



# Selecting and Using Chemical Fumigants and Soil Sterilants for Ornamental Disease Control

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Soil-borne diseases are among the most troublesome and difficult to control of all pathogens that attack nurseries, golf courses, greenhouse crops, and home and landscape settings. One approach used especially by some nurseries and greenhouse operators is the use of chemicals, or fumigants, that eliminate the pathogens in the top several inches of the soil prior to seeding or planting. It is perhaps more extensively used by tobacco growers for seedbed preparation and by potato and small fruit growers.

This publication is intended primarily for people considering use of fumigants for production of landscape plant materials, such as in nursery operations, treatment of greenhouse soils and occasional golf course greens. There is also limited usefulness for certain fumigants in home garden or landscape settings; and a brief discussion of their uses in that setting is also included.

Note: Fumigants are toxic chemicals—handle them with care. They are poisonous to microorganisms, plants, insects, nematodes and other animals. They are usually applied where soil-related problems are serious and no other control measures are possible or practical.

All fumigants are hazardous, some are extremely so. People, plants and pets can be seriously injured by their improper selection and use. If you are not prepared to read, understand and follow the label directions on fumigant packages, don't consider using them!

## Where Fumigants Will Help—Some Examples

Fumigation often benefits sites that have been used for several years and whose productivity has been reduced in spite of good fertility, ample irrigation, and other appropriate management practices. Fumigants also play a role where disease-free plant materials are being produced for sale to others. Some state nurseries, for instance, cannot grow healthy plants without fumigation. Some greenhouse operations include fumigation of potting soil, cold frames, pots and similar products, especially where steam treatment is not available or soil-less media are not being used. Tree replant sites might benefit from treatment in occasional instances.

Some labels contain directions for several specialty uses, such as the treatment of small amounts of potting



*Fumigants are available in liquid or granular form and in small or large quantities. Select the chemical and quantity according to your needs.*

soil, fumigation of tree planting sites, and for severing root connections between diseased and healthy trees.

Light, rather sandy soils generally respond more favorably to fumigation than do heavy, clay-type soils.

## General Directions for Use

Labels for each chemical give more explicit details concerning use precautions and proper application. The following comments are intended to provide an overview of their use.

All fumigants operate by volatile action. That is, although the chemical may be purchased as a compressed gas, liquid or granule, a volatile gas is ultimately formed and released. That gas must permeate through the soil, come into contact with the pest to be controlled and penetrate it. For best results, several requirements must be met:

1. **Soil tilth.** The chemical won't go where the soil is not loose and friable. Disease-causing organisms inside clods will probably not be killed. Be sure to work the soil as deeply as you want the chemical to penetrate.

2. **Soil temperature.** Most fumigants work best at temperatures between 60 ° and 80 °F six inches below the soil line. At lower temperatures, they may not work, or they may work more slowly. At higher temperatures, the chemical may dissipate too rapidly to provide effective control.

**3. Soil moisture.** Soil moisture is about right when soil squeezed into a ball breaks apart easily when pressed lightly. Under dry conditions, the chemical may be lost too rapidly and when too wet, cannot be distributed properly. Moreover, good soil moisture increases the sensitivity of many pathogens.

**4. Organic matter.** Organic matter ties up the chemical. Be sure plant material is well decomposed. Organic soils respond very poorly, or not at all, to fumigation.

**5. Soil type.** The soil most amenable to good penetration and distribution of a fumigant is light sandy soil. Heavy clay soils respond poorly.

**6. Seals.** Most chemicals require a plastic tarp, or sometimes a water seal, to keep the chemical within the soil long enough to kill pests.

**7. Time of application.** It is best to apply when all the above conditions are met, which is usually in the spring or fall. Fall applications work best provided the previous crop can be removed before temperatures fall.

**8. Waiting period.** A waiting period of two weeks or more, depending upon conditions and chemical used, is needed before planting can be done. Planting too soon will severely injure the crop. You can usually shorten the waiting period somewhat by working the soil two or more times, about a week after application.

