TESTING FILM PERMEABILITY TO FUMIGANTS UNDER LABORATORY AND FIELD CONDITIONS

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Plastic films are commonly used to tarp the soil surface to reduce fumigant volatilization losses. Some of the commercial films, however, are relatively permeable to fumigant vapors and a large proportion of the applied fumigant mass escapes to the atmosphere. The use of low permeability films, such as virtually impermeable films (VIF), semi-impermeable film (SIF), and metalized film, rather than standard polyethylene (PE) films can reduce fumigant emissions to the atmosphere and may improve fumigant performance. To develop realistic management practices that minimize fumigant flux to the atmosphere, film permeability must be assessed. The key to measuring the permeability of the films is to test them after field tarping. Film types and properties vary widely among manufacturers and the label does not accurately characterize film performance in the field. For example, VIF has been shown to have extremely low permeability under laboratory conditions (before tarping), but its permeability changes significantly under field conditions (after tarping). This may be due to a breakdown in the VIF properties under field conditions during tarping (i.e., stretching and cracking of the low permeability layer).
In a bedded drip-fumigation system, fumigant flux from standard high barrier film was 3 to 5 times greater than flux from VIF, and 2 times greater than flux from SIF. Therefore, the use of generic terms to describe film permeability can be misleading, and there is a need to establish accurate film permeability values that can be used to set standards for film performance and to minimize atmospheric emissions of alternative fumigants.

Film permeability to gases can be measured by a variety of standard methods. The most commonly used methods to test film permeability (i.e., ASTM D1434 and ASTM D3985) are tedious and require specialized instruments. Recently, a simple method was developed to measure film permeability by estimating the mass transfer coefficient of a fumigant across the film (Papiernik et al., 2002). This method has been tested for various PE films, SIF, and VIF and was found to produce sensitive and reproducible estimates of film permeability (Papiernik and Yates, 2002; Ha and Ajwa, 2006). However, there is a need to validate this newly developed method relative to the industry established standard methods (i.e., the ASTM D1434 or ASTM D3985 methods). Also, there is a need to determine film permeability before and after tarping to determine changes in plastic permeability and integrity under field conditions.

The objectives of this research are to: 1) collect permeability data for commercial films that are being used by strawberry and cut flower growers before and after tarping to document changes in film properties under different cultural practices and various soil and environmental conditions; 2) evaluate film permeability using the standard ASTM methods and the mass transfer coefficient method for films that will be used by researchers in the USDA-ARS, AWP strawberry and cut flower research and demonstration projects; 3) coordinate with other researchers to verify and test the two permeability measurement methods to ensure the accuracy of measurements obtained with the newly developed mass transfer coefficient method; 4) implement a stakeholder outreach plan to foster the adoption of permeability standards that will minimize fumigant emissions; and 5) provide researchers and growers with testing and extension services to determine film permeability for the alternative fumigants.

Methods

A complete setup of permeability cells was constructed and the mass transfer coefficient for some commercial films and fumigants was determined by Ha and Ajwa (2006). The proposed research will estimate film permeability for commercial tarps using the permeability cells for various fumigants before and after tarping by using a micro-gas chromatograph as described by Ha and Ajwa (2006).

Plastic films will be collected from commercial strawberry and cut flower beds after tarping along with unused samples to evaluate the effect of cultural practices on film integrity. This project will involve: 1) collecting VIF, SIF, and standard tarps from experiments outlined in the strawberry (Fennimore, PL) and cut flower (Gerik, PL) proposals to test changes in permeability and physical properties (stretching) of the film; 2) working with TriCal to evaluate gluing technology for VIF, especially determining the permeability of glued VIF joints using various glues; 3) monitoring fumigant flux through plastic in selected treatments listed in the strawberry proposal; 4) demonstrate the benefit of low permeability films in drip and shank fumigation.

In all strawberry and cupflower research and demonstration trails, film samples will be collected, labeled, archived, and shared with other researchers to compare results from analyses conducted at different laboratories to validate the methodology and to establish measurement protocols.

We will also construct an apparatus to measure film permeability following the standard industry methods (based on ASTM method) through collaboration with a local analytical laboratory. This apparatus will be used to estimate film permeability for the various fumigants. Results will then be used to validate the newly developed mass transfer coefficient method. The ASTM protocol will be outlined in the final draft of this proposal.

Potential impact of this project

This project will collect critical information on film permeability, which can be used to reduce fumigant volatilization losses from fumigated fields or would allow for reduced application rates of fumigants. The data collected can help growers to cope with upcoming stringent buffer zone and township caps requirements. This project will help validate a new film permeability method, which will allow for fast and accurate evaluation of film permeability.

References:

Ha, W., and H.A. Ajwa 2006. Plastic film permeeability to soil fumigants. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. Orlando, FL. Abstract 49, 1-3.