TIF TARP ON EMISSION AND FUMIGANT MOVEMENT IN AN 8-ACRE FIELD

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The primary goal of the project was to collect field data to address issues associated with the use of totally impermeable film (TIF) tarp and assist regulatory agencies in decision-making on adoption of TIF tarping technology in soil fumigation. The issues include potential surges in emission following tarp-cutting that potentially increase the exposure risks to workers and by-standers. Another concern was emissions at TIF tarped field edges through bare soil. Determination of safe tarp-cutting time, quantification of off-tarp edge emissions, and evaluation of fumigant fate and movement in soil will assist in the development of safe practices, policies and regulations on TIF tarp use.

SPECIFIC OBJECTIVES: 1) Monitor fumigant concentration changes in air under TIF tarp, 2) Determine fumigant distribution and changes over time in soil profile in TIF tarped field and monitor movement at tarp edges, and 3) Determine emissions from TIF tarped field and at or near TIF tarp edges in bare soils.

STUDY METHODS: A field trial was conducted from June 4−20, 2011 in Lost Hills, Kern County, CA by fumigating one 8-acre field for monitoring. The soil type was Milham sandy loam (fine-loamy, mixed, superactive, thermic Typic Haplargids). Pic-Clor 60 (40/60 mixture of 1,3-D and CP) was applied using a Noble plow rig at 652.6 kg/ha (582.7 lbs/ac, or 261.0 kg/ha 1,3-D and 391.6 kg/ha CP). The rig was equipped with two large shanks fitted with injection nozzles that were set to inject fumigant at 30 cm depth and spaced at 25 cm. Fumigant application was carried out from 0700 to 1120 on June 4. The application time for specific sampling locations (soil gas and emissions with chambers) were used as time 0. The TIF tarp (VaporSafe^{TM}, 1-mil, EVAL-resin barrier film, Raven Industries, Sioux Falls, SD) was placed on the field immediately with the rig following fumigant injection. The tarp was cut on June 20.

Emission sampling from the tarped field, as well as at or near the edge area at a distance of 0 and 2 m in bare soil, was carried out using dynamic flux chambers (DFCs). Duplicate locations were selected for installation of the chambers (Figure 1). Large XAD sampling tubes (226-175, XAD-4, 8 x 150 mm, 400/200 mg, SKC, Eighty Four, PA) were used to trap fumigants 1,3-D and CP. The tubes were changed for new ones at 4-6 h intervals. The inlet air to chamber was sampled for background corrections. After the tarp-cutting the sampling continued for another 24 hours by repositioning the chambers on the tarp-removed areas.

Air under the TIF tarp (above soil surface) was sampled at the same locations in four areas (NE, SE, center of N and NW) of the field where soil gas sampling probes were also installed to monitor fumigant concentration changes in soil profile throughout the trial. Total 16 sets of soil-gas sampling probes were installed inside the field plus 4 more sets off the field in the tarp edge areas. Each set of probes contains either 5 (10, 25, 45, 70 and 100 cm) or 10 (0, 5, 15, 25, 35, 45, 55, 70, 85 and 100 cm) sampling depths. At each location, two sets of probes (one at shank trace and the other between shank traces at an injection line) were installed and replicated. Target sampling times were 9, 24, 48, 72 h followed by 3-day intervals after application. The last sampling was conducted 48 h after tarp-cutting. Small XAD sampling tubes (226-93 XAD-4, 7 x 70 mm, 80/40 mg, SKC, Eighty Four, PA) were used to trap fumigants by drawing the air through.

All XAD tubes were stored in a cooler with dry-ice in the field and transferred to a -80^{o}C freezer in the lab before extractions for analysis. Fumigant concentration in gas samples, emission flux, and cumulative emission losses were calculated.

RESULTS AND DISCUSSIONS**:** TIF tarp appeared to be effective to reduce emissions although data were not absolutely conclusive by the chamber measurements in this large field trial. Over the 16-day tarp covering period, cumulative emission loss of about 7% 1,3-D and 6% CP of total applied was measured by one chamber, but 91% and 59% loss by the other from the TIF tarped field and such high emissions measured can only be explained by the tarp damage during application as observed in the area. A small surge in emission was measured after the tarp-cutting (ave. 6% and 2% loss for 1,3-D and CP, respectively). Although emission flux measured immediately off the tarp-edge on bare soil was initially several times higher than that from the tarped field, the flux dropped substantially with time and distance with a maximum flux below 0.01 mg/m^2/sec measured at 2 m distance from the tarp edge.

Air under the TIF tarp in the fumigated field achieved a maximum concentration of 8.3 µg/cm^3 CP and 6.9 µg/cm^3 1,3-D in about 24 h following application. Similar peak concentrations were observed in the first 3 days around noon time. The concentration then decreased fast for the next 3 days and also began a shift to a higher 1,3-D/CP ratio. 1,3-D concentration under the tarp decreased to at or below 1.00, 0.25 and 0.10 µg/cm^3 on Day 10, 13, and 15, respectively with CP concentrations half or lower than 1,3-D.

Higher concentrations at injection lines were observed for most of the soil gas probes especially at earlier times following application. The data also showed continuously higher CP concentrations than 1,3-D at earlier times for all depth or at lower soil depths throughout the monitoring period, which may indicate lower mobility of CP than 1,3-D. Similar distribution pattern of the fumigants in soil-gas phase were observed; but concentration range showed field variations. Fumigants were detected at tarp-edge areas up to 2 m but with much lower concentration range than in the field and also mostly observed in the first few days.

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Figure 1. Sampling layout for emissions with dynamic flux chambers at TIF tarped and edge areas in a large field trial in June 2011, Lost Hills, CA.

Figure 2. Soil-gas sampling probes for monitoring fumigant concentration changes in soil profile in a large field trial in June 2011, Lost Hills, CA. Probes were installed to various soil depths.