HOW EFFECTIVE IS YOUR SOIL FUMIGATION? HERE ARE THE DETERMINING FACTORS

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Although soil fumigation has become a part of a new high-tech production system for many, actually it is one of the oldest pest control practices in modern use today.

In order to select the proper fumigant for a successful soil fumigation program, we must understand the relationships between the fumigants we are using, the pest(s) we are trying to control, and the condition of the soil where the fumigants are being applied. Listed below are eight factors to be considered in a successful soil fumigation:

--Soil preparation
--Soil temperature
--Soil moisture
--Fumigant
--Injection depth
--Sealing
--Soil aeration
--Waiting period

Soil preparation -- The beginning of a successful fumigation is the soil preparation. Our objective is to start cultivation well in advance of fumigation, to allow sufficient time for trash and debris to decay. **Organic matter** such as **crop residues** poses several problems in relation to soil fumigation:

- In especially dry conditions, rate increases may be required in going from a low organic to a high organic soil.
- Restriction of the ability of the fumigant to move through the soil.
- Soil fumigants are absorbed more readily by organic matter, effectively reducing application rate.
- Trash tends to catch on application equipment, causing delays and inconsistent application rates.

The soil should be in good tilth and friable, with no **clods** present. A clod represents two problems:

1. Compacted soil which will not allow the fumigants to penetrate and control the pest within the clod, and
2. Clods make it difficult to seal a soil surface.

In very compact soils, most of the air spaces become disconnected from each other (surrounded by water) and fumigant movement is very slow.

Another consideration concerning soil preparation is the **soil type**. Fumigants move differently through different **soil types**. A silt loam or clay soil represents a fine-textured soil. Sand is classified as a coarse-textured soil. Fine-textured soils will have greater air spaces between particles. This air space can be filled with even more water than is found in sand, causing available air space to be restricted and reduced. This factor makes it more difficult for the fumigant to move through fine-textured soils (clay, silt loam) than

sandy soils. Taking this into consideration, generally a clay soil should be dryer prior to fumigation, and sandy soil can be quite wet and still achieve good fumigation.

Soil temperature – The activity of fumigants is markedly affected by temperature; the extent depending on the fumigant used. Generally soil temperatures should be at a minimum of 50°F or above for the maximum activity of most fumigants. Temperature affects the rate of volatilization, diffusion, and metabolic activity of seeds, insects, fungi, etc. At lower soil temperatures fumigants become more soluble in **soil water**. At the same time the percent of fumigant decreases in the soil air, therefore giving a slower movement of the fumigant in a cold soil as compared with movement in a warm soil.

Soil moisture – Adequate soil moisture is required for maximum activity. Please note that fumigants move 10,000 to 30,000 times faster in **soil air** than in **soil water**. As soil moisture increases from dry to field capacity the amount of fumigant in the soil **water increases**, and the amount in soil **air decreases**. In case of saturation or wet soil the fumigant will not move through the soil as a gas, limiting its effectiveness.

Fumigants – Listed below are the more common fumigants used today:

Gas Fumigants	**Liquid Fumigants**	**Granular**
Methyl Bromide (G.L.C.C)	Telone® (Dow)	Basamid® (BASF)
	Vapam® (Amvac)	
	Sectagon® (Or-Cal)	
	Chloropicrin (Niklor)	

The objective of soil fumigation is to establish a lethal concentration for a sufficient period of time to kill the target organisms throughout the soil. When conditions are favorable, the fumigants injected into the soil volatilize and move through the soil air, at the same time dissolving in the soil water creating a dynamic equilibrium between soil air and soil water. Most fumigants do not move through soil in water. An exception to this is Vapam®. Vapam® can become a true solution in water and moves through the soil in water.

Injection depth – This depends on the type of fumigant and sealing method used. Keep in mind that fumigants are volatile and move upward, therefore the depth of the injection should exceed the desired area of control. If possible, the depth of the soil should be worked deeper that the intended application depth.

Sealing – Since some fumigants are more volatile than others, these generally require tarping. (Gases, such as Methyl Bromide) Less volative fumigants such as liquid fumigants may require soil compaction, water or other sealing devices other than a tarp. Overhead irrigation is recommended in sealing many broadcast liquid fumigants. With adequate soil moisture before fumigation, sometimes a drag board is sufficient to seal liquid fumigants. Compacting the soil surface or reducing air space is also very effective with some fumigants.

Soil aeration – This refers to the span of time following the fumigation, necessary for delaying planting, to avoid injury to the crop. In the case of tarped fumigants, this would be the interval between tarp removal or puncture and planting. Aeration period is depending upon:

1. Temperature – the higher the temperature, the shorter the waiting period.
2. Moisture – loss is greater under dry condition.
3. Type of Fumigant – some are more volatile than others and are lost more rapidly.
4. Soil Condition – soil compaction results in persistence of fumigant.

