DYNAMIC FLUX CHAMBER SYSTEMS FOR FUMIGANT EMISSION MEASUREMENTS

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Emission assessment from soil fumigation is an essential component for several projects under the Pacific Area-Wide (AW) Integrated Pest Management Program for Methyl Bromide Alternatives. The objective of this project was to design and construct Dynamic Flux Chamber Systems (DFCs) to automate sample collection and record critical data using readily available materials. Twenty four DFCs were built and used for field trials in 2007. A few problems were experienced in the field trials and upgrades were required for significant improvement in field operation and data collection.

APPROACH AND PROGRESS: The Dynamic Flux Chamber System (DFCs) consisted of a flow-through chamber and an automated sampling and data module. The chamber design was modified from Gao et al. (1997) and has the new dimension for covering a surface area of 50.8 x 25.4 cm to accommodate the 50.8 cm shank spacing from a standard Telone rig and/or 25.4 cm furrow width in raised bed strawberry fields for emission measurement. A prototype of the chamber was manufactured from galvanized sheet metal by a fabrication shop (AAW Metal Works, Inc., Fresno, CA). Air flow through the chamber was created using a shop vacuum powered by a generator in 2007 and was upgraded in 2008, to an individual vacuum pump powered by a 12-V battery for each chamber. A portion of the outflow was sampled by a sampling line. A smoke test to visualize the air flow indicated a uniform flow distribution or laminar flow pattern in the chamber at the flow rate of 5-7 L/min for chamber flow and 100-120 mL/min for the sample flow (Fig. 1). These flow rates were used in field emission measurements. Laboratory tests also indicated that with these flows, the potential vacuum created within the chamber was negligible (<1 cm H_2O).

The automated sampling and data module was modified from Wang et al. (1999), and it consisted of a datalogger, three latching solenoid valves, a tube manifold, two electronic flow meters, a diode voltage stabilizer, and a custom-designed circuit for energizing the solenoid valves. The datalogger was programmed to control the sampling schedule for a specific experiment (Figure 2), using two channels to record the chamber and sample flow every minute. A third channel of the datalogger recorded times when the valves changed sampling position. The module was housed in a plastic weather resistant electrical box placed on top of the chamber. More detailed information about the electronic box and operation was described in Pflaum et al. (2008).

A preliminary laboratory test was conducted for recovery of fumigant emissions using the flow through chambers. A galvanized steel metal box (50.8 cm long x 25.4 cm wide x

10.2 cm deep) with an open top was covered with a high density polyethylene (HDPE) film before sealing to a flux chamber using silicone sealant and aluminum tape. A known amount of 1,3-dichlorpropene or 1,3-D (containing 52% *cis* 1,3-D and 48% *trans* 1,3-D) was injected into the box. Emission samples were collected with XAD sampling tubes (ORBO™ 613, XAD 4 80/40mg, Supelco, Bellefonte, PA) for about two days using a chamber flow of 5 L/min and a sample flow of 100 mL/min. Fumigant concentration changes in the bottom box was also monitored over time by taking gas samples and analyzed on a GC with a head space sampler. Duplicate chambers were tested and the average recovery for cis 1,3-D and trans 1,3-D was 77 and 90%, respectively. A small amount of the fumigants in the box might have subjected to degradation during the test. Additional tests are needed to determine and verify that the unaccounted 1,3-D (e.g. 23 and 10%) were degraded during the laboratory tests. The results indicated that the DFCs were able to quantitatively recover 1,3-D entering the chamber through emissions.

FIELD APPLICATION. In field applications, the DFCs were installed in soil plots to measure emissions. Figure 3 shows DFCs used in a 2007 field trial using 3.2 cm diameter vacuum plastic hose to a shop vacuum. Fresh air was drawn from 3 m above the soil surface to the DFCs through a 3.8 cm diameter PVC pipe connected to the vacuum hose. Monitoring of the inlet air indicated that fumigant concentrations were negligible from the air source.

