MEASURING FUMIGANT CONCENTRATIONS AND PERSISTENCE IN SOIL WITH PID - VOC DETECTORS

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Photo ionization detectors (PID) are useful tools for detecting volatile organic compounds (VOCs). As a direct reading instrument, they use a 10.6 eV lamp and Ultraviolet (UV) light to ionize compounds that can be counted by a detector. The PID offers instantaneous readings and can be used for both short and long-term sampling, for measuring air or soil concentrations, and can detect a wide variety of VOCs. For the projects reported herein, MiniRae PID-VOC equipment (RAE Systems, Inc., Sunnyvale, CA) was purchased through the USDA ARS – South Atlantic Area Wide Project and provided to cooperators for collecting soil atmosphere samples to quantitatively determine fumigant concentrations. A broader objective was defined to study pest control and crop response inconsistencies associated with the methyl bromide alternative fumigants. For the project, calibration standards and operational protocol were developed and implemented to operate the VOC meters.

The experiments described herein involved taking soil VOC measurements of a number of chisel or drip applied soil fumigants, under a variety of plastic mulch films of differing permeability, at different locations across the mulch covered plant bed. Samples were taken at various times following fumigant application using a 6 inch long perforated soil sampling probe. Actual bed locations included bed center, midway, and bed shoulder. For most field studies, mean VOC concentrations per fumigant treatment and bed location were averaged from at least 5 to as many as 16 random measurements within each fumigant treatment and experimental field location. For these studies, peak concentration measurements from the MiniRAE 2000 over a 30 second sampling period were used to characterize soil atmosphere gas concentrations, retention characteristics of different plastic mulches over time, as well as relative differences in cross bed, gas phase movement of the different fumigants with time.

METHODS: Three field studies were conducted to evaluate soil concentrations (ppm) and dissipation of either 1) Midas 50 /50 (175 lb/ta); 2) Midas 98 /2 (88 lb/ta) or 3) Telone C35 (26 gpta) under as many as 12 different, commercially available, high barrier (semi impermeable) to virtually

impermeable (VIF) plastic mulch films. All fumigants were applied to a depth of 8 inches with standard tractor driven fumigation equipment, to either a wide bed (36" wide) via 3 chisels per bed (12 " apart) at the Ruskin site, or to narrow beds (28'' wide) via 2 chisels (14" apart) at the Dover location. Immediately following fumigant application, the different mulch films were installed over the raised plant bed and cut and or buried at the row ends. Plot lengths were 200 and 250 feet for the Ruskin and Dover locations respectively. Soil gases were monitored in plot centers beginning the day following fumigant application and soil monitoring holes covered by duct tape following soil gas measurement.

In 6 grower field trials, drip fumigation was evaluated as an end of season crop termination treatment for plant and pest control efficacy. Drip fumigation treatments included metham sodium (55 gpa), metham potassium(33 gpa), Telone EC (13 gpa), or Telone Inline (13 gpa). Assessments of strawberry plant mortality were made two to three weeks post application. Following fumigant application, soil VOC concentrations were monitored and recorded, typically on a daily basis, to determine fumigant concentration, persistence under holey plastic, and to determine differences in gas phase movement across the plant bed between specific fumigants.

Results & Discussion: In the mulch trials, VOC monitoring of soil gas concentration and persistence was able to differentiate, relative to LPDE, the general retentiveness of different gas impermeable plastic mulches to each of two fumigants (Figures 1,2). Regardless of fumigant, LDPE mulch films were always characterized as the least retentive of the mulches evaluated, with fumigants generally dissipating completely from soil within 3 days. PID-VOC monitoring was also fairly accurately, capable of differentiating between broad categories of mulch impermeability to the different fumigants. In the crop termination trials, highest relative concentrations were always observed at the bed center and point of application along the drip line. For metham sodium and potassium, soil concentrations at the bed shoulder were generally less than 10 percent of the maximum concentration observed at the bed center. Concentrations of Telone InLine were always observed at highest concentration at the bed center diminishing to a level of about 60% of maximum concentration at the bed shoulder. In these end of season crop termination trials, VOC monitoring of soil gas concentrations was able to differentiate relative differences in cross bed, gas phase movement of different drip applied fumigants. In general, summary of these data appears to demonstrate the higher gas phase diffusion capability of 1,3-D (Telone) relative to either metham sodium or potassium. There have been a limited number of studies investigating the utility of PID-VOCs. Because there have been few studies on the impact of specific compounds, or of mixtures of compounds which the PID-VOC does not differentiate, establishing toxic

(lethal concentrations) cannot be directly extrapolated from these studies. As a crop destruction treatment, the rapid disappearance and general lack of cross bed movement of some fumigant gases observed in these studies may have occurred as a result of the 18,000 existing plant holes per acre in the plastic mulch at seasons end. Inconsistencies observed in nematode control may be related not only to cross-bed movement but also to reducedpersistence of the fumigant in soil. Similarly, drip tubing which was clogged at various points in the field may also prevent uniform fumigant application and distribution.

KEY POINTS:

$ In these trials, PID-VOC monitoring was able to confirm and differentiate, relative to LDPE, broad categories of gas impermeability among plastic mulches to different fumigants.

$ In the drip fumigation crop termination trials, highest relative concentrations of any given fumigant were always observed at the bed center, always diminishing in soil concentration from the point of application along the drip tape at bed center.

$ In general, summary of these data appears to demonstrate the higher gas phase diffusion capability of 1,3-D (Telone) relative to either metham sodium or potassium.

