

Abstract

Tropospheric ozone (O_3) is among the most damaging air pollutant to plants. Plants alter the atmospheric O_3 concentration in two distinct ways: (i) by the emission of volatile organic compounds (VOCs) that are precursors of O_3 into vegetation through stomata and destruction by nonstomatal pathways. Isoprene, monoterpenes, and higher terpenoids are emitted by plants in quantities that alter tropospheric O_3 . Deposition of O_3 into vegetation is related to stomatal conductance, leaf structural traits, and leaf surface characteristics. O_3 enters leaves and reacts with various cellular components, leading to oxidative stress and cell damage. The potential to open the black box.

Keywords: Tropospheric ozone, volatile organic compounds, stomatal conductance, leaf structural traits, oxidative stress, cell damage.

Introduction: Tropospheric ozone (O_3) is a major air pollutant that causes significant damage to plants and ecosystems. It is formed in the atmosphere through the reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Plants play a crucial role in the atmospheric O_3 cycle by emitting VOCs and taking up O_3 through stomata. This process is influenced by various factors, including stomatal conductance, leaf surface characteristics, and leaf structural traits. Understanding the mechanisms of O_3 deposition and its effects on plants is essential for developing strategies to mitigate its damage.

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Ozone is a highly reactive gas that can cause oxidative stress and cell damage in plants. It enters leaves through stomata and reacts with various cellular components, leading to the formation of reactive oxygen species (ROS). ROS can damage DNA, proteins, and lipids, leading to cell death and tissue damage. The damage caused by O_3 is often characterized by necrotic lesions on leaves, reduced photosynthesis, and growth retardation.

VOCs are a diverse group of organic compounds that are emitted by plants. They include isoprene, monoterpenes, and higher terpenoids. These compounds are emitted in quantities that can significantly influence the atmospheric O_3 concentration. Isoprene is the most abundant VOC emitted by plants and is known to be a precursor of O_3 . Monoterpenes and higher terpenoids are also emitted by plants and can react with O_3 to form secondary organic aerosols (SOA).

NO_x is a group of nitrogen oxides that are emitted by plants and other sources. They are major precursors of O_3 in the atmosphere. NO is emitted by plants through the process of nitrification, while NO_2 is emitted by plants through the process of denitrification. NO_x reacts with VOCs in the presence of sunlight to form O_3 .

VOC emissions from plants are influenced by various factors, including temperature, light intensity, and leaf surface area. Higher temperatures and light intensities generally lead to higher VOC emissions. Leaf surface area is also an important factor, as larger leaves have a greater surface area for VOC emission.

% of O_3 is destroyed by nonstomatal pathways. This process is influenced by various factors, including leaf surface characteristics and leaf structural traits. Nonstomatal pathways include deposition on leaf surfaces and uptake by cuticular waxes. The deposition of O_3 on leaf surfaces is influenced by the surface area of the leaf and the presence of cuticular waxes. Cuticular waxes act as a barrier to O_3 deposition, reducing the amount of O_3 that enters the leaf.

Stomatal conductance is a key factor that influences O_3 deposition. It is the rate at which O_3 enters the leaf through stomata. Stomatal conductance is influenced by various factors, including light intensity, temperature, and humidity. Higher stomatal conductance leads to higher O_3 deposition. Leaf structural traits, such as leaf thickness and leaf surface area, also influence stomatal conductance and O_3 deposition.

O₃ deposition is a complex process that involves both stomatal and nonstomatal pathways. The total O_3 deposition is the sum of O_3 that enters the leaf through stomata and O_3 that is deposited on the leaf surface. The relative contribution of each pathway varies among different plant species and under different environmental conditions.

Some plant species are more resistant to O_3 damage than others. This is often due to their ability to emit VOCs that react with O_3 in the atmosphere, reducing its concentration. Some species also have thicker cuticular waxes or other structural traits that reduce O_3 deposition. Understanding the mechanisms of O_3 resistance in plants is essential for developing strategies to protect crops and ecosystems from O_3 damage.

O₃ damage to plants is often characterized by necrotic lesions on leaves, reduced photosynthesis, and growth retardation. The damage is caused by the formation of ROS, which damage cellular components and lead to cell death. The extent of damage is influenced by the concentration of O_3 and the duration of exposure. High concentrations of O_3 can cause severe damage, while low concentrations cause less damage.

Some studies have shown that the damage caused by O_3 is reversible. Plants can recover from O_3 damage if the concentration of O_3 is reduced. However, the extent of recovery depends on the severity of the damage and the species of the plant. Some species are more resilient to O_3 damage than others and can recover more quickly.

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