EVALUATING MOVEMENT OF 1, 3-DICHLOROPROPENE THROUGH PLASTIC FILMS

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The movement of soil fumigants through plastic mulch films following soil fumigation is of interest because reducing film permeability may result in increased efficacy and reduced emissions. Low-density or high-density polyethylene films (LDPE or HDPE) were reported to be permeable to soil fumigants, while virtually impermeable films (VIF) were shown to greatly reduce movement of these fumigants (Papiernik and Yates 2001). Although VIF reduces permeability and improves efficacy of fumigants (Gilreath and Chellemi 1998, Noling et al. 2001), it has not met with widespread grower acceptance for a number of reasons, primarily higher cost and poor handling characteristics. As a result, there is still a need to identify films and/or coatings for polyethylene films that will reduce movement of fumigants, but will not be as costly or difficult to handle. The method reported here was developed as a quick, simple, and inexpensive way to detect differences in film permeability.

The test chamber used is shown in Fig. 1. Details of construction materials are given in the figure. All seams were sealed with silicon adhesive and chambers tested for leaks by filling with water and allowing to stand overnight. The capacity of each chamber was 2950 ml. Telone® II (97.5% 1, 3-dichloropropene) was introduced into the lower chamber by placing 0.5 ml in a 25 ml scintillation vial and placing the vial into the bottom of the chamber. Plastic mulch films were placed between two chambers and the chambers held together tightly with hex bolts and wing nuts as shown in Fig. 1. Chambers were held outdoors in a shaded area where daytime temperatures varied, but generally ranged from about 25 - 33°C.

Concentrations of 1, 3-dichloropropene (1, 3-D) in the lower (source) chamber and upper (receiving) chamber were determined using Gastec® detection tubes (#132HA) capable of detecting 50-500 ppm of 1, 3-D. Tubes were inserted into the chambers through ¼ in brass ball valves inserted into the middle of each chamber. The opening of each ball valve was covered with vinyl electrical tape at the start of each test to minimize leakage of air into or out of the chamber when the valve was opened. A small slit was cut into the tape and the detection tube inserted into the middle of the chamber through this small slit. A Sensidyne® Gas Detection Pump (Model AP-1S) was used to draw 100 ml of air from each chamber through the detection tube.

Mulch films tested included LDPE (Pliant Co., 1.25 mil), Metalized (ReflecTec Foils, Inc., 1.25 mil), VIF (Hytibar, Klerks Plastic Co.) and a coated HDPE film from Sonoco. Several coatings provided by Randal Shogren, USDA, Peoria, IL were tested as well. Coatings were applied to LDPE film on a horizontal surface

using a paintbrush and allowed to dry. Films and coatings were tested in a completely randomized design with four replications.

Results from an initial trial are given in Fig. 2. The test was run for 6 days with 1, 3-D levels assessed at 12 hr intervals, although only the 24 hr readings are presented here. By three days, movement was near maximum for the three types of film tested. There was little change in percent of 1, 3-D in the receiving chamber after this time and subsequent tests were conducted for three days only. Amounts of 1, 3-D in the source and receiving chambers separated by LDPE film were nearly equal after three days. The metallic film was somewhat less permeable than LDPE although the differences were significant only at 1 and 2 days. VIF film did allow a small amount of 1, 3-D to move into the receiving chamber, but was significantly less permeable than the LDPE and metallic films at all evaluations.

Results from several trials are presented in Figure 3. No effort was made to include all materials tested, but results with films and coatings of interest are given. The Sonoco coated film, and two of the USDA coatings resulted in significantly reduced permeability of LDPE to 1, 3-D. Although all were somewhat more permeable than the VIF film tested initially, all show promise for improving the retention of 1, 3-D. Liquid coatings tested were applied to horizontal surfaces for these trials. Application to vertical surfaces or slightly sloped surfaces resulted in runoff of the applied materials. In order to be practical on raised beds, the adhesive properties these materials will have to be improved to avoid runoff, particularly on bed shoulders.

Although not as precise as methods presented elsewhere (Papiernik and Yates 2001), this method does appear to be adequate for identifying differences in permeability of mulch films. The method is quick and relatively inexpensive. It should have utility where a quick indication of mulch or coating permeability is desired.

References

Gilreath, J. P. and D. O. Chellemi. 1998. Gas impermeable mulch film affects pepper production. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions 1998:15-1 – 15-2.

Noling, J. W., J. P. Gilreath, and E. R. Rosskopf. 2001. Alternatives to methyl bromide field research efforts for nematode control in Florida. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions 2001:14-1 – 14-3.

Papiernik, S. K. and S. R. Yates. 2001. Transport of fumigant compounds through HDPE and Virtually Impermeable Films. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions 1998:16-1 – 16-3.

Figure 1. Diagram of chambers used for mulch permeability studies.