To see whether treated soil is safe for planting, use a lettuce germination test. Fill a one-pint mason jar <sup>3/4</sup> full of the fumigated soil and immediately cap it tightly. Then soak some lettuce seeds in water at room temperature for 30 minutes. Dip a square of absorbent cotton in water (don't squeeze it out!), place 10-15 soaked seeds on the square and quickly insert the square with the lettuce seeds into the jar and tighten the lid again. Go through the same procedure with a jar filled with untreated soil. This will serve as a comparison. Put both these jars in daylight and check after two days for germination. (For large treated areas, prepare more than one set of jars.) If the seed with the treated soil is not germinating, you need to work up and aerate the soil longer. You can also



*Nursey soils sometimes benefit markedly from fumigation treatment. Note the rows of healthy conifers growing on treated soils (arrow). Rows on either side were not fumigated.*

test whether soil is safe by setting 6- to 10-inch tomato seedlings in the treated area. If they remain erect and healthy for four days, then the soil is likely safe to plant.

**9. Don't recontaminate!** Don't destroy the beneficial effects of fumigation by re-introducing pests by using dirty tools, diseased plants, runoff water from untreated areas, etc. Of course, recontamination will eventually occur by wind contaminants, upward growth by non-fumigated pests below the fumigated soil, etc. However, the effects are often not as bad as when the pest is quickly re-introduced before beneficial, protective organisms have a chance to reestablish.

Note: Treating the soil sometimes temporarily upsets the nitrogen availability in the soil. A toxic response can occur. You can usually prevent this by applying a nitrate, rather than an ammonium source of nitrogen after treatment. Avoid application of manure or most other forms of organic matter prior to fumigation.

## Precautions with Fumigants

The label on each fumigant indicates its relative toxicity and how best to handle the product safely. Be sure to read and heed! For instance, some call for use of gloves, but others, such as methyl bromide, warn against their use. Respiratory devices are called for under certain circumstances, but not others, usually where ventilation is inadequate. All warn against skin exposure and advise what to do in the event of accidental contact.

Do not use fumigants in greenhouses where living plants are found. Also, do not use fumigants under or within three feet of the drip line of plants you wish to save.

Store fumigants away from the home, in dry, well protected and properly labeled storage areas. Check fumigants periodically to assure that containers remain intact. It is best to buy shortly before use, and no more than is needed for use at that time.



*Small garden beds in open areas that do not have roots of nearby perennials in them are ideal for fumigating. These beds are being fumigated because of a history of root rot disease.*

## Materials Available and Which to Choose

Several materials are available. The fumigant you choose will be determined by the availability of the products in your area, comparative costs, method of application best suited to your circumstances, time of year when you want to treat and specific problems you are trying to solve. The following text and the table below outline the products available.

**Chloropicrin.** Commonly known as tear gas, this material is occasionally used by itself as a fumigant, and sold for this purpose under such names as Chlor-O-Pic. More frequently it is mixed with methyl bromide to broaden the range of effectiveness. A combination of 33% chloropicrin and 67% methyl bromide is available under the trade name Terr-O-Gas 67. This combination is more effective against *Verticillium* and *Fusarium* fungi than either product alone.

**Dazomet.** One brand name for dazomet is Basamid. Dazomet is the only granular product available. The granules may be applied over the surface of the soil, then immediately worked in and the surface sealed with water by sprinkling for 2-4 hours. Its range of effectiveness is somewhat similar to metam sodium, although the results are not always the same. Some crops do not respond as well following the dazomet application, as compared with metam sodium, but it was superior to the latter for *Cylindrocladium* root rot control in Wisconsin nursery trials some years ago. Dazomet would probably have use for home landscape problems, but it may no longer be available in small quantities.

**Formaldehyde.** Commercial formaldehyde is often available as Formalin (40%) from drugstores. It is not generally offered on the market as a pesticide, but it is one of the oldest and simplest treatments, especially for the amateur. While it is not particularly effective against nematodes, and has a toxic effect upon members of the cabbage family when planted in treated soil, it is useful



*Commercial equipment is available to treat larger areas, such as nursery sites. In these illustrations, methyl bromide is being injected into the soil and then covered by plastic for proper fumigant action.*

for treating small quantities of soil, or treating wooden packing boxes, and so forth. One part of formaldehyde can be mixed into 49 parts of water and applied as a drench at the rate of 1/2 to 1 1/2 gallons to each square foot

