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Impact of Soot Particle on Public Health and Vegetation in Industrial Dominating Area, District -Kangra (Himachal Pradesh) India

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Abstract: *Soot particles are tiny black particles released from burning fossil fuels like coal and oil. The presence of soot particles poses significant risks to public health and vegetation. Understanding and mitigating the impact of soot particles is crucial for safeguarding both human health and the vitality of ecosystem The purpose of review article is to find out the impact of soot particles on public health and vegetation in industrial dominating area, District-Kangra, Himachal Pradesh. The findings of other researchers were analysed and suggestive measures were given to reduce the impact of soot particles on public health and vegetation.*

Keywords: *Soot particles, Polycyclic Aromatic Hydrocarbons (PAH), Particulate matter, Public Health*

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1. Introduction

Soot is a term used to describe a form of particulate pollution called PM particulate matter 2.5 which is 2.5 micrometre in a diameter or less [1]. Soot formation can occur in all kinds of practical combustion system, especially in systems that operates on a diffusion flame scheme. The primary soot particles formed in various combustion processes [2]. Soot particles have a complex structure and consists of at least two major fraction: the first is a graphic part (elemental carbon) on which the fractional group containing hetero atoms (such as O, H, S) are chemically bonded and the second fraction consists of organic compound consists of PAH (Polycyclic aromatic hydrocarbons) [3]. Soot particles absorb sunlight well and act as a short - lived warming agent [4]. The term "Black carbon" is often used to describe the carbonaceous materials absorption properties [5]. Black carbon is a mixture of " graphite like elemental carbon and high absorbing organic matter [6]. Black carbon is derived from incomplete combustion of fossil fuels, woods, Biomass as well as from certain industrial processes [7]. Black carbon that comes from combustion processes scatters and absorb solar radiation and leads to poor air quality and cardiovascular disease [8]. The emission of soot or smoke is not limited to aesthetics or even energy conservation as these emissions are often associated with carcinogenic Polycyclic aromatic hydrocarbons [9]. Particulate matter is a key indicator of Air pollution and human activities and causes a number of illness leads to many health problems [10]. Particulate matter is a lumpy material with a mobility diameter of 50 - 100 nm, mainly composed of carbonaceous cores on which organic compound and sulphuric acid may be condensed [11]. Long term exposure to Particulate matter 2.5 has been limited to increased mortality from ischemic heart disease, pulmonary disease, heart stroke [12]. The particulate matter present in atmosphere affects directly the vegetation like affecting its stomata, foliar [13]. Vegetation is a reliable indicator of the overall effect of air pollution, particularly in the case of particulate matter [14]. More than two million deaths are predicted to occur globally each year as a directed result of air pollution affecting the lungs and respiratory system [15]. Fine particulate matter and ozone are responsible for around 2.1 and 0.47 millions of deaths [16]. Airborne suspended particular matter is an all over world very

serious concern [17]. Airborne particulate matter is that pollutant which represents many challenges [18]. According to global burden of disease report, it ranks highly among the avoidable causes of non - communicable disease [19]. Particulate matter is important because of its impact on human health, climate, visibility, reactivity [20].

2. Discussion

It was observed that the stomata of *Phaseoulus vulgaris* and *Zea mays* plants were not plugged by fly ash from a power plant. However, they noted that gaseous diffusion increased in dusted leaves due to the presence of particles [21]. It was found out that the particles did not physically block stomata, they influenced gaseous exchange potentially by altering surface properties or creating microenvironments that affected diffusion rates. According to investigations dust deposited onto vegetation may be increasing result of increased open cast mining, road traffic. The Study demonstrated the detrimental effects of dust on various types of vegetation including crops, grassland, shrubs, and trees. This includes changes in photosynthesis, respiration, and transport within plants [22]. Dust can also contribute to the formation of phytotoxic gaseous pollutants, affecting plant health and ecosystem dynamics. The ice forming activity of soot particles in a cloud chamber was investigated by **[**23] showing that the amount of aerosol particles capable forming of ice crystal was influenced by a variety of factors**,** including temperature**,** the mean radius of aerosol particles, and the degree of oxidation of soot particle surfaces. Oxidation was found to reduce the number of surface chemical groups that could participate in hydrogen bonds with water molecules. This indicates that the surface chemistry of soot particles plays a significant role in their ice nucleating ability, potentially affecting cloud formation processes and atmospheric dynamics. [24] investigated that soot particles in urban and mountain areas around Lhasa City in Tibetan Plateau revealed interesting findings. Qualitative analysis indicated that sulphur accumulated on soot particles as they migrated from urban to mountain areas. Soot particles collected from urban areas and lacked nitrite, whereas those dispersed in mountain areas contained $BaCl_2$ (Barium chloride) reactive sulphate. This suggests that soot particles may increase the buffering capacity of aerosol particles from urban areas and contribute to the formation of particulate sulphate in the Tibetan Plateau. These findings shed light on the complex interplay between urban and remote

