#### **Current Status of Fumigants**

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#### Southern Region small fruit consortium

#### www.smallfruits.org

🚓 SRSFC Activities - Crops - R

ops - Regional E

IPM/Production Guides

County Agent Training Weather



#### Mission

To involve collaborative efforts at various sites across the region between small fruit growers and grower organizations, industries and service organizations allied with and/or serving small fruit growers, agricultural extension programs and research stations working together to enhance the development of the small fruit industries in the region.

Read More.

#### Training

Blueberry Pruning Videos - 2017



#### News

Small Fruit News - Vol. 18, No. 3, July 2018



#### Research

Current Sponsored Projects - 2018



# Site Selection

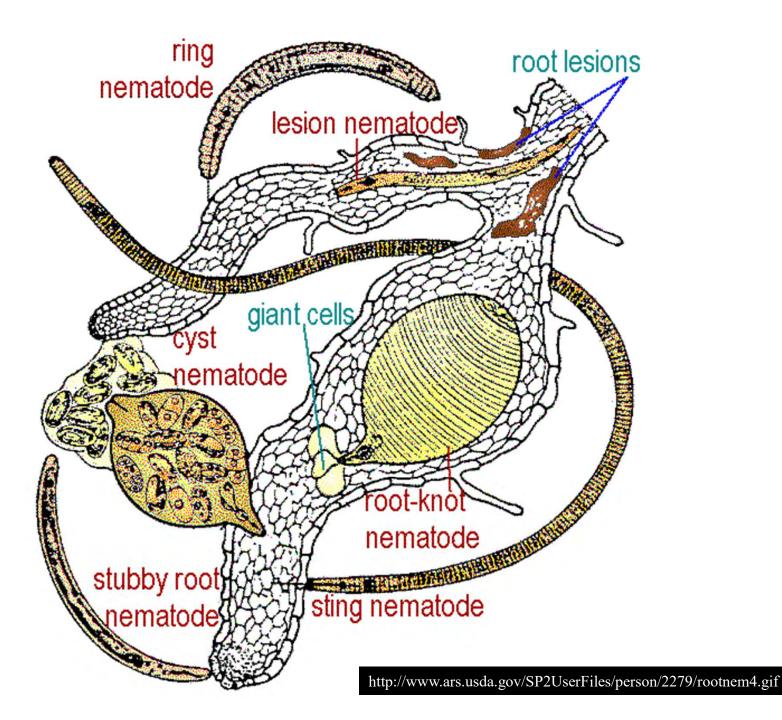
 Good soil drainage is critical!
 Areas of standing water will increase the possibility of *Phytophthora* and likely other diseases.

# Other IPM Practices Rotation Weed control and good air flow

#### Black Root Rot of Strawberry (disease complex)

- "A complex interaction of many fungi, nematodes, and poor soil characteristics. Organisms or factors involved in one area may not be involved in others." (Jay W. Pscheidt, Oregon State University)
- Symptoms general blackening or dark discoloration of roots, poor root growth, and poor foliage growth and health
- Soil fumigation required for control