Waiting period – Always follow label instructions and consider all of the above conditions.

NOTE HERE: Most fumigants are **restricted-use pesticides**, and are for sale and use only by **certified applicators** or persons under their **direct** supervision, and only for those uses covered by the certified applicator's certification.

CARING FOR FUMIGATED SOIL

Solid Tarp Fumigation (400 lb/A Methyl Bromide-Chloropicrin)

Treatment time: The plastic cover should remain in place for a minimum of 48 hours. Control, however, may be achieved after 24 hours if the soil temperature at 6 inches is above 60°F or 16°C.

Aeration period: For transplants, aerate for 7 to 10 days. (Terr-O-Gas 98) If rains or low temperatures (below 60°F) occur during aeration, extend the aeration period.

Sanitation: Once the cover is removed from the fumigated field, that soil is susceptible to contamination. The major sources of contamination are wind, transplants, erosion, unclean equipment, and animals.

When reworking the soil before seeding or transplanting be sure your equipment does not disturb the soil any deeper than 4 to 5 inches. This practice prevents any untreated soil from being brought to the surface.

Continue pesticide applications as if the soil had never been fumigated. This will keep the weeds, insects, and diseases in check as they attempt to reinfest.

Keep field borders mowed and prevent any weeds in the area from going to seed. Pull or destroy any weeds that survive the fumigation or that have come in from some other source. Be sure not to let them go to seed. Wash off your equipment before entering a fumigated field. Any mulch material must be as free of contaminants as possible.

Weed control to be expected in Midwestern states after soil fumigation with Methyl Bromide-Chloropicrin.

Weeds Controlled	**Control Not Guaranteed**	**Some Control**
Quackgrass	Horsetail	Canada thistle
Broomsedge	Canada thistle	Yellow nutsedge
Wild oats	Yellow nutsedge	Purslane
Cheat	Red root pigweed	Henbit
Downy broomgrass	Purslane	Pigweed
Large crabgrass	Henbit	
Barnyard grass	Carpetweed	
Goosegrass	Venice mallow	
Nimblewill	Common mallow	
Witchgrass	Velvetleaf	
Fall panicum	Morning glory	
Foxtail	Clover	
Johnsongrass	Vetch	
Wild garlic	Cranesbill	
Knotweed	Prickly sida	
Smartweed	Redstem filaree	
Red sorrel		
Curled dock		
Lambsquarter		
Tumbleweed		
Chickweed		
Mustard		
Shepards purse		
Wild parsnip		
Common milkweed		
Motherwort		
Catmint		
Jimson weed		
Horse nettle		
Plantain		
Yarrow		
Ragweed		
Burdock		
White heath aster		
Bull thistle		
Wild lettuce		
Pineapple weed		
Goldenrod		
Dandelion		
Cocklebur		

METHYL BROMIDE & CHLOROPICRIN

Supplied in various brands and formulations or percentages.

Terr-O-Gas 67 (GLCC)
Chloro-Pic (Great Lakes Chemical) and others

Characteristics: A gaseous fumigant supplied in steel cylinders, both pressurized and non-pressurized. The boiling point of methyl bromide is 36°F and that of chloropicrin is 230°F. The boiling points of their formulations range from 36°F to 45°F.

Maintained as a liquid when under pressure, changes to a gas immediately when exposed to soil. Usually tarped with plastic. Some crop uses are on tobacco and nursery seedbeds, strawberries, tomatoes, melons, and others. Also used non-tarped by deep injection in bedding. These crops include tobacco and fruit trees.

Safety: Do not trap methyl bromide and/or chloropicrin **on the skin**. Wear loose fitting clothes. Do not wear rings or gloves. Wear eye protection. Always keep water nearby on the machine and service trucks. Handle fumigant in the open with operator upwind. Read labels thoroughly and instruct all employees of precautions.

Full-face respiratory protection is not required. **Use only** self-contained breathing apparatus when concentrations are **above 5ppm**.

Application equipment: Applied through a closed system. Use only components designed to withstand working pressures of **not less than 150 P.S.I**. Materials of choice are brass, copper, stainless steel, black carbon steel, and polyethylene. Gasket material must be Teflon or Viton. Threading sealant materials can be Teflon tape and RTV silicone. **Do not use** aluminum, magnesium, or any of their alloys, or PVC, Neoprene, Buna-N, EPDM, or rubber.

