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Pollutant Emissions from Brick Kilns and Their Effects on Climate Change and Agriculture

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ABSTRACT

Continuous increase in population has resulted in increased demand for building material. Bricks are the major building material and are a fast-growing industrial sector in many countries such as Pakistan, China, India, and Bangladesh. Despite its integral role, it is among the top three factors that cause the emission of harmful pollutants that not only affect our climate and human health but also effecting agriculture sectors to a great extent. Brick kilns emit gases like SO_2, CO, Black Carbon, CO_2, NO_x, PM, etc., that affect our biotic and abiotic components of the ecosystem. So, the objective of this paper is twofold. Firstly, it has been focused on the pollutants emissions from brick kilns, their effects on climate and agriculture sectors. Secondly, the possible techniques have been discussed that can be used to reduce or eliminate its harmful impacts. It was found that the pollutant emissions from brick kilns like SO_x, NO_x, CO_2, CO, unburnt hydrocarbons, Particulate matter, heavy metal, and various other compounds have a significant effect on the surrounding environment, climate and agriculture field in the vicinity of brick kilns. If the proper technology for reducing pollutants will not be installed in the brick kiln, there might be a serious disadvantage of climate and especially in the agriculture field in the vicinity of brick kilns.

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1. INTRODUCTION

Continuous increase in population in developed as well as developing countries such as Pakistan, China, India, and Bangladesh cause an immense increase in demand for building material. Bricks play an integral role as a building material. Brick kilns emit a lot of pollutants that directly have a bad impact on our agriculture sector as well as climate. Studies had shown that on average brick kilns emit particular matter ($P.M_{2.5}$), SO_2 (1500tons), CO (302,00 tons), carbon black (6,000 tons), and carbon dioxide (1.8 million tons). For 1000 bricks there is an average emission of 6.35-12.3 kg for carbon monoxide, 0.52-5.9 kg for sulfur dioxide, and 0.64-1.4 kg $PM_{2.5}$ (Bhat *et al*., 2014). Currently, SO_2, NO_X, and suspended PM are among the most contributing factors causing air pollution. These pollutants affect the air quality index that further impacts the human respiratory system. It also causes skin cancer, respiratory disorders in humans (Khan *et al*., 2019). These gases when considered regarding agriculture sectors can affect them a lot. These pollutants can affect a plant's growth, physiology, anatomy, rate of photosynthesis and respiration, etc. it causes an overall decrease in food crop yield leading to a shortage of food (Adrees *et al*., 2016).

Here, the objectives of this paper: (i) it has been focused on the pollutants emissions from brick kilns, their effects on climate and agriculture sectors; and (ii) the possible techniques have been discussed that can be used to reduce or eliminate its harmful impacts.

2. METHODS

It is a descriptive type of research and review of recent articles in which the effort has been made for the collection of data from recently published articles related to brick kiln emission and their effect on the ecosystem. It has been focused on the pollutants emissions from brick kilns, their effects on climate and agriculture sectors. Secondly, the possible techniques have been discussed that can be used to reduce or eliminate its harmful impacts.

3. RESULTS AND DISCUSSION

During the last few decades due to increasing urbanization and industrialization, air pollution has become serious environmental stress to plants. Air pollution has become serious environmental stress to crop plants due to increasing industrialization and urbanization during the last few decades. Sulfur dioxide (SO_2), nitrogen oxide (NOx), carbon monoxide (CO), tropospheric ozone (O_3), and heavy metals, as well as suspended particulate matter, are the most injurious and dispersed pollutants in brick kilns. 80 tons of particulate, 30 tons of carbon, 7 tons of NOx, and 5 tons of Sox were the annual estimated indication of emission from a brick industry. Plants in the instantaneous vicinity of emissions sources are more susceptible. For the maturing season, at concentrations of about 1850 µg/m^3 for 1 h, 500 µg/m^3 for 8 h, and 40 µg/m^3 has been revealed that the most sensitive species of plants start on to show visible signs of spoil to sulfur oxides (Asif *et al*., 2020).

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Figure 1. Black carbon emission from brick kiln.

In terms of foliar injury, biochemical alterations on vegetation and physiological sulfur dioxide show harmful effects, and short-term SO_2 destroyed PSII, decreased the fluidity of the thylakoid membrane, and also affect the process of electron transport. The leaf is the most sensitive part of the air pollutants. The overall physiology of plants is affected due to the particulates and gaseous pollutants. Plants' susceptibility to pathogens and pests can in due course alter due to the accumulation of particulates on the surface of the plant and a momentous decline in photosynthesis in most plants occurs due to the exposure to dust. Without physical damage to the plant, thus may alter plant production and growth. The primary site for pollutant attacks is the cellular membrane and lipids play a vital role in maintaining membrane function and structure. Plants show visible changes which would include modification in the biochemical processes or accretion of certain metabolites depending on their sensitivity level and can be used as a bioindicator of air pollution.

