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Methyl Bromide(MeBr) as a Quarantine Treatment for Some Insects in Wood

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Abstract: With the risk of the spread of quarantine pests in the wood trade, an effective treatment for wood plays an important role in quarantine measures. Based on field experiments, confirmatory fumigations were carried out using methyl bromide(MeBr). For wood fumigation under tarpaulins, experiments were conducted at doses of $\geqslant 48g/m^3$, with a 16 hour exposure time when treatment temperatures were above 15℃; and when treatment temperatures were above 27.5℃, the MeBr dose was adjusted to $\geqslant 32g/m^3$ with a 24 hour exposure time. All larvas of beetles and insects (belonging to Scolytidae) were completely killed. In a fumigation chamber, the following MeBr doses were used; 80 g/m^3 (5 – 10℃), 64 g/m^3 (11 – 15℃) and 48 g/m^3 ($\geqslant$16℃) in which all trial insects were completely killed.

Key words: methyl bromide, wood, fumigation, Cerambycidae, *Scolytidae*

Introduction

All logs imported into China, from various parts of the world, are covered with bark and are potential sources for quarantine pests being introduced into our country. Wood-boring beetles (*Cerambycidae*) and some insects (mainly belong to *Scolytidae*) are very damaging pests. Potentially, they are a serious threat to our forests, lumber, and the esthetic and dollar values of properties and to the diversity of tree species in the forest environment.

Currently, according to ISPM15, methyl bromide fumigation and heat treatment are the only two treatment methods allowed for regulated wood packaging material. As methyl bromide(MeBr) is permeable through timber, it is capable of the eradication of all beetles and wood-boring insects. Here we report the results of wood fumigation with MeBr, which included land tarpaulin fumigation, railway wagon fumigation, and shipboard container fumigation.

Materials and Methods

Imported timbers tested were larchwood, silver birchwood and sprucewood from Russia, cherrywood and beechwood from European Union countries. Within these timbers, larva, pupa and adults of the following insects are likely to be found; *Monochamus*, *Ips subelongatus* Motsch., *Ips typographus* Linnaeus., *Scolytus ratzeburgi* Jans and *Tetropium castaneum* Linnaeus. The moisture contents were in the range of 29.2% – 55.1%.

Materials: new polyethylene (PE) sheeting, thickness > 0.15mm; double – face glued tarpaulin, length16.5m, width 6.2m, thickness 0.3 – 0.4mm; railway wagons, length 12.4m, width 2.8m, high 2.0m; transport containers, 40 feet.

Fumigant: MeBr packed in 40kg pressurised steel cylinders, purity 98%, made by Jiangsu Lianyungang Dead Sea Bromine Compounds.

Fumigant concentration testing: the XK – III, thermal conductivity instrument of Chinese manufacture (CPQ Technology Company, Animal and Plant Quarantine Institute, Beijing, People's Republic of China); the American made Fumiscope (Key Chemical, Clearwater, FL); 10s50, portable gas chromatograph; MiniRAE 2000 VOC detector, made by RAE systems inc.

Method: The fumigation procedures were carried out according to two standards (SN/T1123 – 2002 and SN/T1124 – 2002) of China quarantine treatment code.

When fumigating wood stacks under tarpaulins or railway wagons they were sited on flat ground at a minimum distance of 50m from any habited area. The wood stacks were constructed in an orderly pile me with a measured volume less than $300m^3$. The volume of the railway wagon was $120m^3$. The moisture content of the wood in each stack was tested and recorded.

For every stack two appropriately marked sampling tubes were inserted. One was in the centre of the stack and the other was placed un-

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der the bark of an insect ridden log.

When sealing the log stacks a piece of canvas was placed on the corners of the stack to protect the PE sheeting against tearing. The system was sealed with the use of sandbags around the periphery of the stack. The transport and railway containers were checked for cracks and sealed with strong adhesive tape.

Fumigation: the fumigant doses were computed volumetrically by calculating the volume of the required grams of MeBr gas with the $V = nRT/P$ relationship. When the gas application was finished, chamber recirculation fans were turned on for 0.5h to enhance the distribution of the MeBr though the fumigated area.

Fumigant Concentration measurement: Fumigant concentrations were monitored after 0.5, 2, 4, 8 (or 12), 16 and 24 hours by using a thermal conductivity (TC) instrument, the XK – III, which was functionally similar to the American made Fumiscope.

Aeration/Ventilation: After 24 hours, the covered sheets were removed or the container doors were opened and the fumigated area was aerated for 30 min.

Environmental measurements: During the introduction of the fumigant and during the fumigation and aeration period, a VOC detector monitored gas leak around the treatment areas and 1m, 10m, 30m and 50m down wind from the stack or container.

Insect mortality: All larva were counted and evaluated after fumigation. Larvae were considered dead if they were limp and showed no movement. Larvae that were turgid or had body movement were considered alive.

Results and Conclusion

Tarpaulin Fumigation

The results show that when the treatment temperature was above 15℃, MeBr fumigant dose $\geqslant 48g/m^3$, and with an exposure time 16 hours, and a concentration $\geqslant 35.5g/m^3$ before aeration, all larva of beetles and insects (belong to Scolytidae) can be completely killed (Table 1). When treatment temperature is above 27.5℃, a MeBr dose of $\geqslant 32g/m^3$, with an exposure time 24 hours, and a concentration of $\geqslant 19g/m^3$ before aeration, the mortality of insects was 100% (Table 1).