The DFCs allow continuous overnight sampling and required less labor during a field trial as compared to using static flux chambers. Sampling time intervals are programmed. We use 3 h sampling intervals for the first 4 days, followed by 4 h and then 6 h for a two week monitoring period following fumigant injection. A chain of two sample (ORBO) tubes have been used for each sampling for the first two days to avoid fumigant break-through.

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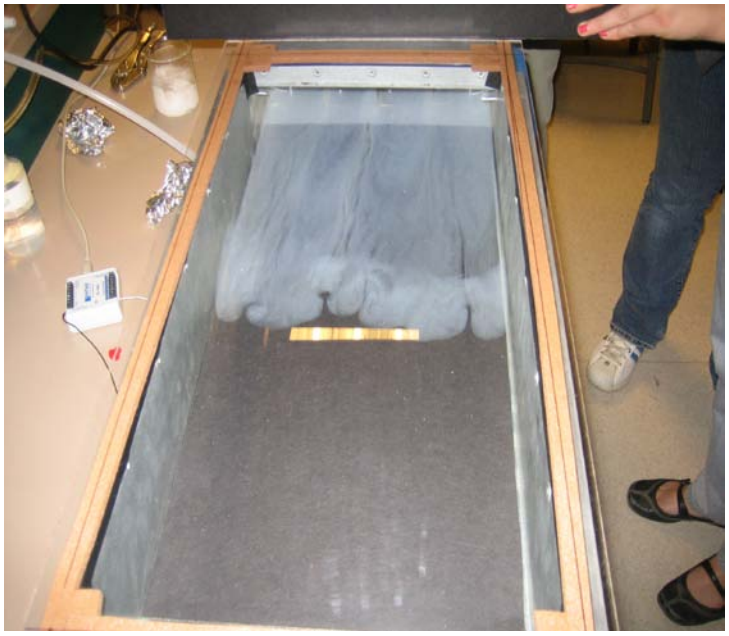

Figure 1. Smoke testing air flow uniformity in the Flow Through Chamber, which was placed upside-down and sealed with a Plexiglas sheet.

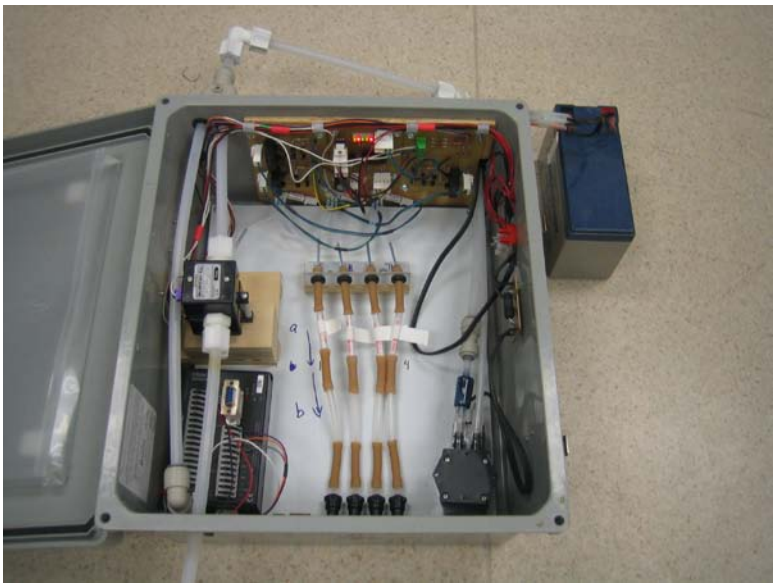

Figure 2. The Automated Sampling and Data Module consisting of a custom designed circuit for energizing latching solenoid valves, flow meters, sample tube manifold, datalogger, and a diode voltage stabilizer.

Figure 3. Field application of the Dynamic Flux Chamber System for measuring fumigant emissions.