Normal working pressure is from 30 P.S.I. to 100 P.S.I. Use only dry, non-flammable compressed nitrogen gas (supplied in cylinders at welding-gas dealers) in the application system. For non-pressurized methyl bromide cylinders the nitrogen regulator should have a check valve and a relief valve (set at a maximum of 150 P.S.I.) With pressurized methyl bromide cylinders use only a “Cla-Valve” regulator designed for methyl bromide. Use properly designed sight-glasses, filters, and fittings. Use Teflon and stainless steel braided hoses. Use proper metering system employing either orifice discs or a methyl bromide flow meter.

Maintenance: Before doing any work with a methyl bromide system, close all the cylinder valves and open the valves on the application system to relieve pressure. Leave the valves open to keep pressure from re-building. Before starting to fumigate, check hose, components, and injection tubes with compressed air to make sure they are clear. Replace all worn and damaged hoses and parts. Open all valves slowly and carefully.

Clean-up & storage: No flushing is needed. Open valves to relieve pressure. Store system dry internally. Store equipment out of the weather. Tape or cover open hose ends.

METAM-SODIUM

Brands: VAPAM® (Amvac)

Characteristics: Handled as a liquid. Water soluble. Use as a concentrate or mix with water. Supplied in poly drums or in bulk poly tanks. Boiling point is 230°F. Forms crystals below 0°F. Use as a row or broadcast treatment, both tarped or non-tarped. Used for peanuts, vegetables, and other crops. Also can be mixed and applied through irrigation systems.

Safety: Wear rubber or vinyl gloves for short-term protection. Wear loose fitting clothes. Wear eye protection. Keep water on hand at all times on the applicator. For respiratory protection, use a full-face canister respirator. Read label thoroughly, and instruct all employees of precautions. Wash with soap and water immediately on exposure, and remove any contaminated clothing.

Application equipment: Applied with pumps on bedders or other special applicators. Knife spacings of five inches or less are used on broadcast applications. Use an adequate soil-sealing method such as drag-board, roller, or irrigation.

Materials that are compatible are stainless steel, Teflon, nylon, polyethylene, neoprene, Viton, EPDM, and black carbon steel. **Do not use** brass, copper, PVC, galvanized steel, zinc, aluminum, or Buna-N!

Keep hose lengths to a minimum, and away from the operator. Transfer system should have dry-disconnecting function. **Do not use** compressed air for transferring!

Maintenance: Before starting, check the system for leaks and obstructions with water. Replace worn hoses and components immediately. **Calibrate** with water.

Clean-up & Storage: Flush system with detergent and water. Completely rinse off the system externally. Store with anti-freeze, and out of the weather.

1,3 DICHLOROPROPENE

Brands: Telone® (Dow Chemicals)
Telone C-17® (with Chloropicrin) (Dow Chemicals)
Telone C-35® (with Chloropicrin) (Dow Chemicals)

Characteristics: Handled as a liquid. **DOES NOT MIX WITH WATER!** Supplied in steel drums or stainless steel bulk tanks. Boiling point is 220°F. **It is flammable!** Changes to gas slowly. Used mostly on non-tarp operations in rows or broadcast treatments. Used on tobacco, vegetable crops, fruit crops, and others.

Safety: Wear rubber or vinyl gloves when handling liquid. Gloves provide short-term protection. Wear loose fitting clothes. Wear eye protection. Keep water at hand at all times on the applicator. Use a full-face organic-vapor respirator. Read label thoroughly, and instruct all employees of precautions. Keep product **away from open flames and sparks.**

Application equipment: Applied with pumps. Injection equipment includes bedders, chisel plows, turn plows, and others. Use only properly designed systems. Keep operating pressures between 10 P.S.I. and 50 P.S.I. Use proper soil sealing techniques. Materials of choice for equipment are brass, copper, stainless steel, black carbon steel, nylon, polypropylene, and polyethylene. Gasket materials should be Teflon and Viton. Threading sealants include Teflon tape and RTV silicone. **Do not use galvanized materials,** aluminum, magnesium, zinc, cadmium, or any alloys of these metals. **Do not use** PVC, EPDM, neoprene, Buna-N, or rubber!

Keep hose lengths to a minimum, and secure them well to their fittings. Electrical components around the fumigant should be explosion-proof. The transfer system should have dry-disconnecting function. **Do not use compressed air** for transferring.

Maintenance: Before starting check the system thoroughly for leaks or other problems with diesel fuel or water. (**Note:** Flush out all water before filling with fumigant!) Check and replace hoses. Check injection tubes for blockage.

Clean-up & storage: Flush system with diesel-fuel to remove the fumigant. Store pump and components with a mixture of one-half oil and one-half diesel fuel to prevent corrosion. Do not store outside. Do not use water or anti-freeze for storage.