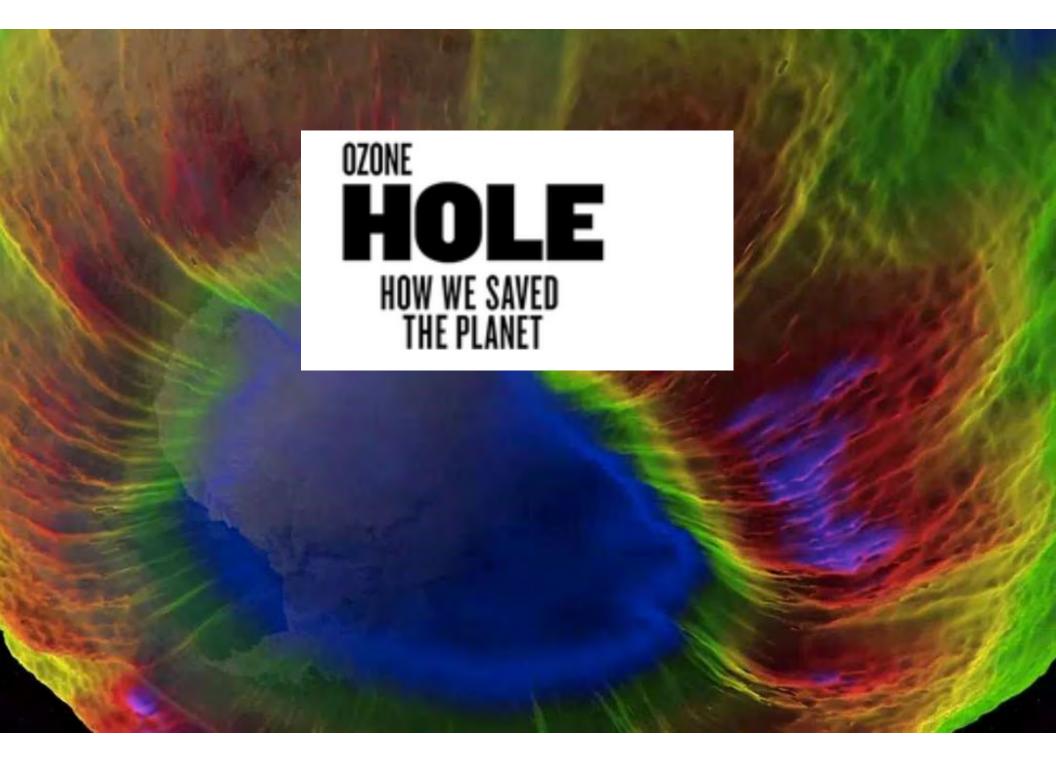


## **Other Reasons to Fumigate**

- Weeds
- Insects
- Etc., anything that can live in the soil and harm a plant

# Fumigants

- Methyl bromide
- Chloropicrin
- Metam-sodium
- 1,3-Dichloropropene



#### **MeBr: Chemical Properties**

- Common Name: Methyl bromide
- Trade Names: Terr-O-Gas, Brom-O-Gas, etc.
- Manufacturer: Great Lakes
- Molecular Formula: CH<sub>3</sub>Br
- Colorless, odorless gas
- Boiling Point: 3.5 °C

Br--CH<sub>3</sub>

#### **MeBr: Pesticide Information**

- Mixed with chloropicrin
  - Warning signal
  - Added activity
- Biocidal properties discovered in 1932 and introduced by Dow Chemical Company
- Relatively cheap and easy to manufacture
- Broad spectrum biocide

## MeBr: A Multi Purpose Biocide

- Insecticide
- Acaricide
- Rodenticide
- Herbicide
- Fungicide
- Nematicide



#### MeBr: Mode of Action (From Bell *et al.*, 1995)

- Narcotic sterilant
- Narcotics induce narcosis, sleep, or unconsciousness
- Enzyme disruption
- Multiple sites
- True MOA is unknown however

#### Uses of Methyl Bromide (From Johnson, 1997)

- 60 million pounds of MeBr used in 1996 in agriculture (92% of all uses):
  - 87% for soil fumigation
  - 8% for quarantine treatments
  - 5% for structural fumigation
- 36 million pounds of MeBr used in tomatoes, peppers and strawberries

#### MeBr Phase-Out Program

**1987** Montreal Protocol accelerated MeBr phase out for industrial nations

- **1999 25% reduction**\*
- **2001 50% reduction**
- 2003 70% reduction
- **2005** Complete phase out

<sup>\*</sup>Based on 1995 consumption levels.











Treatments were generally applied in the same plots from year to year – an effort to determine whether control methods would break down over time if utilized without crop rotation.

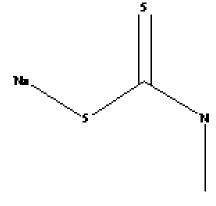


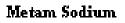




## Metam Sodium: Chemical Properties

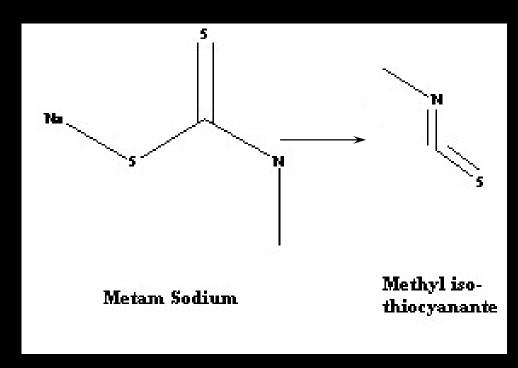
- Common Name: Metam sodium
- Trade Names: Vapam
- Manufacturer: Amvac
- Molecular Formula: C<sub>2</sub>H<sub>5</sub>NNaS<sub>2</sub>
- Chemical Class: Dithiocarbamate
- Used as nematicide, fungicide, and herbicide
- Safer than most other fumigants





#### Methyl Isothiocyanate

- Metam sodium degrades rapidly into methyl isothiocyanate
- Inactivates sulfhydryl groups in amino acids
- Possible carcinogen???

