



## Chapter 4

# Soil Fumigation

## Need for Soil Fumigation

### Consider Previous Cropping History

Select a site that does not have a history of Verticillium wilt in any crop. Also, select a site that does not have a history of red stele or black root rot. To minimize the risk of black root rot, do not replant strawberries immediately after removing an old strawberry planting.

In general, it is also not a good practice (due primarily to Verticillium) to plant strawberries immediately after solanaceous or other Verticillium-susceptible crops. These include tomatoes, potatoes, peppers, eggplant, melons, okra, mint, brambles, chrysanthemums, roses, or related crops. If possible, select sites that have not been planted to any of these crops for at least three to five years. There should be no herbicide residual in the soil from previous crops.

### Is This the First Planting of Strawberry on the Site?

If the land has no recent (five years or less) history of strawberry production or Verticillium diseases in other crops, soil-borne diseases such as red stele or Verticillium wilt should not be a problem.

### Are You Replanting Strawberries on the Site?

If strawberries are to be replanted in the same field, crop rotation must be used or the field should be fumigated. Chemical fumigation is currently not an option in organic production systems.

With rotation, the site should be plowed, worked down, and planted to a crop that is not susceptible to Verticillium wilt for a minimum of two years. Many soil-borne pathogens form specialized survival structures and are capable of surviving for several years in soil, even when strawberries are not present. The longer the site can be rotated away from strawberries prior to replanting, the better.

The combination of crop rotation plus soil fumigation is a sound approach that is used by many conventional growers. However, for organic growers (who cannot use soil fumigation), crop rotation alone often provides acceptable control for most soil-borne diseases, if the rotation is sufficiently long.

Neither crop rotation nor soil fumigation will reliably provide adequate control of red stele. With red stele, disease-resistant cultivars and improved soil drainage must be emphasized. Cultivars with resistance to red stele and Verticillium wilt should always be used.

## Points to Consider When Using Soil Fumigation

Soil fumigation kills most weed seeds, plant pathogens, nematodes, and insects in the soil. Fumigants are generally applied as liquid formulations (Figures 4-1-A and B). After application, true fumigants volatilize to form gases; other pesticides used in a similar manner may remain mixed with soil water.

When using soil fumigation, consider the following points:

- **Target pests.**

Rates vary for different target pests. In general, nematodes and soil insects are killed at lower rates than weed seeds and fungal or bacterial pathogens. Weed seeds are the most difficult to kill with fumigation. At present, methyl bromide is the only fumigant that provides excellent weed control consistently.

- **Soil texture.**

As the microscopic spaces between soil particles get smaller and less abundant (as in heavy or compacted soils), fumigant rates must be increased to overcome reduced or slower diffusion and penetration. On heavy soils, rototilling (when dry) can increase the pore



Figure 4-1-A. A gravity flow rig on a tractor for injecting liquid fumigants into the soil.



Figure 4-1-B. Shanks for injecting fumigants into the soil.

space of the soil, improving the effectiveness of subsequent fumigation.

- **Soil temperature.**

For effective fumigation, soil temperature at a depth of 6 inches must be at least 50°F. Higher soil temperatures favor greater volatilization of fumigants and greater movement through soil spaces.

- **Soil organic matter.**

Decomposed organic matter improves soil structure and generally helps fumigant dispersion in the soil. However, very high amounts of organic matter may adsorb or tie up a fumigant, reducing its effectiveness. Fresh (undecomposed) crop debris may hinder fumigant dispersion in the soil and may also harbor insects and pathogens that escape the fumigant. Organic matter is most beneficial when it is thoroughly decomposed.

- **Soil moisture.**

Fumigants move through air spaces in soil and dissolve in soil water. They must enter the soil solution to contact and kill pests. Moderate levels of soil moisture therefore aid in obtaining effective fumigation.

During or immediately after application of soil fumigants, the soil surface should be sealed to prevent the fumigant chemical from escaping into the air too rapidly. This can be done by rolling (Figure 4-2), irrigating, or covering with a tarp or plastic (Figure 4-3), depending on the type of fumigant. At least two to three days of fumigant activity and at least four to 14 days of venting (for fumigant dissipation) should elapse between application of fumigants and planting (depending on the type of fumigant). A three- to four-week interval is better. For this reason, fall is usually the best time to fumigate.



Figure 4-2. Rolling the field to seal in the fumigant.



Figure 4-3. Solid tarping with plastic to seal in the fumigant.

Spring fumigation can be very effective, however, if soils are warm enough and the proper preplant interval is observed. Avoid plowing too deeply after fumigation so that untreated soil is not mixed with treated soil near the surface. Shallow plowing or tilling with clean equipment is recommended. See Table 4-1 for a summary of the characteristics of common soil fumigants.

For good fumigation results:

- Ideally, the site should be worked, fitted, and fumigated in September.

- Plow the soil 8 to 10 inches deep and then disk or rototill so there are no clods, large soil particles, or stones. This should be completed in late August or early September.
- Have a soil temperature between 60 and 70°F at a 6-inch depth.
- Soil moisture should be 50 to 75 percent of field capacity. Check soil moisture with a tensiometer.
- Organic matter (cornstalks, grass, straw, etc.) should be well decomposed.
- Depending on soil type, temperature, and the fumigant used, a two-week to two-month period must intervene between fumigation and planting to avoid crop damage. Some fumigants require only a seven-day waiting period.

Soil testing for nematodes, grubs, or other soil problems aids in the decision of whether or not to fumigate. Do this soil testing in July.

*We wish to thank Diana Roll, The Ohio Department of Agriculture for assistance with this chapter.*

**Table 4-1. Fumigant Rates and Spectrum of Activity.**

Common Name	Trade Name	Rates/Acre	Level of Control <sup>a</sup>			Comments
			Nematodes	Fungi	Weeds	
1,3-dichloropropene	Telone II	16-20 gal	4	1	0	Slight suppression of some soil-borne organisms.
1,3-dichloropropene + chloropicrin	Telon C-17	35 gal	4	5	1	Effective against most soil-borne diseases; some weed seed suppression.
	Telon C-35	35 gal	4	5	1	
methyl isothiocyanate compounds	Vapam	50-100 gal	4	4	3	Most effective when applied through over-head irrigation; incorporate thoroughly in soil.
methyl bromide	Brom-O-Gas	275-350 lb	5	4	4-5	Requires a plastic seal; highly toxic to humans; weak against some <i>Pythium</i> species.
methyl bromide + chloropicrin	Terr-O-Gas 67	275-350 lb	5	5	4-5	Most effective for control of weeds, soil-borne diseases, nematodes, and insects; requires plastic seal; highly toxic.

<sup>a</sup> 0 = no control; 5 = excellent control.

**Note on methyl bromide:** Methyl bromide has been the standard for soil fumigation for many years. This is largely due to its efficacy for killing weed seeds as well as other soil-borne pests and diseases. Due to problems with bromine in the atmosphere, the use of methyl bromide as a soil fumigant in the United States is being phased out. Methyl bromide will be used until current stockpiles are used up. A great deal of research has been conducted to develop new fumigants with the same or better activity than methyl bromide. There are some good materials being developed and at the time this bulletin was printed, methyl iodide was reported to be close to registration in the United States for use as a soil fumigant. Methyl iodide is very similar to methyl bromide and has been reported to have very good activity as a soil fumigant. Consult your local cooperative extension service as to the availability and use of any new soil fumigants.