

SOIL COMPACTION EFFECTS ON FUMIGANT GAS EMISSIONS

Paul E. Sumner, Extension Engineer
Stanley Culpepper, Extension Weed Scientist
Tifton Campus University of Georgia
P.O. Box 748
Tifton, GA 31793
psumner@uga.edu

Introduction

Chloropicrin fumigant gas will be the controlling factor for buffer zone (distance from public and private habitat) restrictions in commercial vegetable production. Buffer zones are being discussed that could reduce the amount of land available to produce commercial vegetables. All liquid fumigants used today in commercial vegetable production have chloropicrin as a component. Chloropicrin is usually injected into the soil where it permeates the soil and kills soil-borne pests. Chloropicrin is a clear, colorless, nonflammable oily liquid with strong, sharp, highly irritating odor and a strong lacrimator. A lacrimator is gas that makes the eyes fill with tears but does not damage them. The high vapor pressure of 23.8 mm Hg @ 25°C of chloropicrin suggests that volatilization is the route of dissipation. Direct photolytic degradation ($t^{1/2} < 8$ hrs) of chloropicrin is the primary route of dissipation in the atmosphere, which suggests it is not a significant threat to deplete the ozone layer. However, if chloropicrin remains in soil, it also degrades in soil with half-lives ranges from 4.5 to 10 days with CO₂ being the terminal breakdown product. (EPA, 2007.)

It is theorized that the closer the soil particles are together (soil compaction), the gas fumigant would stay in the soil profile longer. An experiment was setup to measure the amount of chloropicrin and DMDS fumigants released on two different soil compactions.

Materials and Methods

Plot land was chosen in the fall of 2008 for a soil type of sand which is comparable to soils used for commercial vegetable production in South Georgia. Plots were random design using LDPE mulch. Plots were tilled with a field cultivator and bedded prior to operation of the fumigation equipment.

Paladin™ a mixture of dimethyl disulfide and chloropicrin (79:21) was applied at 75 gpa with a prebedder injecting fumigants 8 inches deep with three knives 11 inches apart on September 8, 2008 in 1.8 m by 15 m plots with 81 cm bed tops. Next, LDPE mulch was applied with a plastic layer. The compaction of the bed was obtained by adjusting the top link on the plastic laying machine. The top link was set at 27.5 (ideal bed preparation setup) and 28.0 inches (more compact bed) in length. Soil

compaction was measured with a Pocket Penetrometer modified with a ½ inch foot on various section of the bed.

Soil samples of 365 cm³ were obtained from each plot with a soil probe (4.8 cm diameter by 20 cm deep). Gravimetric moisture content basis was determined for each sample by weighing the soil and placing the soil in a 105°C oven for 24 hours and reweighed. Next, the samples were evaluated for field capacity water content. Soil samples were placed on a ceramic plate. The sample is then saturated with water for 24 hours to equilibrate. The porous ceramic plate with saturated soil is pressurized to 1/3 bar of pressure. After 24 hours in this chamber, the moisture content in the soil was determined with above method.

Chloropicrin was measured with a gas detector pump (GASTEC GV100S) and a detector tube (Sensidyne #172S). An inverted HDPE funnel (1.9 L) with a rubber stopper measuring 16.5 cm in diameter fill opening by 22 cm high with a 2 cm drain was glued (silicon) to plastic mulch beds (Figure 1). Chloropicrin gas collected inside the funnels for a known period of time (1-10 minutes). After the known period, a 100 ml sample was drawn through the detector tube from the inside of the funnel by the gas detector pump. The chloropicrin detector tubes had a range of 0.05 – 16 ppm.

Dimethyl disulfide was measured with a handheld volatile organic compound (VOC) monitor (MiniRae 2000) with a range of range of 0-10,000 ppm. DMDS measurements were taken immediately after the chloropicrin inside the inverted funnel.

Samples of the accumulated gas inside the funnels were taken from 3 to 55 hours after application. Fumigants were measured in the funnels until no gases were detected.

Results and Discussion

Average soil moisture content for this experiment was 5 %/dry weight of soil. The field capacity of sand soil type was 5.4 %/dry weight of soil therefore the soil was at 92% field capacity when the test was started. Figure 2 illustrates the temperature cycle occurring during the test on a typical bed. Soil temperatures at a depth of 8 inches averaged 87°F and ranged a minimum of 79 to a maximum of 96°F.

Chloropicrin gas emissions on LDPE covered beds at two compaction settings are shown in figure 3. When the top link was extended to create a firmer bed, gas emissions was reduced by 20 percent. Dimethyl disulfide gas emission reduced by 9 percent when the top link was lengthened to increase bed density (figure 4).