Table 1. Data of tarpaulin fumigation

Exposure time, h	Dose (g/m^3)	Stack number	Volume m^3	Concentration (g/m^3) 0.5	2	4	12	16	24	Exposure temperature, ℃/relative humidity	Mortality%
12	48	3	120	77	73	49	46	---	---	15 – 29℃	100
		12	170	60	47	44	41	---	---	42 – 80%	100
	64	5	225	75	69	61	42	---	---	15 – 29℃	100
		4	50	80	53	42	34	---	---	42 – 80%	100
	80	1	38	107	94	92	63	---	---	15 – 29℃	100
		2	115	106	104	85	70	---	---	42 – 80%	100
16	48	6	126	84	77	63	55	39	---	15 – 29℃	100
		7	115	67	50	49	44	32	---	42 – 80%	100
	64	10	430	85	70	64	63	54	---	15 – 29℃	100
		11	18	90	83	76	68	47	---	42 – 80%	100
	80	8	235	119	105	102	91	77	---	15 – 29℃	100
		9	207	122	114	83	78	70	---	42 – 80%	100
24	48	14	114	74	70	67	54	48	27	15 – 29℃	100
		13	600	87	83	71	65	56	40	42 – 80%	100
	64	17	225	114	108	97	93	76	35	15 – 29℃	100
		18	54	139	130	108	90	78	48	42 – 80%	100
	80	15	56	140	135	132	120	94	65	15 – 29℃	100
		16	85	122	120	102	97	88	57	42 – 80%	100
	48	1	888	87	74	71	68	56	34	27.5 – 43℃	100
		2	684	98	91	79	70	66	37	51 – 84%	100
	32	3	1440	70	69	55	50	34	21	27.5 – 43℃	100
		4	3490	78	76	62	55	41	17	51 – 84%	100

Environmental Air Testing

Testing of the environmental air during exposure and aeration period showed that there was some gas leakage. The result indicated that the greater the distance from the fumigation facility, the lower fumigant concentration. 30m from the fumigated stack can be regarded as a safe distance.

Container Fumigation

The container fumigation results showed that all the indicated MeBr dosages and exposure time options can completely kill the trial insects. Especially 5 – 10℃ & 80g/m^3, 11 – 15℃ & 64 g/m^3 and ≥16℃ & 48 g/m^3 MeBr can completely kil all beetles and insects (belonging to Scolytidae). The average MeBr concentrations were 49.3 g/m^3, 42.1 g/m^3 and 33.2 g/m^3 before aeration in above three dosages (Table 2).

Table 2. Data from container fumigation

Temperature (℃)	Dose (g/m^3)	Repeat	Concentration (g/m^3) 0.5h	2h	4h	8h	16h	24h	Insect samples	Mortality
5 – 10	80	1	102.0	90.7	79.2	69.3	57.7	—	17	100
		2	90.1	83.3	69.6	54.3	41.1	—	21	100
		3	110.0	93.0	82.1	70.7	—	49.2	34	100
		4	127.0	97.7	85.3	69.2	—	50.5	25	100
11 – 15	64	1	94.7	84.3	69.2	56.5	45.9	—	27	100
		2	80.7	77.8	68.5	50.9	38.2	—	19	100
		3	105.2	86.2	72.1	55.7	—	37.2	28	100
		4	96.0	87.6	81.0	69.3	—	49.3	40	100
	80	1	137.7	110.0	97.2	76.2	64.2	—	34	100
		2	129.7	108.3	87.8	67.4	56.7	—	30	100
		3	125.5	95.7	83.7	71.3	—	53.2	23	100
		4	105.5	92.1	82.3	73.3	—	48.3	19	100
16 – 20	48	1	86.2	76.7	57.7	45.2	36.6	—	24	100
		2	80.2	69.2	50.1	38.1	29.8	—	34	100
		3	90.1	82.0	62.5	48.3	—	25.0	26	100
		4	87.7	79.1	64.2	50.7	—	27.2	31	100
	64	1	97.6	88.7	76.6	57.0	44.0	—	29	100
		2	100.7	80.6	67.7	48.1	36.6	—	16	100
		3	101.2	86.0	72.2	51.5	—	32.5	44	100
		4	105.0	92.0	78.0	59.6	—	37.7	32	100
	80	1	119.3	101.6	81.1	70.6	59.7	—	22	100
		2	106.4	97.0	78.1	65.5	44.3	—	31	100
		3	117.0	97.5	82.7	69.3	—	55.4	34	100
		4	123.0	107.2	92.3	67.7	—	42.4	28	100
>21	48	1	93.7	76.5	63.3	48.6	40.8	—	29	100
		2	87.7	70.5	58.6	43.4	35.4	—	24	100
		3	97.3	80.0	67.3	50.2	—	38.2	22	100
		4	86.2	73.6	64.0	46.5	—	25.1	33	100
	64	1	115.0	92.7	80.2	72.5	48.6	—	30	100
		2	102.4	85.5	71.8	63.7	40.1	—	30	100
		3	100.0	87.0	72.3	65.5	—	39.0	19	100
		4	93.7	82.5	70.2	62.3	– –	35.5	19	100

Discussion

There is no doubt that proper MeBr dosage and enough exposure time can completely kill beetles and insects (belonging to Scolytidae) larva. But, there are some points we should notice. Ambient air and wood humidity was high. Difference in temperature between day and night at the colder temperatures resulted in the formation of large amounts of ice. Some pieces of wood released a noticeable quantity of CO_2. All above factors influence the readings on the gas detector, leading to data instability. After several trials, we found that the average moisture of the wood was > 20%, and the relative humidity in fumigation space was 42% – 84%. We used desiccant and CO_2 sorbent to make the data more uniform and the trial more reliable.

Although fumigant concentration is low in the fumigation area, care should be taken that fumigation team members operate environmental MeBr gas monitoring instruments and wear a full-face mask with the correct filter and clothing to cover exposed skin.

Currently MeBr is regulated internationally through acceptance of the Montreal Protocol of 1998. Much research has been directed toward MeBr alternatives and the reduction and recovery of MeBr.

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