environments, highlighting the potential role of soot particle in regional aerosol dynamics and atmospheric chemistry. Investigation of the black carbon aerosol in Pune, a tropical urban location in Southeast India, provided valuable insights into seasonal variations and influencing factors [25]. The study revealed that Black carbon concentrations were highest during the winter season, reaching levels approximately 80% higher than the annual average. This increase was attributed to prevailing metrological conditions such as low wind speeds, which led to the accumulation of pollutants in the atmosphere. Conversely, during monsoon season reduction in Black carbon levels, dropping to approximately 68% lower than the annual average. This decline could be attributed to the washout effect caused by precipitation, as well as the influence of winds originating from marine areas, which likely transported pollutants away from the region. investigation delved into the diverse sources of fine particulate matter released into the atmosphere, ranging from natural sources like open fires to anthropogenic sources such as power plants, traffic, and agriculture. The study revealed that these particulate pollutants exert detrimental effects on plants, including stomatal closure, leaf necrosis, chlorosis, and deterioration in soil quality. Deposition of particulate matter can lead to alterations in photochemistry and subsequently stunt plant growth. This suggests that the impact of particulate matter on plants extends beyond immediate physiological responses, potentially disrupting plant development and ecosystem dynamics over time [26].

The studies on indoor air pollution highlighted the presence of particulate matter as a major indoor air pollutant with potential adverse health effects. In Kosice city, Slovakia, the study focused on monitoring particulate matter in three rooms. Particularly, the total suspended particles and their thoracic fraction were analysed. The results showed that suspended particulate matter contained a high amount of metals relative to settled particles. This suggests that the indoor air quality may be significantly influenced by air borne particulate matter, particularly in urban environments like Kosice city [27]. The study of [28] uncovered the significant role of soot aerosol particles, also referred to as light – absorbing, Black, or elemental carbon, causing global warming. Due to their ability to absorb light, there particles are major contributors to the earth`s atmosphere`s warming, particularly in the visible and infrared spectral zones. From the study it was found out that the optical

properties of soot particles are affected by their position within the host particles. This suggests that the way soot is distributed within its host particle can affect its ability to absorb or scatter light, ultimately impacting its contribution to radiative forcing and climate change. In investigating soot deposition removal from exhaust gas recirculation coolers, [29] explored the forces acting on individual particles adhered to the cooler's surface or deposited within its layer. By understanding these forces, it becomes possible to determine potential mechanisms for removing the soot particles. This research is crucial for optimizing the performance of diesel engines and reducing emissions of nitrogen oxides (NO). In his investigation on soot particle adsorption by tree leaves, [30] compared the quantitative deposition velocities of five tree species :. *Pinus densiflora, Taxus cuspida , Plantanus occidentalis, Zelkova serrata and Ginkgo biloba.* The study revealed that needle leaf trees exhibited higher deposition velocities compared to broadleaf trees. Specifically, P. densiflora had the highest deposition speed followed by *T. cuspidata , Plantanus occidentalis, Zelkova serrata and Ginkgo biloba.* This finding suggests that certain tree species are more efficient at absorbing soot particles from the air. Particle size indeed plays a crucial role in determining the impact of particulate matter on human health. The findings highlighted that the Particulate matter is composed of solid and liquid particles suspended in the atmosphere, with varying sizes ranging from coarse to fine. These particles can penetrate different parts of the respiratory tract, with smaller particles often reaching deeper into the lungs, potentially causing more severe health effects. Therefore, understanding the size distribution of particulate matter is essential for assessing its health implications and developing effective mitigation strategies [31].

