Sulfur

By Dilibe, Alena, Travis, Shoko
What is it?

It’s a non-metallic element that is bright yellow at it’s purest state.

It is a polyatomic molecule.

Octa sulfur – cyclo S 8
• Chemical properties
  – Burns in blue flams which emits SO2 into the atmosphere
  – It’s insoluble in water but soluble in other non polar molecules like toluene and benzene

• Physical properties
  – Sulfur forms polyatomic molecules with different chemical formulas
  – Octa sulfur – cyclo S 8 is it’s purest from melting point of 115 °C and boiling point 444 °C. Anything below 95 degrees breaks down the molecular shape of cyclo S 8.
Where is sulfur located?

In meteorites/sedimentary rocks
In volcanos
In hot springs
In soil
Combinations with other elements
Role of sulfur

• An essential component in the synthesis of amino acids required to manufacture proteins in plants.
• Required for production of chlorophyll and utilization of phosphorus, vitamins, and other essential nutrients.
• It increases the size and weight of grain crops and enhances the efficiency of nitrogen for protein synthesis.
How Sulfur is used as plant nutrition
Symptoms of Sulfur Deficiency

- Light green to yellowish color that first appears on the younger upper leaves
- Veins in the leaves are even lighter in color
Symptoms of Sulfur Deficiency

- Reduction in growth, branching, and leaf size
- Plants are small and thin with short, slender stalks
Symptoms of Sulfur Deficiency

• Purple or red-brown pigmentation may develop on both young and old leaves

• Spotting of leaves may occur
The Sulfur Cycle

- Atmospheric deposition
- Animal manures and biosolids
- Organic sulfur
- Plant residues
- Absorbed or mineral sulfur
- Plant uptake
- Immobilization
- Mineralization
- Atmospheric sulfur
- Crop harvest
- SO₂ gas
- Volatilization
- Mineral fertilizers
- Runoff and erosion
- Elemental sulfur
- Oxidation
- Bacterial oxidation
- Reduced sulfur
- Bacterial reduction
- Leaching
- Component
- Input to soil
- Loss from soil
- Sulfate Sulfur (SO₄²⁻)
Soil sulfur is present in both inorganic and organic forms. Most of the sulfur in soils comes from the weathering of sulfate minerals; however, approximately 90% of the total sulfur in the surface layers of noncalcareous soils is in organic matter. Inorganic sulfur is usually present in the sulfate ($\text{SO}_4^{2-}$) form, which is the form of S absorbed by plant roots.

Elemental sulfur is a good source of S, but it must first undergo biological oxidation to $\text{SO}_4^{2-}$, driven for example by *Thiobacillus thiooxidans* bacteria or via a symbiotic arbuscular mycorrhiza, before plants can assimilate it. This oxidation can contribute to soil acidity by producing sulfuric acid.

In higher plants, sulfur metabolism is initiated by the uptake of sulfate by roots from the environment. Plants assimilate inorganic sulfate into Cys, the first sulfur-containing amino acids, and various sulfur-containing secondary metabolites.
Model depicting S transfer through an endomycorrhizal symbiosis. Roots and fungal mycelium both import $\text{SO}_4^{2-}$ from external sources (1 and 12), and fungal uptake can supply isolated mycelium (8). The transfer of $\text{SO}_4^{2-}$ through the mycorrhizal symbiosis is inversely related to root uptake (1 and 5). Cys and Met are imported by the fungus (13 and 14), resulting in a reduction of fungal uptake of $\text{SO}_4^{2-}$ (11) and the transfer of a reduced form of S to the root (4). The reduction of $\text{SO}_4^{2-}$ (7 and 2) and uptake of reduced S (13 and 14) lead to incorporation in the protein pools in both roots (3) and fungus (6). Putative steps in the assimilation pathway based on sequence data are depicted as gray arrows. Steps involving putative S assimilation genes are labeled in gray letters as follows: a, high affinity sulfate permease; b, sulfate adenylyltransferase; c, $\gamma$-cystathionine lyase; d, $\beta$-cystathionine synthetase. IRM, Intraradical mycelium.
# Natural Inputs to the Global Sulfur Cycle

(Million metric tons per year)

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<th>Erickson, Kellogg and others, Friend, Granat and others, Ivanov, Butcher,</th>
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<tbody>
<tr>
<td>Biological decay:</td>
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<tr>
<td>On land</td>
<td>110</td>
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<td>In oceans</td>
<td>170</td>
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<td>Volcanic activity</td>
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<td>Sea spray:</td>
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<td>To ocean</td>
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<td>To land</td>
<td>5</td>
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<tr>
<td>Total</td>
<td>45</td>
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<td>Aeolian (wind-driven)</td>
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Conditions Affecting Uptake of Sulfur by Plants

• **Sand:** If soil is sandy, the sulfur is leachable, and so sandy soils are typically low in organic matter. Organic matter acts as a reservoir for sulfur in the soil—determining nutrient availability.

• **Cold Soil:** Low soil temperatures slow the process by which the various forms of sulfur are converted to the nutrient available sulfate (SO\textsubscript{4},) that can be taken up by the plant’s roots, as this is a microbial process.

• **Poor Drainage:** Highly saturated soil contains less oxygen, hindering the microbial process of converting forms of sulfur to the plant available sulfate.

• **Pollution:** Pollution from industrial sources can cause high levels of sulfur (sulfur dioxide and hydrogen sulfide) to be deposited in soil.

• **Irrigation Water:** Irrigation water can contain large amounts of sulfur, though excessive irrigation of sandy soils can leach sulfur out of the root zone of plants.

• **Application of NH\textsubscript{4} (ammonium):** Adding NH\textsubscript{4} to soil has been shown to increase plants’ ability to uptake SO\textsubscript{4}.

*Functional pathway for sulfur assimilation metabolism.*
Sources


Sources

• Davidiana, J. C., & Koprivab, S. (2010). regulation of sulfate uptake and assimilation—the same or not the same? *Molecular Plant*, *3*(2), 314-325. the rate of sulfate assimilation between more sulfate or less sulfate in plants


Sources

Sources


