NEW FUMIGANTS, ECOFUME AND ECOTWIN, TO CONTROL THE INSECT PESTS IN LOG

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In Japan, 12.6 million m^3 of logs were imported from many countries in 2002. About 80% of imported logs were fumigated with methyl bromide and about 800 tons were consumed for plant quarantine treatment. Since 1995, we have studied on two new fumigants of Ecofume(methyl isothiocyanate (MITC) 30%, liquefied carbon dioxide 70%) and Ecotwin (MITC 30%, sulfuryl fuluoride (SF) 30%, liquefied carbon dioxide 40%) (Table 1) as alternatives to methyl bromide.

Ecofume

MITC which is an active ingredient of Ecofume is crystalline with high vapor pressure of 20.7 mmHg at 20 and low boiling point of 119 . It has been used for soil fumigation by injecting its oil formulation into the soil. To vaporize MITC in the air more quickly, it was dissolved in liquefied carbon dioxide in a pressurized cylinder by utilizing its property of high solubility in liquefied carbon dioxide, and sprayed into a tarpaulin by high pressure of liquefied carbon dioxide. The data in laboratory test at 15 using tarpaulin bag of 100 liter show that the gas concentration reached maximum within 1 hour after dosing of Ecofume and then the concentration reduced rapidly in a few hours because of its property of high rate of adsorption to fumigated items(Fig. 1). On the other hand, in a case of vaporizing from the filter paper immersed in ethanol solution of MITC by aeration, gas concentration remained low because of synchronous progress of the vaporization and the adsorption to fumigated items. Naked insects were highly susceptible to MITC, but insects under bark and in xylem were more tolerant. Direct exposure of MITC to naked larvae of *Monochamus alternatus* resulted in complete mortality at the dose of 0.5 g m^3, but it needed 40 g MITC m^3 to kill all the larvae in logs of Japanese pine at 15 . This difference in susceptibility ascribes to the adsorption of MITC to wood. Most of all stages of

insects under bark and in xylem were perfectly killed at lower doses than 130 g m^3 of Ecofume, but a few percent of *M. alternatus*, *Xyleborus validus, Xyleborus pfeili,* and *Xylosandrus germanus* were alive even at 130 g m^3. Applied dose of 180 g m^3 of Ecofume is required for a complete mortality considering its adsorption rate to fumigated items.

Ecotwin

SF has been examined by Dow AgroSciences as an alternative to methyl bromide, and Vikane was registered as the agricultural chemical for logs infested with forest insect pests in Japan in 2002. SF was selected as a combination partner of MITC by the following reasons; (1) High efficacy against larval, pupal and adult stages of the insects but low efficacy against egg, (2) Low boiling point of 55.2 , (3) Low rate of adsorption to fumigation items , (4) High solubility in liquefied carbon dioxide and high compatibility with MITC. Large-scale mortality tests with Ecotwin were conducted in tarpaulin(3.2 m^3) at timber yard of the local port in 2003. Papua New Guinean log(85 cm in diameter, 2 m in length without bark) infested with *Xyleborus perforans*, Japanese red pine log(15 cm in diameter, 50 cm in length with bark) infested with *X. pfeili* and *Cryphalus fulvus*, and Japanese cedar log(6 cm in diameter, 30 cm in length with bark) infested with *Callidiellum rufipenne* were fumigated at 50 g m^3 and 70 g m^3 of Ecotwin for 24 hours with 73 76%(v v) loading. Inside and outside temperatures of the tarpaulin were 18.3 21.2 (average 19.7) and 11.2 21.2 (average 15.6) during fumigation, respectively. High concentration of SF was maintained during fumigation and final gas concentration was 21.9 g m^3 at 24 hours after treatment, while gas concentration of MITC declined rapidly just after dosing by high rate of adsorption to the log and was 0.5 g m^3 at the end of fumigation of 24 hours after treatment(Fig. 2). All developmental stages of *X. perforans*, *X. pfeili*, *C. fulvus* and *C. rufipenne* were completely killed at the doses of 50 g m^3 and 70 g m^3 (Table 2). Ecotwin is expected as a possible alternative to methyl bromide for the fumigation of logs infested with forest insect pests.

Table□. General information of Ecofume* and Ecotwin*

	Ecofume	Ecotwin
Active Ingredient	Methyl Isothiocyanate 30.0%	Methyl Isothiocyanate 30.0% Sulfuryl Fluoride 30.0%
Formulation	Liquefied Carbon Dioxide Formulation in a Pressurized Cylinder	
Vapor Pressure(20□)	4.9 MPa	3.7 MPa
Dose	130□180 g/m^3	50□70 g/m^3
Recommended Target Pests	Forest Insect Pests	
Exposure Time	24 hours	
Temperature	15□	
Year Registered as Agricultural Chemicals in Japan	Dec-2000	Jan-2004
Sales	Not Yet	

*Ecofume and Ecotwin are trademarks of Yashima Sangyo.