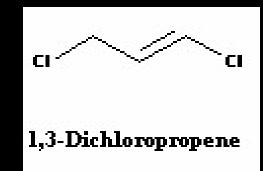


#### Metam Sodium Summary

- Control levels of soilborne fungal diseases are similar to those offer by MeBr
- Root-knot nematode and nutsedge control less than MeBr
- Investigated by the EPA as a potential carcinogen

## 1,3-Dichloropropene

- Common Name: 1,3-dichloropropene
- Trade Names: Telone II
- Manufacturer: DowElanco
- Molecular Formula: C<sub>3</sub>H<sub>4</sub>Cl<sub>2</sub>



- Nematicide, fungicide, and herbicide
- Mixed with chloropicrin to form Telone C-17 and C-35 and PicClor products as examples

## **1,3-Dichloropropene Summary**

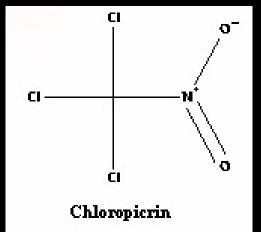
- Comparable control of disease and nematodes when compared to MeBr
- Improved root-knot nematode control when compared with metam sodium
- Weed control not acceptable unless supplemented with a herbicide
- Potential carcinogen and ground water contamination concerns

## Chloropicrin

- Common Name: Chloropicrin
- Trade Names: Chlor-O-Pic
- Manufacturer: Great Lakes
- Molecular Formula: CCl<sub>3</sub>NO<sub>2</sub>



 Limited activity as a nematicide, bacteriocide, and fungicide



#### **Chloropicrin Summary**

- Limited activity as a herbicide and nematicide comparatively
- Soilborne disease control is less than MeBr for many pathogens
- Sole use of chloropicrin will probably be minimal in the future
- However, can be used to enhance the activity of 1,3-D and metam sodium

## **Methyl lodide**

- Analogous to MeBr in its activity as a biocide
- Absorbs more UV in the atmosphere than MeBr and rapidly degrades
- No threat to ozone depletion
- Expensive and cost to grower would be 10X of MeBr
- Phytotoxicity reports
- No longer marketed

## **Dimethyl disulfide**

- Paladin
- Odor issues
- Phytotoxicity reports
- No longer marketed

Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds in Plasticulture Strawberries <sup>1</sup>						
	Rate per Tr	reated Acre <sup>2</sup>	Relative Efficacy <sup>3</sup>			
Product	Volume (gal)	Weight (lb)	Nematodes	Disease	Nutsedge	Weeds: Annual
Pic-Clor 60 (chloropicrin + 1,3-dichloropropene)	48.6	588	E	E	Р	G
Pic-Clor 60 EC <sup>4</sup> (chloropicrin + 1,3-dichloropropene)	42.6	503	E	E	Р	G
Pic-Clor 80 (chloropicrin + 1,3-dichloropropene)	34	440	G	Е	Р	F
InLine <sup>4</sup> (1,3-dichloropropene + chloropicrin)	29 to 57.6 (see label)	325 to 645 (see label)	Е	E	Р	G
Telone C-35 (1,3-dichloropropene + chloropicrin)	39 to 50	437 to 560	Е	Е	Р	F
chloropicrin <sup>5</sup> + metam sodium <sup>5</sup>	see labels + see labels	see labels + see labels	VG	E	F	VG
chloropicrin <sup>5</sup>	see labels	see labels	F	Е	ND	ND
Tri-Pic 100EC <sup>4</sup> (chloropicrin)	8 to 24	100 to 300	F	Е	ND	ND
metam potassium <sup>5</sup>	see labels	see labels	G	G	Р	VG
metam sodium <sup>5</sup>	see labels	see labels	G	G	Р	VG
Dominus <sup>6</sup> (allyl isothiocyanate)	25 to 40*	212 to 340*	F	G	Р	G
Telone II (1,3-dichloropropene)	15 to 27	153 to 275	Е	Р	ND	ND
Telone EC <sup>4</sup> (1,3-dichloropropene)	9 to 24*	91 to 242*	Е	Р	ND	ND

<sup>1</sup> Fumigants with lower efficacy against weeds may require a complementary herbicide or hand-weeding program, although use of virtually impermeable film (VIF) or totally impermeable film (TIF) may increase weed control, particularly with Telone C35. Refer to the Herbicide Recommendation section of this guide for directions pertaining to herbicide applications. Telone can persist more than 21 days under cool or wet soil conditions.

<sup>2</sup> Rates can sometimes be reduced if products are applied with VIF or TIF.

