



Integrating air pollution tolerance in urban green spaces

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Abstract

Urban areas, particularly those with high vehicular traffic, face significant challenges related to air pollution. Enhancing urban green spaces by planting tree species tolerant to air pollution can mitigate these issues. This research article evaluates the suitability of various tree species for air pollution tolerance and their potential to enhance urban green spaces along traffic-area verges. By analyzing the physiological and morphological characteristics of selected tree species, this study identifies optimal candidates for urban planting to improve air quality and urban sustainability.

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

Introduction

In rapidly urbanizing environments, the detrimental effects of air pollution pose significant challenges to public health and environmental sustainability. As cities expand and industrial activities intensify, concentrations of pollutants such as particulate matter, nitrogen oxides, and volatile organic compounds increase, contributing to a range of health issues and ecological degradation. In this context, the integration of air pollution tolerance in urban green spaces emerges as a promising strategy to mitigate the adverse impacts of pollution while enhancing the quality of urban life. Urban green spaces, including parks, gardens, and roadside verges, play a vital role in urban ecosystems by providing essential ecosystem services such as carbon sequestration, temperature regulation, and stormwater management. Beyond their aesthetic appeal and recreational value, these green areas have the potential to serve as natural filters, removing pollutants from the air and improving overall air quality.

The concept of integrating air pollution tolerance in urban green spaces involves strategically selecting and cultivating plant species known for their ability to absorb and mitigate air pollutants. By incorporating such species into urban landscapes, cities can create green corridors that not only enhance biodiversity and aesthetics but also serve as effective buffers against the harmful effects of air pollution. This integration represents a convergence of disciplines, including environmental science, urban planning, horticulture, and public health. It requires a holistic approach that considers the ecological characteristics of plant species, the dynamics of urban air pollution, and the socio-economic context of urban development.

While the idea of using vegetation to combat air pollution is not new, recent advancements in plant selection, monitoring

technologies, and urban design have revitalized interest in this approach. Researchers and policymakers are increasingly exploring innovative strategies to optimize the effectiveness of green infrastructure in mitigating air pollution and promoting human well-being.

In this context, this study aims to evaluate the feasibility and effectiveness of integrating air pollution tolerance in urban green spaces, focusing specifically on roadside verges in urban areas. Through a combination of field trials, physiological assessments, and data analysis, we seek to identify suitable tree species capable of thriving in polluted urban environments while actively contributing to air quality improvement.

By shedding light on the potential benefits and challenges of this approach, this research aims to inform urban planners, policymakers, and environmental practitioners about the importance of integrating air pollution tolerance into green infrastructure planning and management. Ultimately, the successful integration of air pollution tolerance in urban green spaces has the potential to foster healthier, more sustainable cities for present and future generations

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, physiological and morphological assessment, field trials, and data collection and analysis.

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

Table 2. Field Trial Performance of Evaluated Tree Species

Species	Growth Rate (cm/year)	Survival Rate (%)	PM Capture Efficiency (%)	NO ₂ 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

5. Discussion

The findings from this study underscore the significance 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 results from Table 1 indicate 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 aids in trapping 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, thus 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 (NO₂) and sulfur dioxide (SO₂). 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 NO₂. *Platanus acerifolia* demonstrated the highest PM capture efficiency (85%) and NO₂ 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 NO₂ 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 NO₂ 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.

Conclusion

Integrating air pollution tolerance in urban green spaces offers a multifaceted solution to the challenges posed by urbanization and environmental degradation. By strategically selecting and cultivating plant species known for their ability to absorb pollutants, cities can create pockets of cleaner air amidst urban sprawl. However, the success of such initiatives relies on careful planning, implementation, and ongoing maintenance. The conclusion drawn from integrating air pollution tolerance in urban green spaces is that while these efforts hold significant promise in mitigating the harmful effects of air pollution, they should be part of a broader, holistic approach to urban planning and environmental stewardship. Collaboration between government agencies, urban planners, environmental scientists, and community stakeholders is essential to ensure the effectiveness and sustainability of these green initiatives. Furthermore, ongoing research and monitoring are crucial to understand the long-term impacts of air pollution tolerance in urban green spaces and to refine best practices for future implementation. Ultimately, by incorporating green infrastructure into urban environments, cities can not only improve air quality but also enhance overall quality of life for residents, promote biodiversity, and contribute to the resilience of urban ecosystems in the face of climate change.

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