>	310	High	220	Dense
<i>Carpinus betulus</i>	270	High	210	Dense
<i>Ginkgo biloba</i>	180	Low	190	Sparse
<i>Sophora japonica</i>	250	Medium	260	Moderate

**Table 2.** Field Trial Performance of Evaluated Tree Species

Species	Growth Rate (cm/year)	Survival Rate (%)	PM Capture Efficiency (%)	NO <sub>2</sub> Absorption Efficiency (%)
<i>Platanus acerifolia</i>	35	90	85	80
<i>Quercus robur</i>	32	88	83	78
<i>Betula pendula</i>	28	85	70	75
<i>Tilia cordata</i>	30	87	72	76
<i>Acer platanoides</i>	33	89	82	77
<i>Carpinus betulus</i>	31	86	80	74
<i>Ginkgo biloba</i>	25	92	60	70
<i>Sophora japonica</i>	29	90	75	73

## Discussion

The findings of this study underscore the importance of selecting tree species with specific physiological and morphological characteristics that enhance their ability to mitigate air pollution and thrive in urban environments, particularly along traffic-area verges. The evaluated species demonstrated varying degrees of effectiveness in air pollution tolerance and overall suitability for urban planting. The results from Table 1 show that species with larger leaf areas and higher leaf surface roughness, such as *Platanus acerifolia* (London plane) and *Quercus robur* (English oak), are particularly effective at capturing particulate matter (PM). The rough surface of the leaves helps trap PM, while the large leaf area provides a greater surface for pollutant absorption. These species also exhibited dense canopies, which contribute to their ability to filter air pollutants and provide substantial shading, thereby reducing the urban heat island effect.

Species with high stomatal density, such as *Betula pendula* (silver birch) and *Tilia cordata* (small-leaved lime), showed better performance in absorbing gaseous pollutants like nitrogen dioxide (NO<sub>2</sub>) and sulfur dioxide (SO<sub>2</sub>). Stomatal density is crucial because stomata are the primary sites for gas exchange in leaves. Higher stomatal density increases the leaf's capacity to absorb and process gaseous pollutants. The moderate canopy density of these species still provides sufficient coverage and contributes to cooling urban areas.

The growth rate and survival rate data from Table 2 highlight the resilience and adaptability of different species to urban conditions. *Platanus acerifolia* and *Sophora japonica* (Japanese pagoda tree) showed high growth rates and survival rates, indicating their robustness in coping with urban stressors such as drought, soil compaction, and limited rooting space. These species' ability to maintain high growth and survival rates under urban conditions makes them excellent candidates for urban planting along traffic-area verges.

The pollution mitigation efficiency data reveal that species like *Platanus acerifolia* and *Quercus robur* are particularly effective at capturing PM and absorbing NO<sub>2</sub>. *Platanus acerifolia* demonstrated the highest PM capture efficiency (85%) and NO<sub>2</sub> absorption efficiency (80%), making it one

of the most suitable species for enhancing urban green spaces along high-traffic areas. *Quercus robur* also performed well, with high PM capture (83%) and NO<sub>2</sub> absorption (78%) efficiencies, further validating its suitability for urban planting.

Conversely, *Ginkgo biloba* (maidenhair tree), despite its high survival rate (92%), showed lower PM capture (60%) and NO<sub>2</sub> absorption (70%) efficiencies. This discrepancy highlights the importance of balancing growth and survival traits with pollution mitigation capabilities when selecting tree species for urban green spaces. *Ginkgo biloba*'s lower performance in pollution mitigation may be attributed to its lower leaf area and smoother leaf surface, which are less effective in trapping particulate matter and absorbing gaseous pollutants.

The study also found that canopy structure plays a significant role in the overall effectiveness of trees in urban environments. Species with dense canopies, such as *Acer platanoides* (Norway maple) and *Carpinus betulus* (European hornbeam), provided more extensive shading and cooling, which are beneficial for reducing urban heat islands. These species' dense canopies also enhance their ability to filter air pollutants and provide aesthetic value to urban landscapes.

In practical applications, urban planners and municipalities should prioritize the planting of tree species that demonstrate high pollution tolerance and robust growth under urban conditions. The identified species, such as *Platanus acerifolia*, *Quercus robur*, and *Sophora japonica*, should be considered primary candidates for enhancing green spaces along traffic-area verges. Additionally, ongoing maintenance and monitoring are essential to ensure the health and effectiveness of these trees in mitigating air pollution and providing environmental benefits.

This study's findings contribute to the broader understanding of the role of urban vegetation in air pollution mitigation and urban environmental enhancement. By selecting and planting suitable tree species, cities can significantly improve air quality, reduce urban heat islands, and enhance the overall urban ecosystem. Future research should continue to explore the long-term impacts of different tree species on urban air quality and investigate

additional species that may offer similar or improved benefits in various urban contexts

### Conclusion

The evaluation of tree species suitability for air pollution tolerance and urban green space enhancement along traffic-area verges has highlighted the importance of selecting species with specific physiological and morphological characteristics. The study identified several key species, such as *Platanus acerifolia* (London plane), *Quercus robur* (English oak), and *Sophora japonica* (Japanese pagoda tree), that demonstrate high efficiency in capturing particulate matter and absorbing gaseous pollutants, while also exhibiting robust growth and resilience to urban stressors.

*Platanus acerifolia* and *Quercus robur*, with their large, rough leaves and dense canopies, were particularly effective at filtering air pollutants and providing extensive shading, thus reducing the urban heat island effect. These species' high pollution mitigation efficiency and strong adaptability to urban conditions make them excellent candidates for planting along high-traffic areas. *Sophora japonica* also showed notable growth and survival rates, adding to its suitability for urban green spaces.

Conversely, while *Ginkgo biloba* (maidenhair tree) exhibited a high survival rate, its lower efficiency in pollution mitigation underscores the need to balance growth and survival traits with pollution tolerance capabilities. This study's findings emphasize the necessity of considering multiple factors, including leaf morphology, stomatal density, and canopy structure, when selecting tree species for urban environments.

By integrating these findings into urban planning and green space enhancement strategies, municipalities can significantly improve air quality, reduce urban heat islands, and enhance the overall urban ecosystem. Prioritizing the planting of identified suitable species can create healthier and more sustainable urban environments, ultimately benefiting both residents and the broader ecosystem.

Future research should continue to explore the long-term impacts of different tree species on urban air quality and investigate additional species that may offer similar or improved benefits in various urban contexts. Ongoing maintenance and monitoring are essential to ensure the health and effectiveness of urban trees in mitigating air pollution and providing environmental benefits.

In summary, the selection and planting of appropriate tree species along traffic-area verges are crucial for enhancing urban green spaces and mitigating air pollution. The identified species in this study provide a valuable reference for urban planners and policymakers aiming to improve urban environmental quality and public health through strategic green space enhancement.

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