Overview of Drip Fumigation

Husein Ajwa, University of California-Davis, Salina, CA 93905, haajwa@ucdavis.edu

The use of fumigants, such as methyl bromide (MB), has long been regarded as a necessary pre-planting practice to control soilborne fungal pathogens and weeds. Currently, only three MB alternative fumigants are registered and available for use in the USA, and intensive research is being conducted to optimize application technologies to improve the performance and to reduce the cost. The registered chemical alternatives are chloropicrin, 1,3-dichloropropene, and methyl isothiocyanate generators such as metam sodium, metam potassium, and Basamid. Iodomethane (methyl iodide, Midas™) is currently being considered for registration by the USEPA.

Chloropicrin has been used as a pre-plant fumigant to suppress fungal pathogens in soil and as a warning agent for odorless fumigants such as MB. The fumigant 1,3-dichloropropene is an effective nematicide that has been used in combination with chloropicrin (e.g., Telone C35 or InLine) to improves the control of soilborne fungal pathogens. Metam sodium may be used to control pathogenic fungi, nematodes, insects and weeds, although it is most efficacious in controlling weeds. Iodomethane has the potential of serving as a viable replacement for MB. When applied at an equivalent weight, iodomethane is more effective than MB in controlling soil fungal pathogens and most weeds. Our research also found that sequential application of metam sodium after chloropicrin, InLine, or Midas™ enhanced the efficacy of reduced rates of these alternatives.

For control of fungal pathogens and weeds, our research found that application of these alternatives by drip fumigation is more effective than by shank injection. Although the alternative fumigants can be applied to soil by shank injection, these fumigants (except iodomethane) have lower vapor pressure and higher boiling points than MeBr, and their efficacy to control soil pathogens and weeds is more dependent on the application method, soil type and condition, and weather conditions.

Drip irrigation systems could serve as a vehicle to deliver water soluble formulations of fumigants to the target soil volume and may provide a more uniform distribution of chemicals in the soil than shank injection. However, several variables may affect the efficacy of drip fumigation in controlling soilborne pathogenic fungi, nematodes, and weeds. These include fumigant/emulsifier formulation, fumigant application rate, amount and rate of water application, irrigation uniformity, soil characteristics (soil texture, permeability, organic matter, water content, etc.), sealing method (type of tarp), and environmental conditions.

Drip fumigation is still in its infancy, and research is being conducted to optimize parameters for this technology. For example, our research determined optimum water carrier amount needed for successful drip fumigation for various soil type and drip tape flow rates. Table 1 lists the amount of application water per two feet of soil depth recommended for drip fumigation of various soils (raised strawberry beds). Application of fumigants in less than 1.5 inches of water will result in poor fumigant distribution and high volatilization losses that diminish the efficacy to control soilborne pathogens and weeds.

When done correctly, drip fumigation reduces worker exposure and allows for simultaneous or sequential application of a combination of fumigants. This paper discusses ongoing studies to determine optimum application rates, soil conditions, plastic mulches, and amount of irrigation water used to apply these alternative fumigants.

Table 1. Estimated water amount needed to treat *two feet* of soil depth using two drip tapes. Application time and water volume were based on 40 inches average bed width (64 inches center-to-center).

Soil type	Amount of application water Inches (gallons)[a]	Drip tape flow rate (gpm/100ft)	Application time using 2 tapes (hours)	Comments
Fine sand and loamy fine sand	1.6 (27,154)	0.5 – 0.67	5.5 – 4.1	Pre-irrigation with one inch of water is needed
Sandy loam and fine sandy loam	2.0 (33,943)	0.5 – 0.67	6.9 – 5.2	Minimum of 1.5 inches is recommended
Sandy clay loam and loam	2.6 (44,125)	0.2 – 0.45	22.5 – 10.0	Split application may be required
Clay, clay loam, and silty clay loam	3.2 (54,308)	0.2 – 0.45	27.7 – 12.3	Soils not common in strawberry production

[a] One broadcast acre-inch of water is 27154 gallons. One bed acre-inch of water is 16971 gallons.