<sup>3</sup> Efficacy Ratings: The efficacy of a management option is indicated by E = excellent, VG = very good, G = good, F = fair, P = poor, and ND = no data. These ratings are benchmarks; actual performance will vary.

<sup>4</sup> Product is formulated for application through drip lines under a plastic mulch; efficacy is dependent on good distribution of the product in the bed profile.
<sup>5</sup> Metam potassium can be Metam KLR, K-Pam, Sectagon K54 or other registered formulations and should be used in soils with high sodium content. Metam sodium can be Vapam, Sectagon 42, Metam CLR or other registered formulations. Chloropicrin can be applied by itself (e.g. Pic100) but is usually applied as a mixture with 1,3-dichloropropene.

<sup>6</sup> Dominus is registered but there is limited experience with the product through university or independent trials in our region; growers may want to consider this on an experimental basis. Planting interval is 10 days. The active ingredient allyl isothiocyanate is similar to the active ingredient in metam sodium products (methyl isothiocyanate) and is likely to behave in a similar manner with a similar pest control profile.

\* Labelled rates are per broadcast-equivalent acre, NOT per treated acre.

#### 2000/2001 Results

Treatments and rate/A	Foliage dry	Total yield (kg/ha)
	weight [g/5	
	plants]	
Untreated check	101.9 b	18,290 d
MBC-33 350 lb	204.4 a	29,591 a
Inline 32 gal + Vapam HL 75 gal	183.9 ab	25,504 abc
Telone C-35 35 gal + Vapam HL 37.5 gal	176.1 ab 🤇	29,166 a
Telone II 15 gal + Vapam HL 75 gal	217.7 a	26,897 abc
Telone C-17 17.5 gal + Chloropicrin 100,	197.1 a	23,686 c
130 lb		
Telone C35 35 gal + Vapam HL 37.5 gal	205.9 a	27,915 ab
Telone II 15 gal + Chloropicrin 100, 130 lb	192.1 a	23,870 bc
LS D ( $P = 0.05$ )	83.8	4,227

#### 2001/2002 Results

Treatments and rate/A	Foliage dry	Total yield (kg/ha)
	weight [g/5	
	plants]	
Untreated check	104.8 cd	9,417 d
MBC-33 350 lb	195.1 a	16,652 ab
Inline 35 gal + Vapam HL 75 gal	107.8 cd	13,821 bc
Telone C-35 35 gal + Vapam HL 37.5 gal	171.6 ab <	15,892 abc
Telone C-35 35 gal + Vapam HL 75 gal	168.5 ab <	18,840 a
Telone C-17 17.5 gal + Chloropicrin 100,	162.8 ab	14,750 bc
130 lb		
Inline 35 gal	97.6 d	12,478 cd
Telone C-35 35 gal	148.1 bc	16,018 abc
LSD ( $P = 0.05$ )	45.9	3,691

#### 2002/2003 Results

Treatments and rate/A	Foliage dry	Total yield (kg/ha)
	weight [g/5	
	plants]	
Untreated check	57.5 b	11,295 c
MBC-33 350 lb	87.7 ab <	17,830 a
Inline 11 gal + Vapam HL 75 gal	74.4 ab	13,633 bc
Telone C-35 35 gal + Vapam HL 37.5 gal	82.0 ab	16,591 ab
Telone C-35 35 gal + Vapam HL 75 gal	98.4 a 🤇	19,182 a
Telone C-17 17.5 gal + Chloropicrin 100,	84.6 ab	19,661 a
130 lb		
Inline 35 gal	83.2 ab	14,507 bc
Telone C-35 35 gal	74.4 ab	16,394 ab
LS D ( $P = 0.05$ )	31.2	3,267







#### **Cost Comparisons**

Pesticide	Active Ingredient	Rate/A	Cost/A
MeBr (67%)	methyl bromide	300 lbs	\$576
Telone C-17	1,3-dichloropropene	18 gal	\$257
Vapam	metam sodium	75 gal	\$356
Pic	chloropicrin	50 gal	\$133
Tillam	pebulate	4 lbs	\$34
	Dail Tifton GA on Mara		

Hendrix and Dail, Tifton, GA on March 8, 2000.

#### **MeBr Alternative Conclusions**

- No single pesticide that can serve as an alternative
- Replacement can only be accomplished through integrated pest management
- Producer decisions based on prior field history targeting the pest that has the greatest damage potential

#### **Soil Solarization**

- Clear plastic placed over soils prior to planting
- Reduces some diseases in tomato and peppers
- Nematode control can be weak at times
- Disease suppression is variable across seasons