[32] investigated the impact of polluting gases, like sulphur dioxide (SO_2) and nitrogen dioxide (NO_2), on plants. These gases can pass through the stomata, the tiny pores on the leaf surface that control gas exchange. Sulphur dioxide, in particular does not only enter the stomata, but also triggers their destruction as a plant's defence mechanism. This closure can stifle the gas exchange necessary for photosynthesis, ultimately affecting the plant's ability to produce energy and grow. Additionally, the presence of these pollutants can directly interfere with photosynthesis, further exacerbating the negative effects on plant health and ecosystem. The impact of

particulate matter on leaves of *Ligustrum lucidum*, an evergreen tree species prevalent in North China, were observed and significant findings emerged. Particularly, at the most polluted site, a substantial accumulation of particulate matter was detected. This underscores the importance of considering local weather conditions and pollution levels when assessing the effects of environmental factors on plant health [33].

The studies on the cooling effect of soot particles over the Brahmaputra River Valley region unveils the intricate relationship between Black carbon and climate dynamics . The study illuminates how Black carbon influences climate by absorbing solar radiation and modifying cloud properties, thereby impacting regional weather patterns. Notably, seasonal variations were observed, with Black carbon and carbon monoxide (CO) contributing up to 55% to climate variability during dry months [34]. The study by [35] into the health effects of soot pollution in Port Harcourt , river state in Nigeria, sheds light on the alarming correlations between air pollutants and various health conditions. The report highlights the significant effects of particulate matter on respiratory diseases, skin abnormalities, trauma, and, child deformities. Moreover, the results show the detrimental effects of prolonged exposure to poor air quality, particularly for those who work in environments with poor ventilation. The crucial link between reducing air pollution levels and alleviating the global burden of disease due to air pollutants was investigated. By mitigating various pollutants emitted from vehicles and other sources, significant improvements can be achieved in public health outcomes worldwide. Particularly, impact of pollutants on vegetation highlights the interconnection between environmental health and ecosystem vitality. From the studies it was found out that pollutants can adversely affect plant physiology, including photosynthesis, pigment uptake, water absorption, and enzymatic activity [36]. From the study of [37] it was found out that the impact of atmospheric particulate matter and trace metals on both ecosystems and human health is indeed a multifaceted environmental issue. These pollutants, often emitted from urban and industrial sources, can have a significant repercussion on plant growth and overall ecosystem health. The deposition of particulate matter and trace metals onto plant surfaces can impede photosynthesis, nutrient uptake, and water regulation, ultimately hindering plant growth and productivity. Furthermore, these

contaminants can accumulate in plant tissues, potentially leading to reduced crop yields and compromised food quality. The investigation by [38]– highlights a critical aspect of air quality degradation and its impact on human health due to vegetation fires in tropical regions. The release of fine particulate matter 2.5 into the atmosphere from these fires significantly deteriorates air quality, posing serious health risks to polluted air. It's alarming to learn that fires in tropical and subtropical regions contribute to 90% of global particulate matter 2.5 fire emissions, underscoring the magnitude of environmental issue. Particulate matter 2.5 are particularly concerning because of their small size, which allows them to penetrate deep into the respiratory tract, causing various health problems such as respiratory infections, cardiovascular disease, and even premature death. The Particulate matter deposition on leave had a detrimental effect on the physical, chemical and biological properties of agriculture crops, resulting in reduced productivity and yield losses. For this study Wheat had been selected for analysis by conducting a survey to determine the possible effects of particulate matter deposition on wheat leaves. Wheat leaves were collected from the wheat crop field at Indian agricultural research institute, New Delhi. For obtaining the micrographs, scanning electron microscope was used which clearly indicated the presence of particulate matter [39]. In 2018 - 2020, average PM 2.5 and PM 10 concentration were 3 times higher than world health organization specified standards. To reduce pollution and develop a healthy risk management strategy in the industrial zone, a behavioural and health risk assessment was used [40].

3. Conclusion

Critical analysis of literature has shown a detrimental impact soot particles have on both public health and vegetation. Inhalation of fine particulate matter from soot can lead to cardiovascular problems in humans, soot particles extend to increased rate of lung diseases, including asthma and bronchitis. Soot particle role in air pollution contributes to the formation of smog and poses a risk to vulnerable populations. Also, the accumulation of soot can disrupt nutrient cycling and stunt plant development. Additionally, the darkening effect of soot on ice and snow surfaces contributes to accelerated melting, influencing regional climate patterns. Tackling the multifaceted challenges posed by soot requires collaborative efforts across sectors to

implement effective measures and promote sustainable practices.

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