Table 2. Mortalities of forest insect pests fumigated at 50g and 70g/m^3 of Ecotwin for 24 hours at 18.3 21.2 with 73 76% loading of log in tarpaulin.

Species	Lumber tested	Stage	Untreated Control		50g/m^3		70g/m^3	
			No. of insect tested	Mortality (%)	No. of insect tested	Mortality (%)	No. of insect tested	Mortality (%)
Xyleborus perforans (in xylem)	New Guinea wood	Egg	0	-	7	100	3	100
		Larva	19	0	158	100	122	100
		Pupa	6	0	70	100	25	100
		Adult	171	11.1	352	100	216	100
		Total	196	9.7	587	100	366	100
Xyleborus pfeili (in xylem)	Red pine	Egg	0	-	3	100	11	100
		Larva	8	0	16	100	18	100
		Pupa	4	0	4	100	0	-
		Adult	5	0	6	100	12	100
		Total	17	0	29	100	41	100
Callidiellum rufipenne (in xylem)	Cedar	Adult	19	0	24	100	20	100
Cryphalus fulvus (under bark)	Red pine	Egg	1	0	63	100	10	100
		Larva	61	0	119	100	48	100
		Pupa	1	0	5	100	1	100
		Adult	4	0	25	100	33	100
		Total	67	0	212	100	92	100

Mortality was evaluated in 7days after fumigation.

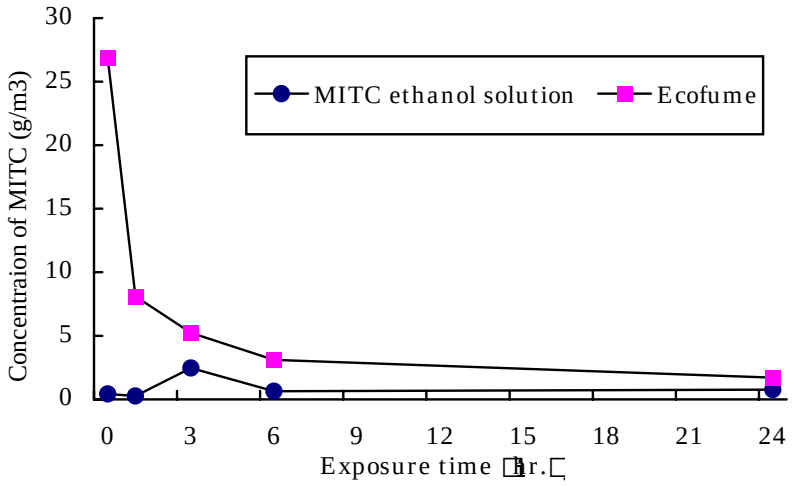

Fig. 1. The progressive gas concentrations of MITC in tarpaulin bag during fumigation of Japanese Pine log(25% loading) with Ecofume and MITC ethanol solution at the dose of 40gMITC/m^3 for 24 hours at 15 .

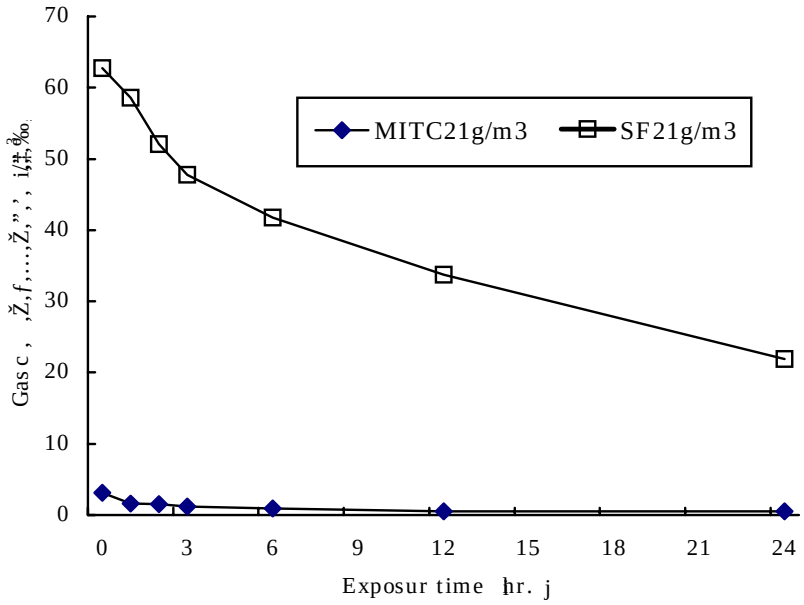

Fig. 2. The progressive gas concentrations of MITC and FS in tarpaulin during fumigation of logs(73 76 % loading) at 70g/m^3 of Ecotwin for 24 hours at 18.3 21.2 .