EMISSIONS OF 1,3-DICHLOROPROPENE AND CHLOROPICRIN FROM SOILS WITH MANURE AMENDMENT AND POST-FUMIGATION WATER TREATMENT

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Application of organic materials (OM) to soil has shown effectiveness in degrading fumigants and reducing emissions of fumigants such as 1,3-dichloropropene (1,3-D) and chloropicrin (CP). Using composted manure to control fumigant emissions can be easily adopted by growers as a source of nutrients and soil amendment material. However, most research results that have shown the effectiveness of using OM to reduce fumigant emissions are based on laboratory studies. There is no conclusive information about the effectiveness of OM amendment on emission reductions from field fumigation. The objective of this research was to determine the effectiveness of soil amendment with composted manure with or without water applications on fumigant emission reductions under field conditions.

Study Method. A field trial was conducted in November 2007 at the USDA-ARS San Joaquin Valley Agricultural Sciences Center (Latitude: 36^{o} 35' 36.74" N; Longitude: 119^{o} 30' 48.71" W) at Parlier, California. The soil was Hanford sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents). During the field trial, the daily maximum, minimum and average air temperature was in the range of 16.8–23.8, 1.8–9.6 and 8.9–14.8^{o}C, respectively. The field was cultivated to 75 cm depth and irrigated two weeks before fumigation to achieve adequate soil moisture conditions for fumigation. The following treatments were applied to field plots (9 m x 3 m for OM treatment and 9 m x 9 m for irrigation treatments) with three replicates in a randomized complete block design:

1. Control
2. Manure at 12.4 Mg ha^{-1}
3. Manure at 24.7 Mg ha^{-1}
4. Manure (12.4 Mg ha^{-1}) + HDPE tarp
5. Water seals (11 mm water sprinkler applied immediately following fumigation and three subsequent applications of 4 mm water at 12, 24, and 48 h, respectively)
6. Manure (12.4 Mg ha^{-1}) plus water seals (combination of treatments 2 and 5).

Telone C35 was shank applied at 553 kg ha^{-1}. Emissions of 1,3-D and CP were monitored following fumigant injection for 10 days. Emission sampling was carried out using dynamic flux chambers by trapping the fumigants on XAD sampling tubes (ORBO™ 613, XAD 4 80/40mg, Supelco, Bellefonte, PA). The samples were extracted and analyzed for the fumigants. In addition, fumigant concentrations in the soil-gas phase, residual fumigant in soil, soil water content and soil temperature were measured either during or at the end of the field trial.

Results. Emission data showed that the control (no OM application) and the two manure treatments at 12.4 and 24.7 Mg ha^{-1} gave the highest and similar emission rates for both 1,3-D and CP for the first 4 days following fumigation. The peak emissions for these treatments were significantly higher than the other three treatments. The water application treatments with or without manure application resulted in the lowest emission rates for both 1,3-D and CP within the first 4 days. The manure + HDPE tarp treatment had 1,3-D flux values slightly higher than but not significantly different from the water treatments. Emission rates followed diurnal temperature patterns and were highest from 1200-1500 h daily and lowest around 0300 h. After emission peak, however, emission flux decreased dramatically with time for the control and manure amendment treatments, and fell below those from the water (seals) treatments. For the two water treatments, emission flux remained similar throughout the whole monitoring period. At the end of the monitoring period, the emission flux from the water (seals) treatments were significantly higher than all other treatments for both 1,3-D and CP. The manure+HDPE tarp treatment had the lowest emission flux for CP throughout the monitoring period.

The cumulative emission loss for 1,3-D over a 10-day monitoring period was highest for the control and the manure amendment at 12.4 Mg ha^{-1}, followed by the manure amendment at 24.7 Mg ha^{-1}. The cumulative emission loss for the two water treatments, and the manure+HDPE treatment was about half that of the control; but due to large field variability, the differences in cumulative emission loss was not significant among the treatments for 1,3 D (α=0.05). For CP, the cumulative emission loss from the manure+water treatment and the manure+HDPE treatment was significantly lower than the control and the two manure amendment treatments.

Water treatments resulted in higher surface soil water content and also higher residual fumigants in soil than no water application treatments. The persistence of fumigants in irrigated soils may have contributed to the relatively high emission rates observed towards end of the trial monitoring. Generally speaking, the post-fumigation water application reduced emission peaks more effectively (from about 100 μg^{-1} m^{-2} s^{-1} from the control to 20 μg^{-1} m^{-2} s^{-1}, or 80% reduction) than the cumulative emission loss (~50% reduction for both 1,3-D and CP).

This study suggested that manure incorporation at the rates of 12.4 and 24.8 Mg ha^{-1} can not adequately reduce fumigant emissions under field conditions. Much higher manure application rates may be needed to achieve emission reductions from soil fumigation. Higher manure application rates, however, may not be economically feasible for some commodities because of the associated costs.