By air pollution, the photosynthetic pigments are the most accountable to be damaged. Chlorophyll is an index of productivity due to change in its concentration may alter the physiological, morphological, and biochemical behavior of the plant. SOx, NOx, CO, and fly ash cause a negative impact on the thylakoid membrane system in the chloroplast (Le & Oanh, 2010). With a decline in the concentration of chlorophyll, injuries in the thylakoid are likely to be connected with it. Leaf damage, stomatal damage, premature senescence, and a decrease in photosynthetic activity, destroy membrane permeability and diminish growth and yield in sensitive plant species can cause by pollutants. Emissions from brick kilns create negative effects on the surrounding vegetation as the plants are exposed not to only one but too many air pollutants. Excess quantity of gaseous SO2 causes destruction of chlorophyll and that might be due to the replacement of Mg+2 by two hydrogen atoms and degradation of chlorophyll molecules to pheophytin. Mg++ is altered by a couple of molecules of hydrogen with an ensuing alter in the light absorption spectral properties of chlorophyll molecules (Raza *et al*., 2021).

Near brick kilns at the elevated amounts of pollutants like SO_2 most likely break enzymes and other proteins, also increased the rate of protein denaturation. For all living organisms, carbohydrates are the vital constituent and source of energy. During photosynthesis, plants prepare this organic substance and during respiration break down. Due to emissions from the brick kiln that can destroy photosynthetic pigments, carbohydrates in the polluted leaves were also reduced. The concentration of carbohydrates determines the sensitivity of plants to air pollution.

Lessening in carbohydrate content can be attributed to enhanced respiration and decreased CO_2 fixation because of chlorophyll decline. It was suggested that pollutants like SO_2, NO_2, and H_2S under hardening conditions can cause more exhaustion of carbohydrates in the leaves of plants grown in polluted areas (Le & Oanh, 2010). The reaction of sulfite with

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aldehydes and ketones of carbohydrates can cause a decrease in carbohydrate concentration. Reduction in carbohydrates also could be due to the devastation of chlorophyll which creates negative effects on the rate of photosynthesis because of the struggle between CO_2 and SO_2 for the carboxylase enzyme. According to detailed ultra-structural observations of plant cells injured by these air pollutants, cellular membrane systems are affected by the pollutants, and membrane permeability is also seen to alter after treatment or exposure to SO_2 and other pollutants. Regarding morphology, anatomy, and physiological characteristics, various changes caused by various air pollutants in plants have been studied (Asif & Hasher, 2021).

In plants, conifers become more sensitive to the effects of sulfur dioxide. Among broadleaf varieties, the most common indicator of SO_2 damage is brown to dark brown necrosis of the venous surface. In industries, the most common harmful pollutants are SO_2, NOx, CO, tropospheric ozone (O_3), heavy metals, and particles. Various air pollutants are considered phytotoxic substances: SO_2 has been phytotoxic for more than a century. Sound exposure to ozone has exceeded 30 years. Ozone effects in the San Bernardino National Forest, and acid precipitation have exceeded 30 years. 20 years or less and the effect of significant levels of nitrogen, NOx, and ammonia compounds in the last decade. The importance of contaminants, such as peroxyacetyl nitrate (PAN) or heavy metals has also been reported. It has been shown that the most sensitive plant species begin to show clear signs of destruction at concentrations of about 1850 µg/m^3 after 1 hour, 500 µg/m^3 after 8 hours, and about 40 µg/m^3 when ripe. In the long run, the supply of sulfur in the soil can affect crop yields. Sulfur dioxide negatively affects leaf damage and physiological and biochemical changes in vegetation. While the content of chlorophyll (chlorophyll "a" and chlorophyll "b") decreases with increasing SO_2 concentration (Ying *et al*., 2021).

Pheophytin, carotenoids, carbohydrates, proteins, and phenols also decrease when exposed to sulfur dioxide. It reduces the fluidity of the thylakoid membrane and influences the electron transport process. The influence of brick kiln emissions on the biochemical parameters of the mallow (photosynthetic pigments, starch, carbohydrates) showed a negative trend. It showed that air pollutants decrease the photosynthetic activity of kachnar leaves and that the phenol content in kachnar leaves increases significantly due to the degree of damage to the leaves. The use of particles and gaseous contaminants, alone or in combination, can seriously affect the general physiology of all parts of the plants, the leaves are most sensitive to air pollutants. Acidic deposits can destroy forests and crops through acidification of the soil, lakes, and rivers. Sulfur dioxide gas can get into the leaves through the stomata and deposit on the outer surface, which directly damages plants and forests and impairs growth. The acute visible damage to plants is caused by the absorption of high SO_2 concentrations in a relatively short time (Le & Oanh, 2010). In addition, leaf complaints are usually lobular chlorosis (a whitish area) that runs through the leaf margins, making fully expanded leaves more susceptible to acute SO_2 damage than the youngest and oldest leaves. Plants commonly considered sensitive to SO_2 include alfalfa, barley, wheat, clover, oat, pumpkin, radish, spinach, lettuce, pumpkin, beans, and tobacco, while resistant plants include asparagus, cabbage, corn, onions, and potatoes. The adverse effects of air pollution on vegetation have been well studied for leaf damage, physiology, and yield characteristics.

