

Grapes, Fumigation with Sulfur Dioxide (SO₂)

Revised 2008

Reasons for SO₂ Fumigation

To control gray mold rot (*Botrytis*) and other decay-causing fungi that develop slowly at temperatures as low as 31-32°F (-0.5 to 0°C). SO₂ also reduces darkening of the rachis. Vinifera grapes tolerate sulfur dioxide gas in concentrations that would damage other fruits, vegetables, eggs, meat, or poultry. Hence, grapes to be gassed must be isolated in a tight room, refrigerator car, or truck. **Do not fumigate mixed loads.**

CAUTION: SO₂ gas in sufficiently high concentration for effectiveness is an irritant and poison and can cause death. Even low concentration (0.04% = 400 ppm) can cause irritation and injury to mucous membranes. A few drops of ephedrine in the nose can provide some relief. A gas mask for acid gases should be at hand. Goggles should be worn to protect the eyes.

CAUTION ON RESIDUES: Because a small segment of the population may experience severe allergic reactions to sulfites, the Environmental Protection Agency (EPA) has proposed a 10 ppm tolerance for sulfite residues in table grapes. Fruit with residues exceeding the tolerance cannot be marketed.

Fumigation in Storage (Total Utilization System)

Grapes are usually fumigated with SO₂ immediately before or after packing and are re-fumigated at weekly intervals using the total utilization system. Recently it has been demonstrated that the amount of SO₂ gas needed to kill *Botrytis* spores, or to inactivate exposed mycelium, is dependent on the concentration and the length of time the fungus is exposed to the fumigant. A cumulative concentration, calculated as the product of the concentration and the time, called "CT product," describes the sulfur dioxide exposure needed to kill the decay organism. A CT of at least 100 ppm per hour is the minimum required to kill spores and mycelium of *Botrytis* at 32°F (0°C) or approximately 30 ppm-hour at 68°F (20°C). This level can be obtained with an average concentration of 100 ppm for 1 hour, or 200 ppm for ½ hour, or 50 ppm for 2 hours, or an equivalent combination of concentration and time. This finding was the basis for the development for the total utilization system.

The total utilization system differs from the traditional system in that there is no excess SO₂ after fumigation. In the total utilization system, the first fumigation is done in conjunction with forced air cooling (initial fumigation). The forced air flows through the boxes and ensures good penetration of sulfur dioxide even to the center boxes on a pallet. In most combinations of boxes and packs, this system produces over 80% penetration, measured as percent of the room air CT product.

Passive Fumigation: This fumigation process is applied weekly. After SO₂ application in the room, fans should run on high speed for over 3 hours so that nearly all of the sulfur dioxide is absorbed by the fruit, packaging materials, and room surfaces. At the end of fumigation, the concentration of sulfur dioxide in the room air should be less than 2-5 ppm, and no venting or scrubbing is needed. In this system, all cold storage rooms should be calibrated to determine the amount of SO₂ to use. Center boxes on a pallet have lower sulfur dioxide exposures than corner boxes, and pallets closest to the sulfur dioxide inlet have higher fumigant exposures compared to those farthest away. To check fumigant penetration and distribution, inexpensive sulfur dioxide dosimeter tubes are available. These dosimeters were originally designed for human safety monitoring.

Dosimeters designated for sulfur dioxide fumigation doses at marked levels from 0-100, and 0-600 ppm-hour are available. These dosimeter tubes work well for measuring the sulfur dioxide CT product inside packed grape boxes. The glass dosimeter tubes are placed in the center of the boxes inside tissue wraps of cluster bags, if these are present, and usually in boxes located in the center of the pallets. After fumigation the tubes are removed promptly and the ppm-hr exposure to sulfur dioxide is directly recorded. The 0-600 CT tubes should be read promptly because some can overestimate the dosage if examining their color reaction is delayed. A dose of at least 100 ppm-hr is the minimum adequate dose. This allows the operator to adjust the amount of fumigant applied to insure that most boxes are adequately protected from decay but not exposed to fumigant levels that might cause excessive residues and bleaching. Details on this work are contained in *Sulfur Dioxide Fumigation of Table Grapes* published by the University of California DANR 1932 publication.

Inspections

Berries covered with mold may indicate that gas has not reached the fruit in high enough concentration, application frequency has not been adequate, or SO₂ has been improperly distributed. Bleaching of the berries, usually starting at the cap stems, is the most common evidence of over fumigation. This injury is more apparent after the fruit is held at 60-70°F (15.5 to 21.1°C) for 1-2 days, at which time injured areas become sunken and may turn brown. If injury is more prevalent in one part of a room than another, it may mean that gas distribution is not uniform.

Fumigation for Export

Grapes intended for export are sometimes packed with bisulfite-impregnated paper pads and enclosed in a box liner.

Shipment: During ocean shipment for periods longer than 10 days or long retail handling in which SO₂ fumigation cannot be applied, the use of SO₂-generating pads in combination with a box liner is advised. These SO₂-generating pads have sodium metabisulfite incorporated into them to allow a constant and slow release of SO₂ during shipment and marketing.

Commercial Fumigation Service

Warehouse operators will often find it most satisfactory to have the SO₂ fumigation done by specialized companies that provide experienced and skillful fumigation service.

Their methods of fumigation may differ somewhat from those recommended by the U.S. Department of Agriculture (USDA), since a study of individual rooms and of the particular grapes in storage may lead the experienced representatives of these companies to modify procedures in relation to the presumed requirements of each situation.

Such modifications in practice do not change the overall purpose of effectively controlling decay, minimizing injury, and meeting tolerances for SO₂ residues.

For Further Information

Crisosto, C. H., J. L. Smilanick, N. K. Dokoozlian, and D. Luvisi. 1994. Maintain table grape postharvest quality for long distance markets. pp. 195-199. International Symposium on Table Grape Production. Anaheim, California. June 28-29, 1994.

Crisosto, C. H., J. L. Smilanick, and N. K. Dokoozlian. 2001. Table grapes suffer water loss, stem browning during cooling delays. *California Agriculture* 55(1), 39-42.

Luvisi, D. A. et al. 1992. *Sulfur Dioxide Fumigation of Table Grapes*. University of California, Division of Agriculture and Natural Resources, Bulletin 1932, 21pp.

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