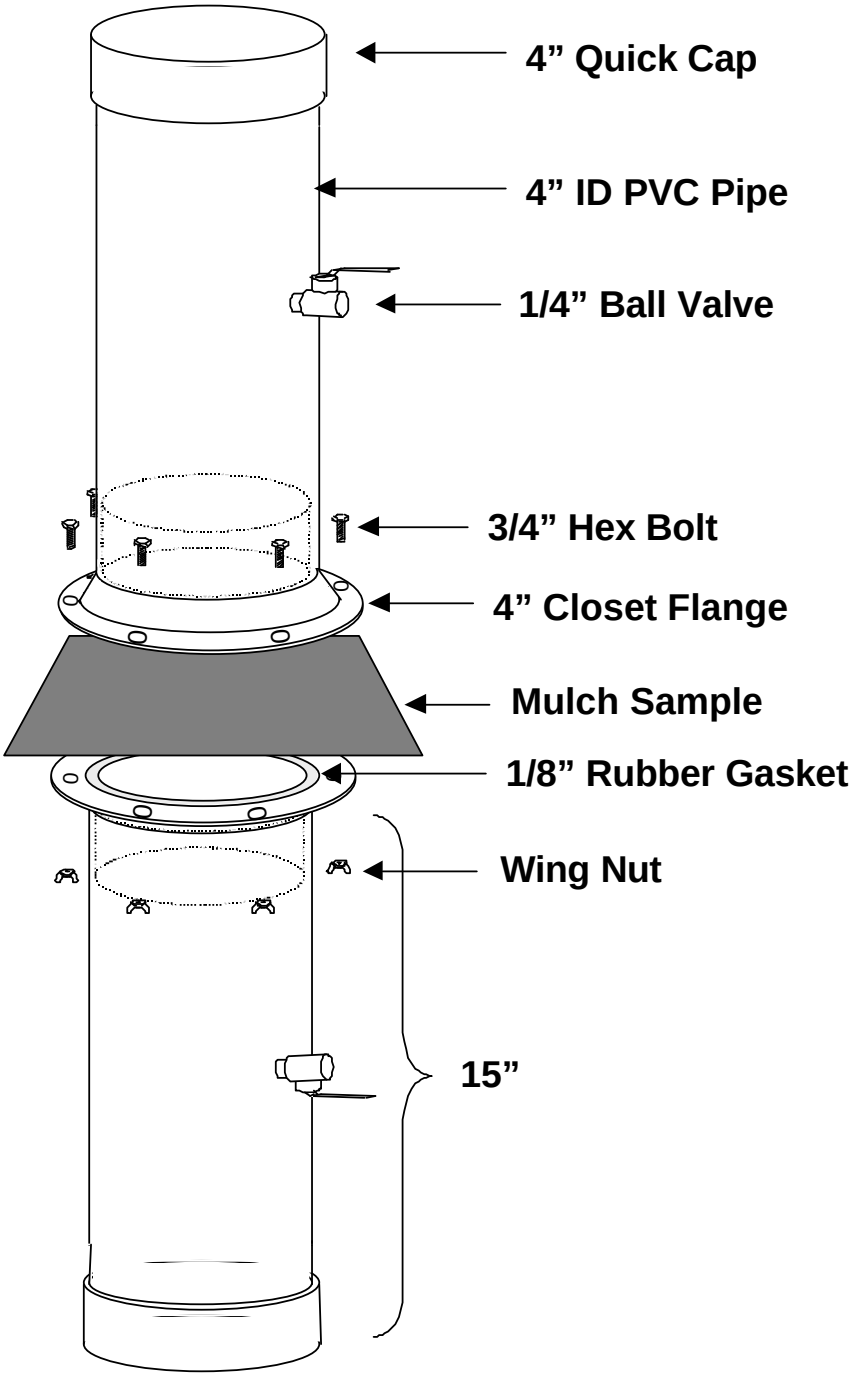

Figure 2. Relative percent of 1, 3-D vapor moving through different mulch films from the source chamber to the receiving chamber at 0-6 days after test initiation. Percent in receiving chamber = ppm in receiving chamber/ppm in receiving chamber + ppm in source chamber x 100.

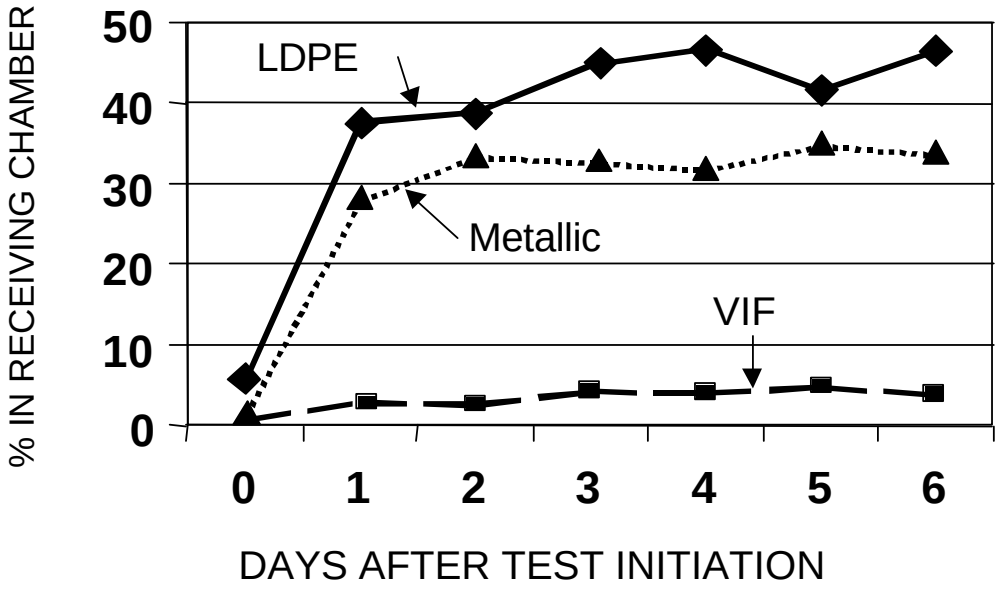

Figure 3. Relative percent of 1, 3-D vapor moving through different mulch films from the source chamber to the receiving chamber at 1-3 days after test initiation. Percent in receiving chamber = ppm in receiving chamber/ppm in receiving chamber + ppm in source chamber x 100.