SIMPLE ESTIMATION METHOD FOR FUMIGANTS GAS PERMIATION RATES BY CUP METHOD

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Methyl bromide (CH_3Br) was a major fumigant used in Japan to control soil-borne diseases in crops such as cucumbers, gingers, tomatoes, melons, green peppers, etc. The use of CH_3Br as a soil fumigant was phased out in 2005, but no new chemical or non-chemical alternative has yet been commonly used as its substitute. For now, chloropicrin, 1,3-dichloropropene and methyl isothiocyanate (MITC) and its generators (dazomet *etc.*) are seen as the best alternatives to CH_3Br. Our monitoring results of fumigants in the atmosphere during several months in horticultural areas showed that even under the current situation, fumigants such as 1,3-dichloropropene, chloropicrin and MITC of high concentration (over several hundred $\mu g/m^3$) were detected frequently, but these high concentrations were temporary, and most air samples contained several $\mu g/m^3$ of fumigants. Restrictions on CH_3Br usage required an intensive search for improved technologies to reduce both dosage and emission of alternative chemicals from fumigated plots into the atmosphere, while maintaining its effectiveness for disease and weed control and providing adequate safety for people who live and work in areas where soil fumigations occur in multiple fields.

Plastic films currently used during soil fumigation to control emissions have been shown to be permeable for fumigant vapors, resulting in appreciable losses to the atmosphere. However, for physicochemical properties of fumigants it is generally difficult to measure gas-permeability rates of fumigants accurately. Therefore, there is hardly information about gas-permeability of fumigants. To date, several measuring methods for gas-permeability rates of plastic films have been proposed. These methods need gas chromatograph equipments and specialized apparatuses. Agricultural extension agents and fumigators require simpler and easier methods to select plastic films, which are suitable for soil fumigation.

Here, we describe a simple apparatus useful for obtaining gas-permeability data, and the effect of temperature and film thickness. By reference to the liquid permeability test (JIS Z 0208), this approach improved the cup method, where a sample of film to be tested is set on the top of a stainless steel vessel (cross-section area: 5 cm^2, internal volume: ca. 15 cm^3), and the upper side is left open to allow it concentration low enough; fumigant liquids are put into vessels, gas-permeability rates are estimated from weight losses of fumigants at several temperatures for 21 hours (Fig. 1). The method was tested using conventional polyethylene and polyvinylchloride and gas-barrier films (0.05 mm thickness) listed in Table 1 and showed that the method produces a sensitive and reproducible measure of gas permeability (Table 2). The quantitative limit of gas-permeability rate, which it

depends on the balance performance, is 0.009 g/m^2/hr. The results of these experiments showed that gas-permeability of film greatly depended on temperature but was relatively constant despite changes in film thickness (Fig. 2).

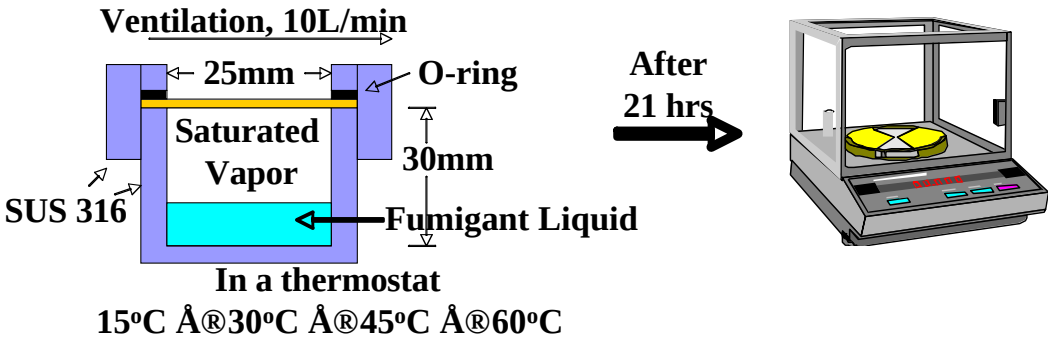
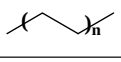
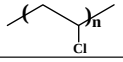
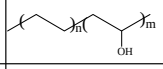
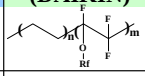
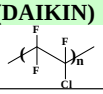
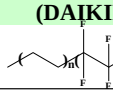
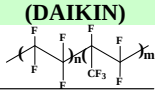


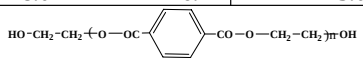
Fig. 1 Test method for determination of fumigants gas permeability rates through plastic films by the cup method

Table 1 Films and their thicknesses used for experiments

Film thickness (mm)

	PE	PVC	Deodorization (TOKAN)	BarrierStar BA (TOKAN)	Orgalloy (Elf Atochem)
			PE+α	EVOH Alloy	Polyamide Alloy
Average	0.054	0.054	0.052	0.042	0.050
CV(%)	9.43	9.01	6.40	13.43	10.62

	EVOH (C.I. Kasei)	PET (TORAY)	PFA (DAIKIN)	CTFE (DAIKIN)	ETFE (DAIKIN)	FEP (DAIKIN)
						
Average	0.063	0.049	0.048	0.058	0.053	0.048
CV(%)	8.04	6.21	5.01	7.00	8.87	5.7



(n=20)

Table 2 Reproducibility of the testing method for fumigants gas permeation rates through plastic films

methyl isothiocyanate

Polyethylene (permeable)				(g/m²/hr/50μm)
temperature(ºC)	15	30	45	60
average	17.78	36.92	108.24	224.56
CV(%)	5.85	2.13	3.96	2.41

PET (gas-tight)				
temperature(ºC)	15	30	45	60
average	0.948	1.9382	11.775	21.094
CV (%)	52.0	16.3	26.7	36.4

(n=3)

Fig. 2 trans-dichloropropene gas permeation rates through plastic films under saturated vapor condition