Agronomic Spotlight

Seminis grow forward

Soil Fumigation and Pepper Production

- Soil fumigation is used in pepper production systems to manage diseases, nematodes, and weeds.
- Several fumigant products and methods of application can be used, but availability varies by state.
- Alternatives to soil fumigation are available and effective.

Soil fumigation involves the application of chemicals to the soil prior to planting. Fumigation products are composed of small, volatile molecules that become gasses upon application and disperse through air spaces in the soil.

The target pests of soil fumigation in pepper production include *Phytophthora capsici* (cause of Phytophthora blight), *Rhizoctonia solani* and *Pythium* spp. (causes of damping-off), *Athelia rolfsii* (cause of southern blight), *Sclerotinia sclerotiorum* (cause of white mold), root-knot nematodes, and several weed species. Some of these problems are difficult to manage without the use of soil fumigation.[1,2]

Methods of Application

Soil fumigants are applied using several methods, depending on the fumigant used. Some fumigants come as granular formulations that are applied to the soil surface and then mechanically incorporated or watered in with irrigation. Liquid formulations are injected into the soil using special equipment, and some formulations are applied through irrigation systems. Adequate soil preparation and appropriate timing are critical, as soil texture, moisture, and temperature can all affect the distribution of the fumigants through the soil profile.[3] Fumigants can be applied to entire fields (Figure 1) or applied in strips to planting beds.

Once in the soil, fumigants volatilize, becoming gasses, so it is important to have a barrier on the soil surface, such as a plastic tarp or water seal, to prevent the chemicals from escaping into the atmosphere. Plastic tarps are usually the most effective at keeping the fumigant in the soil and are required for some types of fumigants. However, they can be expensive, especially for whole-field fumigations. Tarps vary in their permeability to the fumigants [low-density polyethylene (LDPE), high-density polyethylene (HDPE), virtually impermeable film (VIF), and totally impermeable film (TIF)]. It is important to select the appropriate tarp material for the specific fumigant used, and the permeability of the tarp can affect the application rate of the fumigant. With whole-field fumigation, the tarps need to be removed and disposed of after the fumigation period. With strip fumigation, the tarps are usually left in place and become the mulch in plastic mulch production systems.[3]

Figure 1. Polyethylene tarp covering a fumigated field.

With application through drip systems , it is important to apply enough water to push the fumigant out to the shoulders of the bed to ensure adequate treatment.

Soil Fumigants

Following are descriptions of the commonly used soil fumigants in pepper production systems (Table 1).[2,3,4] Registrations and use restrictions vary from state to state and can change from year to year, so it is important to carefully read the most current product labels and carefully follow all label requirements and recommendations.

Chloropicrin (Pic-Clor 60 and others) is effective against several soilborne, fungal plant pathogens. It is not as effective for controlling nematodes or weeds, so it is often used in combination with other products. Because it is easily detected by its strong odor and eye irritating properties, chloropicrin is also used as a chemical warning agent.

1,3-dichloropropene (Telone® II, Telone® C-17, Telone® C-35) provides nematode control, but does not provide broad spectrum weed control. The "C" formulations include chloropicrin for pathogen control.

Metam sodium (Metam 426, Vapam® Soil Fumigant, Vapam® HL Soil Fumigant, Sectagon-42 Fumigant, and others) is used to control plant pathogens, nematodes, and weeds.

Metam potassium (K-Pam® HL™) has properties similar to those of metam sodium and is also used to control plant pathogens, nematodes, and weeds.

(Continued on page 2)

Soil Fumigation and Pepper Production

(Continued from page 1)

Dimethyl disulfide (DMDS) (Paladin®) provides good control of several soilborne fungal pathogens and nematodes but marginal (variable) weed control.

Allyl isothiocyanate (Dominus®) is used to control soilborne fungal pathogens, nematodes, and weeds. It is a naturally occurring component of mustard oil. The state registrations of this product are somewhat limited. Check current labels to determine where it can be used.

TABLE 1. TARGET PESTS OF SOIL FUMIGANTS

Fumigant	Nematodes	Plant Pathogens	Weeds
Chloropicrin	none to poor	excellent	poor
1,3-Dichloropropene	good to excellent	none to poor	poor
Metam sodium	good to poor	good to poor	good to poor
Metam potasium	good to poor	good to poor	good to poor
Dimethyl disulfide	good to excellent	good to excellent	poor to excellent
Allyl isothiocyanate	being assessed	being assessed	being assessed

Table adapted from Becker et al., 2005, Noling, 2016, and Rosskopf et al., 2005.