Chemical	Formulation	How applied	Toxicity and "signal word "	Waiting period* (days)	Restricted use?	Home gardener use?
chloropicrin	compressed gas	soil injection	high/ "danger/poison "	14-30	yes	no
dazomet	granule	surface	moderate/ "caution "	21-30	no	yes
formaldehyde	liquid	soil drench	moderate	21-30	no	yes
metam sodium	liquid	soil drench	moderate/ "warning "	14-21	no	yes
methyl bromide	compressed gas	soil injection	high/ "danger/poison "	14	yes	no
Vorlex	liquid	soil injection	high/ "danger/poison "	7-21	no	no

\*Assumes soil is ideal for fumigation.

of prepared soil. You can do this with a sprinkling can. Do so in a well-ventilated area, taking care to avoid contact with skin or inhaling fumes. Then cover with plastic, canvas or other suitable material for 48 hours. Do not plant until the formaldehyde odor is gone, usually 21 to 30 days later.

**Metam sodium.** The active ingredient is sodium-N-methyl dithiocarbamate, or SMDC, and is sold under a variety of trade names such as Vapam, Nemasol and Busan 1020. It is a versatile fumigant, often applied with irrigation systems to vegetable and small fruit producing acreages. It is labeled for treatment of tree replant sites, for treating garden soils, for establishing "barriers" between diseased and healthy oaks and elms infected with vascular wilt diseases, and other uses. Although somewhat toxic, it has been applied by many home gardeners successfully, and without incident. Under those circumstances it is usually applied via a sprinkling can or hose-end attachment. One quart of product is generally applied per 100 square feet in sufficient water to obtain good distribution; then the area is irrigated thoroughly to provide a good water seal. Activity extends approximately the depth of the material as it has soaked into the soil. If covered with a plastic tarp instead of irrigated in, the amount of chemical needed can be cut in half.

**Methyl bromide.** Methyl bromide is probably the most toxic of the fumigants listed. Often small concentrations of chloropicrin are added to this odorless chemical to provide a detectable odor and thus increase the handling safety. Commercial applicators are available to make the treatments, if desired. The Wisconsin state nurseries have employed these services for several years, for instance. Smaller areas, such as cold frames or golf greens, can be treated with 1 or 1½ pound cans. The chemical is injected under sealed plastic tarps or covers by means of plastic tubes attached to the cans with devices that puncture and release the liquid safely. Once released, the pressurized liquid quickly changes to a gaseous state and permeates through the prepared soil. Two pounds per 100 square feet are typically suggested for disease pathogen control,

while lesser amounts generally control weed seeds. Methyl bromide has demonstrated considerable translocation into nearby root systems. Take special care to avoid treating areas containing roots of shrubs or trees that you want to save. Brand names include Brom-O-Gas (available in 1 and 1½ pound cans), Terr-O-Gas 98, which like Brom-O-Gas is 98% methyl bromide and 2% chloropicrin, but is available in cylinders for large scale fumigation, and Terr-O-Gas 67, mentioned earlier under chloropicrin.

**Vorlex.** This product contains 1,3-dichloropropene and methylisothiocyanate as the primary active ingredients. Vorlex is typically injected into the soil with injector knives. It is sometimes more effective against *Verticillium*. At lower soil temperatures, Vorlex is more effective than the other chemicals. Consequently, it maybe applied later in the fall, often after harvest, so that normal cropping operations are not disrupted. Its effectiveness against weeds is only fair, unless precautions are taken to obtain adequate surface treatment, e.g., by covering the soil with tarp. Another alternative is to inject into the row to be treated, then scrape the top inch or two of soil away before planting. This is because the soil surface does not receive adequate fumigation in most instances. Row treatments reduce chemical required and also reduce cost of treating large-scale crops.

## Steam and Heat Treatments

Although we have dealt with chemical treatments in this publication, sterilization through steam or heat (electrical sterilizing units) treatment is recommended wherever this is possible. Florists, for example, generally have steam available and use this method routinely. Steam heat is economical, there is no waiting period, and it eliminates the problem of possible chemical residue. Using aerated steam, heat soil to a uniform temperature of 145-165° F for 30 minutes. Dry heat soil to 180° F for 30 minutes. Regardless of treatment, for best results, follow precautions listed in the General Directions section.

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