Figure 1. Valroy Rd - Spring 2008 - Midas 98/2 (88lb/a) / Mulch Trial

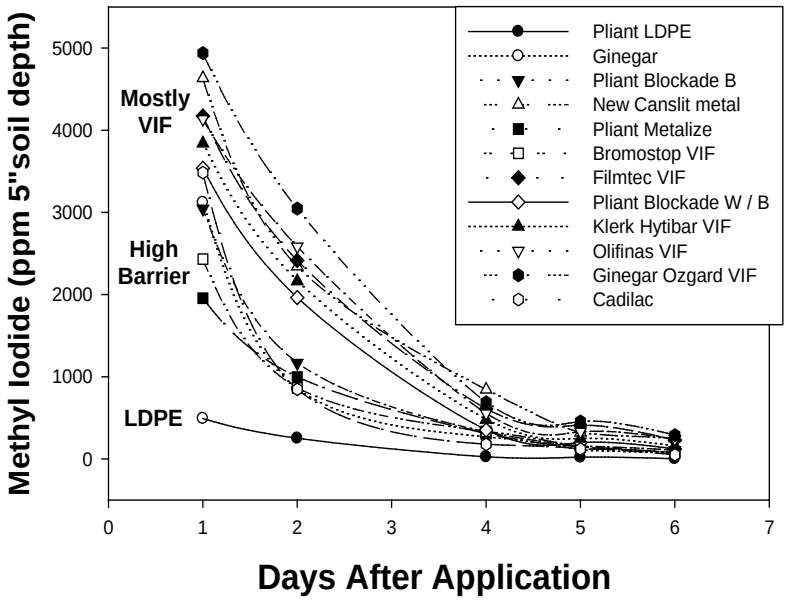

Figure 2. Telone C35 (26 gpta) -Mulch Trial
FSGA Research Farm - Fall 2008

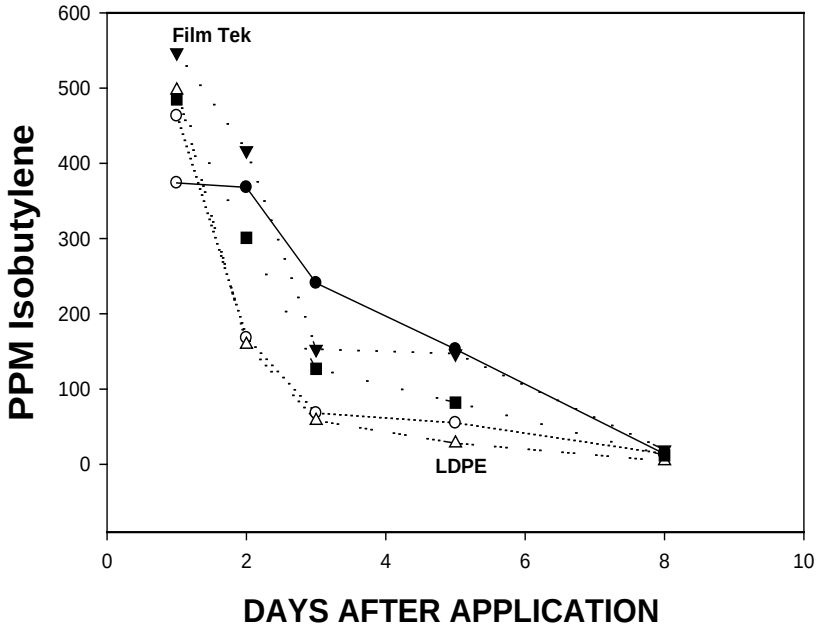

Figure 3. CG Farms Vapam HLDrip Fumigation (55 gpa) trial. Application involved 3.5 hr Injection Period to Block 12 East using 1- Queen Gil drip tape per 30" bed.

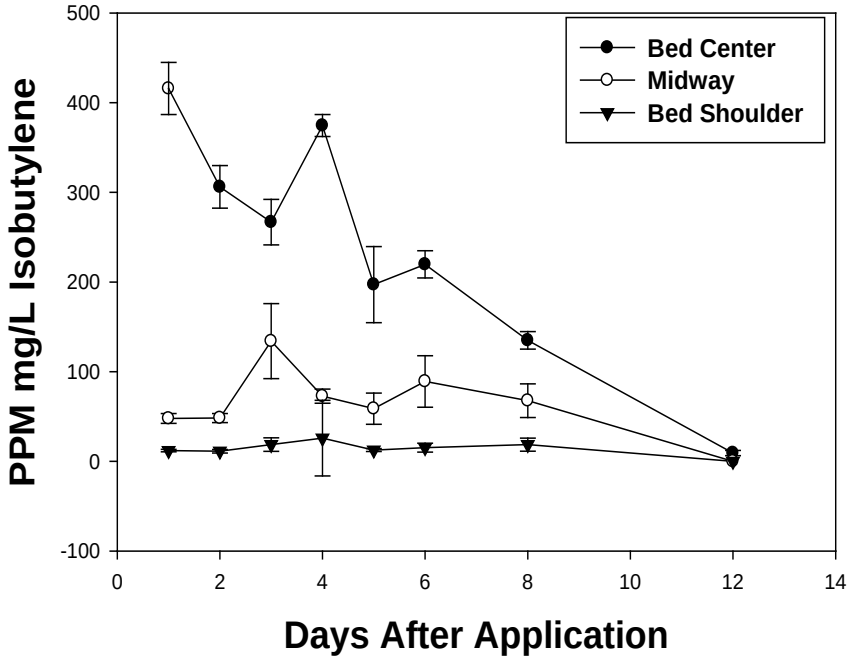

Figure 4. Cross Bed Movement of Fumigant Gases