Fumigation practices for peppers in the southeastern US

In the southeastern US, peppers are typically produced on raised beds covered with plastic mulch and irrigated using drip irrigation systems. Fumigation of the beds, under the plastic mulch, is often a component of these systems. Growers can produce multiple crops from a single fumigation. Beds are fumigated in the spring for a pepper crop before planting. A two to four week plant-back period is needed to give the fumigant time to act and dissipate. Transplanting during this time can kill transplants. A summer crop of cucurbits can follow the peppers, using the same beds and mulch, followed by a winter brassica crop before the cycle repeats in the spring.[5]

Chloropicrin, metam sodium, and DMDS are commonly used to control *Phytophthora capsici, Pythium, Fusarium* and *Rhizoctonia.* The addition of a herbicide is needed, especially with chloropicrin and DMDS, to control weeds such as yellow and purple nutsedge.[2,5] Fumigants should be applied to well-aerated soil at 50 to 80% field moisture capacity during periods with moderate soil temperatures.[6]

Alternatives to fumigation

Resistant varieties to diseases such as Phytophthora blight and root-knot are available and/or being developed.

Biofumigation involves the addition of specific kinds of organic matter (brassica green manures) to soil. The decomposition of these materials kills or inhibits soilborne pests. The best results are usually seen when the fields (or beds) are tarped after the addition of the organic matter.[7,8]

Soil solarization involves covering soils with clear or photo-selective polyethylene to raise soil temperatures. The elevated temperatures reduce populations of pathogens and weeds and promote activities of pathogen suppressive microbes. Solarization is most effective when done during the warmest part of the year.[9]

Anaerobic soil disinfestation (ASD) is a process in which low oxygen conditions are induced by adding quickly decomposable organic matter to soil, covering the amended soil with plastic mulch, and irrigating the soil to the point of saturation.[10] An advantage of ASD over soil solarization is that the ASD treatment does not need to take place during the hottest time of the year, which can disrupt production.[9] ASD treatments have been shown to effectively reduce infection of peppers by *Phytophthora* and reduce nematode populations.[11, 12] The organic matter used is often material that is inexpensive and readily available in the area, such as rice bran, rapeseed cake, chicken litter, and molasses.

Sources:
[1] Kan-Rice, P. 2013. Finding alternatives to methyl bromide. UC Agriculture and Natural Resources. [2] Rosskopf, E., Chellemi, D., Kokalis-Burelle, N., Church G. 2005. Alternatives to methyl bromide: A Florida perspective. APSnet Feature, June 2005. [3] Becker, J., Chism, W., Donaldson, D., Kaul, M., and Kiely, T. 2005. Use and usage of soil fumigants: Methyl bromide, chloropicrin, 1, 3-dichloropropene, metam sodium, metam potassium, dazomet. U.S. Environmental Protection Agency Office of Pesticide Programs, Biological and Economic Analysis Division. [4] Noling, J. 2016. Nematode management in tomatoes, peppers, and eggplant. University of Florida IFAS extension, ENY-032. [5] Gianessi, L. 2013. The importance of soil fumigation: Southeast vegetables. CropLife Foundation. https://croplifefoundation.org/benefits-studies/fumigants/. [6] Granke, L., Quesada-Ocampo, L., Lamour, K., and Hausbeck, M. 2012. Advances in research on Phytophthora capsici on vegetable crops in the United States. Plant Disease 95:1588-1600. [7] Hansen, Z. and Keinath, A. 2013. Increased pepper yields following incorporation of biofumigation cover crops and the effects on soilborne pathogen populations and pepper diseases. Applied Soil Ecology 63 (2013) 67– 77. [8] Wang, Q., Ma, Y., Yang, H., Chang, Z. 2014. Effect of biofumigation and chemical fumigation on soil microbial community structure and control of pepper Phytophthora blight. World J Microbiol Biotechnol (2014) 30:507–518. [9] Rosskopf, E.N., Serrano-Perez, P., Hong, J.C., Shrestha, U., Rodriguez-Molina, M., Martin, K., Burelle, N.K., Shennan, C., Muramoto, J., Butler, D. 2015. Anaerobic soil disinfestation and soil borne pest management. Book Chapter. Chapter 13, Vol:46, pages 277-305. [10] Shrestha, U., Wszelaki, A., and Butler, D. 2014. Introduction to anaerobic soil disinfestation as a fumigant alternative. University of Tennessee Extension, SP 765-A. [11] Serrano-Pérez, P., Rosskopf, E.N., De Santiago, A., Del Carmen Rodriguez, M. 2016. Anaerobic soil disinfestation reduces survival and infectivity of Phytophthora nicotianae chlamydospores in pepper. Scientia Horticulturae. 215:38-48. [12] Di Gioia, F., Ozores-Hampton, M., Hong, J.C., Burelle, N.K., Albano, J.P., Zhao, X., Gao, Z., Wilson, C., Thomas, J., Monaghan, K., Swisher, M., Guo, H., Black, Z., Rosskopf, E.N. 2016. The effects of anaerobic soil disinfestation on weed and nematode control, fruit yield and quality of Florida fresh-market tomato. HortScience. 51(6):703-711.

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology, Development & Agronomy by Monsanto.