The Absorption of Sulfur Dioxide by Plants as Shown by the Use of Radioactive Sulfur

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Sulfur is an essential element for both plants and animals. It is known to be present in three amino acids, cystine (and cysteine), methionine and jenkol acid as well as the tripeptide glutathion and two vitamins, thiamine and biotin.

Large areas deficient in sulfur for maximum plant growth have been found in this country (1, 3, 5, 6, 9). At least eight factors must be studied in evaluating the sulfur fertility picture in a particular area. They are:

1. The amount of sulfur brought down in the precipitation.
2. The amount of sulfur absorbed directly by the soil.
3. The total reserves present in the soil.
4. The amount of sulfur removed by crops.
5. The amount of sulfur removed by erosion.
6. The amount of sulfur added to the soil in plant residues and fertilizers.
7. The amount of sulfur lost by erosion.
8. The amount of sulfur absorbed by the crop directly from the atmosphere and used in its nutrition.

Of these eight factors, the last is the subject of this investigation. The direct absorption of sulfur dioxide by the plant may well be a contributing factor in sulfur fertility. Although the concentration of sulfur in the atmosphere is low, in the order of 0.05 ppm, the total amount of sulfur in the atmosphere is almost unlimited. If the plant can utilize this form of sulfur, and build up organic matter, much as it takes in and assimilates carbon dioxide, then this is an important source of sulfur for plants. Thomas and Hendricks (8) and Setterson et al. (7) have found indications that plants are able to utilize sulfur dioxide in this manner. However, in no case where sulfur dioxide was applied as a source of sulfur was the root growth medium isolated from the sulfur dioxide containing atmosphere. The possibility remains that the sulfur dioxide may have been absorbed by the growth medium, oxidized to the sulfate, and taken up by the plant in this form.

To obtain more direct evidence on this problem, an experiment was set up in which the atmosphere around the tops of the plants was separated from the roots of the plant and the growth medium. This was accomplished by using a special stem-sealing wax suggested by Withrow. A mixture of lanolin, spermaceti, and vistone in the ratio of 3:1:1 gave the desired characteristics.

It made a tight seal, had a melting point of approximately 100° F, was noninjurious to the plant, elastic enough to maintain a tight seal as the plant continued to grow in size.

To measure the ability of plants to take up atmospheric sulfur in the form of sulfur dioxide, the applied gas was enriched with radioactive sulfur.

APPARATUS

Eight galvanized iron tanks filled with nutrient solution were used as the medium for plant growth. Each tank supported two panes of glass 14 inches square. Eight holes 1/2 inch in diameter were drilled in each pane of glass. Germinating seedlings held in place with glass wool were placed in these holes. A piece of glass tubing about 1 inch high around each plant and glued to the pane of glass and containing sealing wax was melted at a low temperature and allowed to cool into the cup around the plant. After hardening, this gave a perfect seal.

A glass cylinder 3 feet high and 12 inches in diameter was placed around each set of eight plants. This was made from a pane of glass with petrowax melted to a moderate temperature. The seal was air tight. A circular plate containing an inlet and outlet hole was glued to the top of the cylinder with glyptal cement. The inlet and outlet were attached to the dispensing system.

The outlet holes of each cylinder were joined to a suction line. Each cylinder was individually connected to an intake side with a tank containing either ordinary air enriched with sulfur dioxide containing radioactive sulfur, or air enriched with sulfur dioxide containing radioactive sulfur. The inlet side water was treated to prevent the introduction of dust into the cylinders. A constant supply of sulfur dioxide was maintained in the system by allowing drops of a water solution of a gas of known concentration to fall on a glass plate heated by an infra-red lamp. As the water evaporated, the gas was released to the system. By controlling the drops were spread far enough apart so that each followed the moisture from the previous drop had evaporated before the next drop was released. The concentration of sulfur dioxide in the system was maintained at approximately 0.1 ppm.

The tanks, cylinders, and suction system are shown in Fig. 1. Fig. 2 shows the dispensing system. Half the tanks were treated with sulfur dioxide and the other half were kept with the atmospheric sulfur dioxide. The plants were grown in a minus-sulfur nutrient solution. The growth for the purpose of the experiment.

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