LABORATORY MEASUREMENTS OF FUMIGANT EMISSIONS FROM AGRICULTURAL SOILS

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The increased use of methyl bromide alternatives for the pre-plant treatment of soil-borne pests has led to concern over their environmental impact when they transfer from the soil to air. The issue of bystander exposure to fumigants and the role of fumigant volatile organic compounds in the formation of near-surface photochemical smog therefore provide impetus for assessing fumigant emissions from agricultural soils. In addition to quantifying emissions, it is also necessary to evaluate strategies designed to limit the release of fumigants from soil to air. Such strategies can be broadly classed as: limitation of the transfer of fumigant gas through the soil (e.g. soil compaction, soil irrigation); limitation of the transfer of the gas across the soil-air boundary (e.g. agricultural tarps); and enhancing the rate of fumigant transformation (e.g. chemical/organic amendments to increase degradation rate). To be widely adopted, such strategies should be effective, low in cost and easily carried out by farmers.

Experimental assessment of fumigant emissions would ideally be carried out at the field scale. However, such experiments are expensive, time consuming, potentially highly variable, and limited in terms of the number of treatments that can be assessed at any one time. Laboratory experiments do not suffer from these limitations and we are therefore using large soil columns and soil chambers to study the fate and transport of soil fumigants, and the effectiveness of emission reduction strategies. Additionally, the extent to which such experiments can provide data comparable to data derived from coupled field studies is being evaluated. As such, the laboratory experiments are typically established in a way that simulates the field conditions e.g. in terms of soil profile construction, soil bulk density profile, soil moisture profile, soil temperature, treatment conditions, fumigant application and fumigant sampling regime.

The presentation will describe laboratory experiments in which the soil behavior and emissions of 1,3-D and chloropicrin have been quantified. With a deep, shank injection of 1,3-D, surface irrigation approximately halved emissions to the atmosphere. Additionally, it was demonstrated that amendment of soil with organic matter reduced emissions to around one-fifth of non-amended soil. Conditions of high organic matter, coupled with irrigation, led to lowest overall emissions due to restriction of gas diffusion towards the soil surface and a high degree of fumigant degradation. In separate laboratory experiments, the use of agricultural tarps in bed-furrow systems with drip 1,3-D and chloropicrin application also led to reductions in fumigant emissions compared to a bare soil surface. High density polyethylene and semi-impermeable film decreased emissions of both fumigants to around 55-60 % of the control levels. The vast majority of emissions in these systems occurred from the bed. Emissions from the furrow were always very low and, consequently, the use of potassium thiosulfate amendment in the furrow had no discernible effect on fumigant emissions. Comparison of the laboratory shank injection data to the data from the coupled field experiment yielded very good agreement. This suggests that laboratory systems can be established in a way that simulates field conditions and therefore offer promise as a supplement to, and possible replacement for, the field approach.