

Green Plants as a Sustainable Solution to Air Pollution

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ABSTRACT

In today's global context, the escalation of air pollution stands out as an immensely critical environmental challenge that has attained a worldwide magnitude. This pressing issue not only impacts every living organism on our planet but is also intricately linked to the phenomenon of climate change. The significant increase in vehicular traffic, rapid urbanization, and infrastructure development have indirectly contributed to a higher concentration of harmful gaseous and particulate pollutants in the atmosphere, posing serious risks to human health. Extensive research has thoroughly documented the adverse effects of these air pollutants, with mortality and morbidity rates varying depending on the type of pollutant and the duration of exposure. However, amidst this crisis, green plants emerge as a cost-effective and promising solution to combat environmental pollution, presenting several additional benefits. Specifically, pollution-tolerant plant species are crucial in reducing ambient air pollution and the urban heat island effect. To assess a plant's tolerance towards air pollution, experts use the air pollution tolerance index (APTI), which calculates crucial factors such as ascorbic acid, total chlorophyll, pH, and relative water content in the plant. This determination provides a reliable method for categorizing plants into either tolerant or sensitive types in the face of air pollution. Moreover, the morphological characteristics of leaves, such as stomata distribution and density, cuticle thickness, and trichome density, play an essential role in adsorbing and absorbing particulate matter from the air. These inherent qualities further enhance plants' potential to combat air pollution in a sustainable manner, making them valuable assets for the future. In light of this, the present review highlights the impressive capacity of plants to remediate air pollutants and explores the various strategies employed in this crucial endeavor. By leveraging the remarkable capabilities of green plants, we have the opportunity to address the air pollution crisis and embrace a sustainable path for the times to come. These remarkable organisms could be the sustainable saviors we need to protect our environment and secure a healthier future for all.

Keywords: Air pollution, Phytoremediation, Air Pollution Tolerance Index (APTI), Climate change, Leaf morphology

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INTRODUCTION

Rapid urbanization and infrastructure development during recent decades has contributed to increased anthropogenic pressures on the environment. The outcome of this situation is 'air pollution' which is posing a threat to both human and ecosystem health, requiring practical, sustainable remediation methods (Leonard *et al.*, 2016). Shockingly, the most recent estimates of mortality due to ambient air pollution (AAP) stand at 8.8 million deaths annually (Lelieveld *et al.*, 2020). Although human existence on earth is very recent as per the geological time scale, anthropogenic activities have increasingly caused a substantial impact on the earth by polluting the environment. Global environmental pollution is an international public health issue with multiple aspects like socio-economic and lifestyle implications (WHO, 2019). Sadly, the air we breathe is polluted much above the threshold limit owing to rapid industrialization, urbanization, the burning of fossil fuels, and other human activities (Lee *et al.*, 2021). There is substantial evidence that rising air pollution is also linked with global climate change as many air pollutants and greenhouse gases (GHG) have not only common sources, but their interaction in the atmosphere also exhibits synergistic effects causing environmental impacts at local and global levels (Bytnerowicz *et al.*, 2007; D'Amato *et al.*, 2016). The World Health Organization (WHO) estimated in 2019 that about 7 million premature deaths were attributed annually to the effects of ambient and household air pollution. Prior to that in 2016, the World Health Organization had reported that more than 92% of the world's population is exposed to air pollutants exceeding the limits prescribed by WHO. This report further suggests that air pollution is the largest environmental risk factor, which leads to

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increased morbidity and mortality. Major air pollutants include particulate matter (PM), nitrogen oxides (NO_x), sulfur oxides (SO_x), ground-level ozone (O₃), and volatile organic compounds (VOCs) (Wei *et al.*, 2017, Archibald *et al.*, 2017). Metropolitan cities suffer from high pollution from multiple emission sources, especially in India. The United Nations Organisation has predicted that by the year 2050, 2.5 billion people will inhabit urban areas, with Asia and Africa contributing to almost 90% of the increase in air pollution (United Nations *et al.*, 2019).

It is unequivocal that the first step towards reducing ambient air pollution is to eliminate/reduce anthropogenic emissions and the second step is remediation of the existing pollutants. Recently, green plants are emerging as rescuers of humanity with their ability to remediate the gargantuan levels of air pollution. Remediation of air pollution by plants is the most environment-friendly and cost-effective approach and is commonly known as phytoremediation. All parts of plants comprising of plant shoots or the above-ground organs of plants together with