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Treatment Manual

Chemical Treatments

Fumigants

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Introduction

Fumigation is the act of releasing and dispersing a toxic chemical so it reaches the target organism in a gaseous state. Chemicals applied as aerosols, smokes, mists, and fogs are suspensions of particulate matter in air and are not fumigants.

The ideal fumigant would have the following characteristics:

- ◆ Highly toxic to the target pest
- ◆ Nontoxic to plants and vertebrates (including humans)
- ◆ Easily and cheaply generated
- ◆ Harmless to foods and commodities
- ◆ Inexpensive
- ◆ Nonexplosive
- ◆ Nonflammable
- ◆ Insoluble in water
- ◆ Nonpersistent
- ◆ Easily diffuses and rapidly penetrates commodity
- ◆ Stable in the gaseous state (will not condense to a liquid)
- ◆ Easily detected by human senses

Unfortunately, no one fumigant has all the above properties, but those used by APHIS and PPQ have many of these characteristics.

The toxicity of a fumigant depends on the respiration rate of the target organism. Generally, the lower the temperature, the lower the respiration rate of the organism which tends to make the pest less susceptible. Fumigation at lower temperatures requires a higher dosage rate for a longer exposure period than fumigation at higher temperatures.

Fumigants vary greatly in their mode of action. Some kill rapidly while others kill slowly. In sublethal dosages, some fumigants may have a paralyzing effect on the pest while others will not allow the pest to recover. Some fumigants have no effect on commodities while others are detrimental even at low concentrations. Commodities vary in their sorption of fumigants and in the effort required to aerate the commodities after fumigation.

Due to the reduction in number of labeled fumigants, there is seldom a choice in selecting fumigants. When there is a choice, factors such as the commodity to be treated, pest and stages present, type of structure, and cost should be considered in selecting a fumigant.

The only authorized fumigants are the following:

- ◆ Methyl bromide (MB)
- ◆ Sulfuryl fluoride (SF) (Vikane)
- ◆ Phosphine (PH) (There are two chemicals used for phosphine, AP—aluminum phosphide and MP—magnesium phosphide)

Much of the information on fumigants is based on MB with modification as needed for the other fumigants.

Monitoring of Quarantine Treatments

Monitoring of program fumigations is performed to ensure that effective fumigant concentration levels are maintained throughout the treatment to prevent the introduction of quarantine pests. Quarantine fumigations employing restricted use pesticides require careful monitoring to assure efficacy and personal safety, to maintain pesticide residues within acceptable limits, and to preserve commodity quality. These requirements are included in the fumigant label, and it is a violation of Federal law to use fumigants and pesticides in a manner inconsistent with its labeling.

Nonperishable Commodities in Temporary Enclosures

PPQ officers will provide onsite monitoring from introduction of the fumigant through completion of the 2 hour gas concentration readings. Half hour and 2 hour readings are required for these treatments. These readings and general

observations permit the officer to determine how a particular treatment is progressing and to make necessary corrections to the enclosure or fumigant concentration level.

Perishable Commodities in Temporary Enclosures

The monitoring officer will remain on the site through the entire fumigation of perishable commodities. Continuous monitoring allows the officer to alert the pest control operator at any time to implement necessary corrective measures. Due to the nature of the commodity and the length of treatment, onsite monitoring of yam and chestnut fumigations may be interrupted after the 2 hour reading when efficacy and safety considerations warrant.

These instructions do not prevent the officer from leaving the immediate fumigation site for brief periods when it is necessary and safe to do so. The pest control operator must be notified of the PPQ officer's intended absence. These absences would ordinarily be limited to 20 minutes and do not constitute a break in service. These practices are in place in many locations and will require only minor modifications in other areas.

Fumigation Guidelines

The following fumigation guidelines are in common usage throughout this manual:

- ◆ Dosage rate is based on 1,000 cubic feet of enclosure space, whether chamber, tarpaulin, van, freight car, ship hold, etc. Dosage should be calculated from the volume of the tarped fumigation enclosure.
- ◆ Dosages are listed by weight in the Treatment Schedules. If liquid measures are needed, convert from weight to volume by using the conversion figures.
- ◆ Ounces per 1,000 cubic feet (oz/1000 ft³) is equal to milligrams per liter (mg/liter) and is equal to grams per cubic meter (g/m³).
- ◆ Volume of commodity being treated should **not** exceed two-thirds of enclosure volume unless otherwise specified in a schedule.
- ◆ Specified vacuum should be held throughout the exposure period.

- ◆ Blowers or fans should be operated as follows:
 - ❖ for propagative material (T200-series schedules), the entire period of exposure, whether NAP or vacuum
 - ❖ under tarpaulin (and vacuum fumigation for other than propagative material), fans should operate for 30 minutes after gas introduction, or until an APHIS-approved gas detection device indicates uniform gas distribution
 - ❖ for all bulk material, forced recirculation is required, check for uniform gas distribution by taking gas readings at four or five locations including at least three from the commodity



Phosphine fumigations do **not** require fans.

- ◆ In this section, all NAP treatments that refer to chamber fumigations should be conducted in USDA-approved chambers. (Refer to [Certification of Vacuum Fumigation Chambers](#) on [page 6-2-1](#) or [Certifying Atmospheric Fumigation Chambers](#) on [page 6-3-1](#)).
- ◆ Methyl bromide treatment schedules are indicated as “MB.” MB generally refers to any methyl bromide label. Specific MB label restrictions are noted in this manual for the “Q” label. Always check the label of the fumigant to be sure the commodity is listed on the label. Commodities that are not listed on the fumigant’s label are not authorized for fumigation with the manufacturer’s gas.

Physical Properties of Fumigants

| Fumigant | Chemical Formula | Boiling Point | Specific Gravity ¹ | Flammability Limits in Air |
|-------------------|--------------------------------|------------------|-------------------------------|---|
| Methyl Bromide | CH ₃ Br | 3.6 °C 40.1 °F | 3.27 | Normally nonflammable. Flame propagation at 13.5 to 14.5 percent by volume only in the presence of an intense source of ignition. |
| Phosphine | PH ₃ | -87.4 °C -126 °F | 1.214 | 1.79 percent by volume |
| Sulfuryl fluoride | SO ₂ F ₂ | -55.2 °C -67 °F | 2.88 | Nonflammable |

¹ Air = 1, anything greater is heavier than air.

| Fumigant | Odor | Effects on Metals | General |
|-------------------|---|---|---|
| Methyl Bromide | No odor at low concentration. Strong musty or sweet at high concentrations. | Reacts with aluminum, may damage electronic equipment | Discharged from cylinders, 1.5 lb cans |
| Phosphine | Garlic-like or carbide due to impurities | Copper, brass, gold and silver severely damaged; electronic equipment damaged. Other metals slightly affected in high humidity. | Evolved from aluminum phosphide or magnesium phosphide preparations |
| Sulfuryl fluoride | None | Non-corrosive | Discharged from cylinders |