Researchers show that gaseous (NOx and SOx) and particulate pollutants (such as SPM and respirable particles (RSPM)) have deleterious effects on wheat and mustard crops and conclude that chlorophyll, ascorbic acid, and carotenoids are present overall is significantly reduced in response to air pollution. It has been shown that pollutants reduce chlorophyll synthesis and thereby increase the decomposition capacity. It is therefore clear that urban air pollution and industrial pollution pose a serious threat to agricultural production in

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neighboring cities and industrial areas. Chlorophyll is essential for photosynthesis and the reduction of chlorophyll. Chlorophyll is used as an indicator of air pollution. Photosynthetic pigments react very strongly to air pollutants and their sensitivity can determine the reaction of plants to pollutants. Continued use of cement dust can clog the pores and hinder gas exchange. Carotenoids prevent photo-oxidation and therefore reduce the severe effects on chlorophyll pigments (Guttikunda *et al*., 2013). Carotenoids have also been reported. Growth in contaminated areas in several factories is significantly reduced and the pigment content is a good indicator of the physiological condition of the plant. Ascorbic acid is an effective natural antioxidant. SO_2 contamination in many grains and legumes also leads to a significant decrease in production. It is known that the use of NO_2 alone and in combination increases the yield of many plants. The harvest loss is usually due to a decrease in PH. It has been tested that NOx or a combination of Sox and NOx is proportional to the loss of taxes on lichens. Certain conifers also make geese more sensitive to this gas in spring and summer than in winter. Older conifers are more sensitive to gas (NO_2). The gas is responsible for the development of the crystalloid structures in the stroma of the chloroplasts and the swelling of the thylakoid membrane. This displaces the plant's photosynthetic activity. The main entry of NOx into plant leaves is through the stomata (Guttikunda *et al*., 2013). NOx in combination with other pollutants, the possible SO_2, can damage vegetation, as this should lead to emissions due to environmental conditions. Since NOx is the precursor of tropospheric ozone formation and that tropospheric ozone (O_3) is an interesting phytotoxic air pollutant.

Different ozone's play a different role in the protection of bites, compensate for harmful ultraviolet radiation in the other layer. Ozone is truly part of the climate of atmospheric pollution in the perception and industrial perception of the world. Ozone is a highly reactive material and before it enters, the stomata can release the receptors for protective cells next to the stomata, which then no longer process environmental signals. Various gases and pollutants from brick kilns also have a negative effect on the associated vegetation. The relatively dense herb decreases near the brick stoves compared to the control. Particulate matter in suspension (PMS) thus affects plants. Dust particles are of local importance in the absence of brick kilns, streets, quarries, cement plants, and other industrial facilities. The direct impact of particles containing contaminants (such as heavy metals) can also cause phytotoxicity (Guttikunda *et al*., 2013).

The accumulation of particles on the surface of plants can change the susceptibility of plants to pathogens and pests. Exposure to dust pollution can significantly reduce the photosynthesis of plants. Therefore, the growth and yield of plants can be changed without physically damaging the plants. Plants also offer a large leaf area for the absorption and accumulation of air pollutants, thereby reducing the amounts of pollutants in the atmospheric environment. Therefore, it can be used as a pollutant indicator. Recent studies on brick kilns have shown that they have a significant negative impact on the environment in terms of air quality, human health, and vegetation. During the operation of the stone oven, the air quality conditions are heavily polluted. Community residents (including schoolchildren) were exposed to brick kiln emissions, leading to respiratory problems. Hence biochemical parameters that have a negative impact on the emissions from brick kilns, such as plant chlorophyll, phytochemicals, carotenoids, carbohydrates, proteins, and lipids in rapeseed, red beans, and eggplant (Skinder *et al.,* 2015).

4. CONCLUSION

From the above discussion, it is concluded that pollutant emissions from brick kilns cause a wide range of distractions in agriculture sectors, air quality, and human life but bricks are

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the building block that is being used excessively all over the world. So, techniques can be used to eliminate pollutants from brick kilns. We can replace traditional methods with the most advanced and updated pollutant control techniques such as the zigzag method or using vertical shaft brick kilns that showed a wide reduction in pollutants emissions. The treatments and techniques for controlling such emissions will be the focus of our next study.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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