This experiment shows that compaction can affect how fumigant gas is being emitted from the mulch bed.

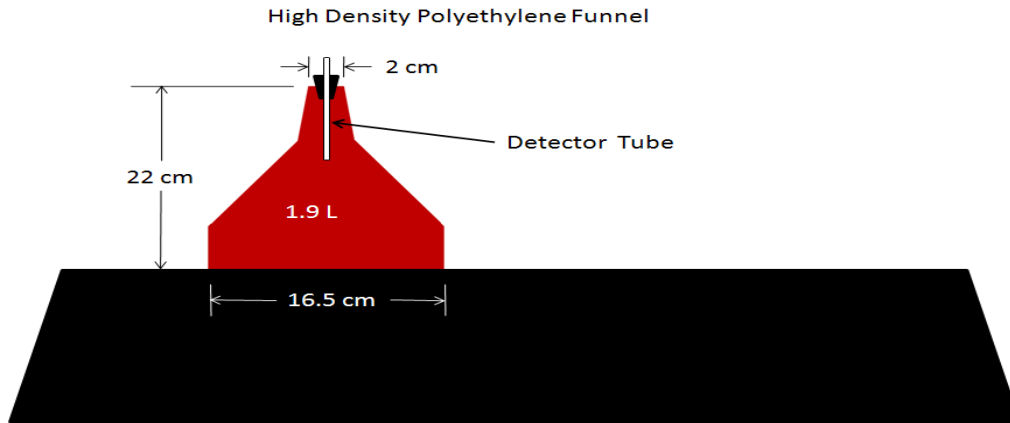


Figure 21. Schematic of fumigant sampling system.

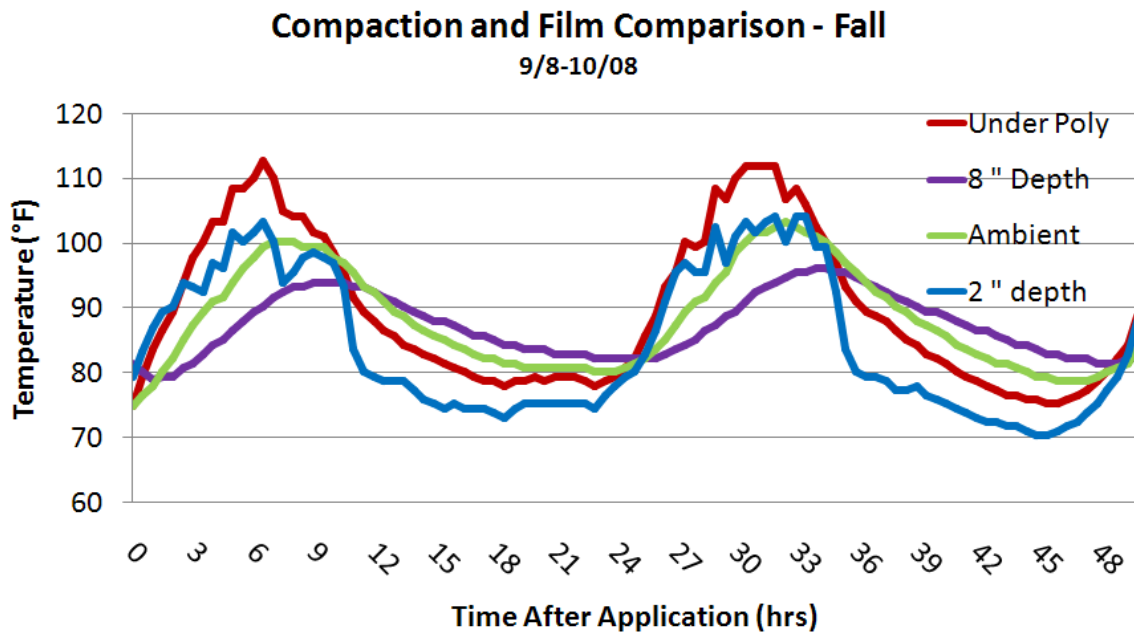


Figure 2. Temperature profile for under poly, 2 inch, 8 inch and ambient during the mulch tests. September 2008.

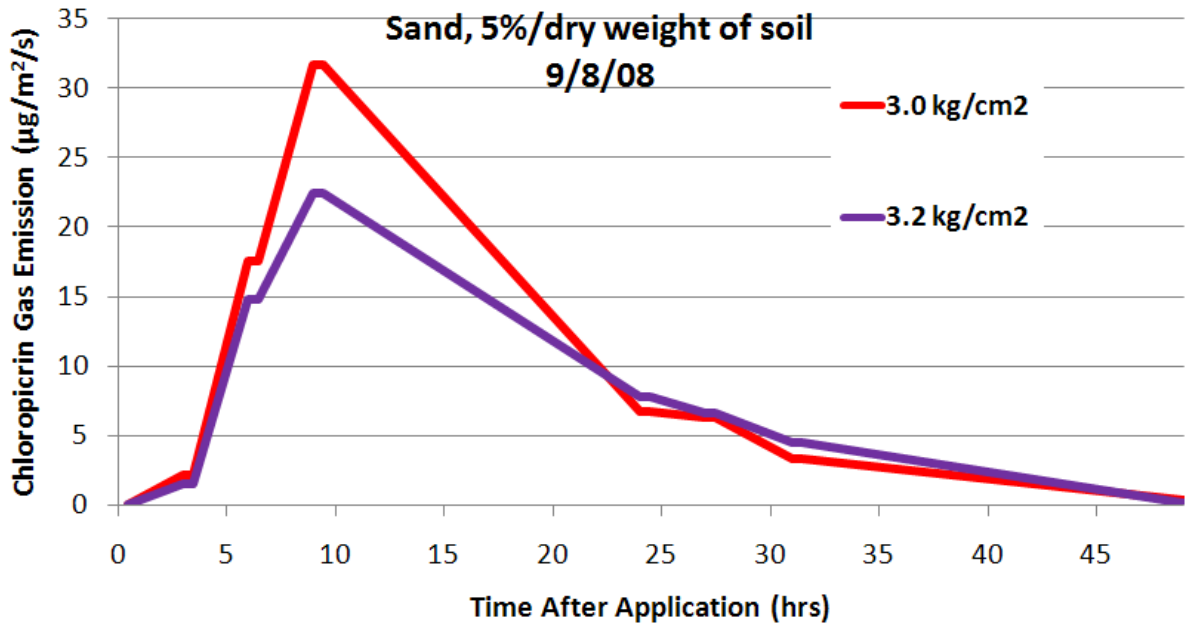


Figure 3. Chloropicrin gas emission on LDPE plastic mulch for two compactions settings. September 2008.

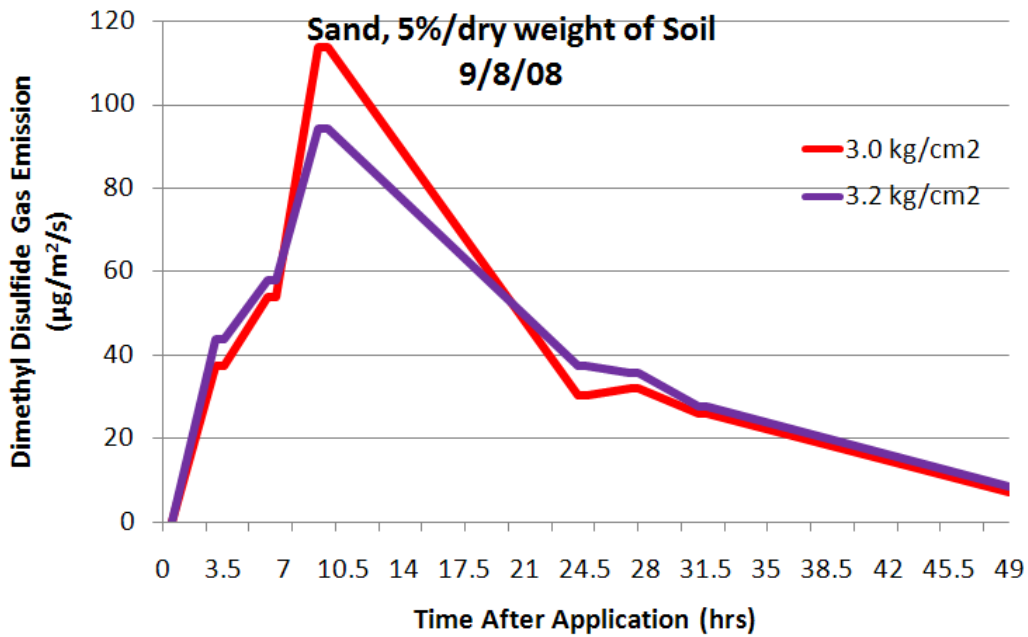


Figure 4. Dimethyl disulfide gas emission on LDPE plastic mulch for two compactions settings. September 2008.