Res. Bull. Pl. Prot. Japan No. 39: 1～6 (2003)

Effects of Methyl Iodide on Mortality of Forest Insect Pests

Hiromitsu Naito, Mutsuro Goto, Noboru Ogawa,
Yukihiro Soma and Fusao Kawakami

Chemical & Physical Control Laboratory, Research Division,
Yokohama Plant Protection Station

Abstract: Each stage of nine species of forest insect pests (*Callidiellum rufipenne, Monochamus alternatus, Semanotus japonicus, Cryphalus fulvus, Ips cembrae, Xyleborus pfeili, Xylosandrus germanus, Pissodes nitidus and Shirahoshizo rufescens*) were fumigated with methyl iodide (MI) at 5, 10, 15, 30 and 50 g/m^3 for 24 hours at 15℃ with approximately 25% loading. Egg stages of five species of the pests were killed completely at 5 − 10 g/m^3 of MI, while larval and pupal stages of all species of the pests under bark and in xylem and artificial diet were also killed completely at 30 g/m^3 except for *C. rufipenne, M. alternatus* and *S. rufescens*. A 100% mortality of all stages of the pests except for *C. rufipenne* larvae in xylem were obtained at 50 g/m^3. MI would be a high potential fumigant for imported logs infested with various species of forest insect pests.

Key words: quarantine treatment, fumigation, methyl iodide, forest insect pests

Introduction

Methyl bromide (MB) was listed as an ozone depleting substance in the Fourth Meeting of Montreal Protocol in November 1992. It was determined that the domestic production and consumption from 1995 was frozen at 1991 levels with the exception for plant quarantine and pre-shipment. It was further requested to make every effort to reduce emission as much as possible in plant quarantine purpose (Tateya, 1993).

Therefore, we have engaged in the development of alternatives to MB and its reduction in plant quarantine because of protection of the Ozone Layer (Kawakami, 1999). As for quarantine treatment of imported timbers, phosphine fumigation alone (Oogita *et al.,* 1997), sulfuryl fluoride fumigation alone (Soma *et al.,* 1996, 1997; Mizobuchi *et al.,* 1996), methyl isothiocyanate fumigation alone (Naito *et al.,* 1999) and these gas mixtures fumigation (Soma *et al.,* 1998; Soma *et al.,* 1999) have been used for the test in the past several years in Japan.

Methyl iodide (MI) fumigant has been also used for the test. MI is a colorless, noncombustible liquid with characteristic odour, with boiling point of 42.5℃, relative vapor density in air of 4.9, solubility in a 100 m*l* of water of 1.4 g at 20℃ and vapor pressure of 50 kPa at 20℃, and turns brown on exposure to light and moisture (ILO, 1999). It is not considered an ozone depleter (ozone depletion potential＝0.016) because it has an atmospheric residence time of only 4 to 8 days compared with 2 years for MB (Albritton and Watson, 1992; Zhang *et al.,* 1997).

Here we report a result of mortality test for forest insect pests by MI fumigation.

Materials and Methods

Test insects

Callidiellum rufipenne (MOTSUCHULSKY): Adults were collected from infesting Japanese cedar and Japanese cypress logs in the forest in Hyogo Prefecture in April to May 2001 and 2002 and then transported to the Research Division of Yokohama Plant Protection Station. These adults were reared on cedar logs using almost the same method (SOMA *et al.,* 1996) as described by MAKIHARA (1991) and obtained the developmental stages of eggs and larvae.

Monochamus alternatus HOPE: Infesting Japanese red pine logs were collected in Ibaraki Prefecture in March to October 2001 and 2002 and then transported to the Research Division of Yokohama Plant Protection Station. Emerged adults were allowed to mate for 24 hours in the cage with red pine twigs and then allowed to oviposite for 1–7 days. The eggs were maintained under the same conditions to obtain the desired stages.

Semanotus japonicus (LACORDAIRE): Adults were collected with band traps attached to living Japanese cedars in Tochigi Prefecture in April 2001 and 2002. Egg, larval and pupal stages were obtained by the same rearing method as *C. rufipenne* and provided for the test.

Cryphalus fulvus NIIJIMA: Infesting Japanese red pine branches and twigs were collected in Iwate Prefecture in April to May 2001 and 2002 and then transported to the Research Division of Yokohama Plant Protection Station. They were putted in the plastic container box with small red pine logs and stored at 25℃, 70% R. H., 16L : 8D photoperiod. These logs with eggs, larvae, pupae and adults were provided for the test.

Ips cembrae (HEER): Infesting Japanese larch logs (15–20 cm diameter, 50 cm long) were collected in Hokkaido Prefecture in May 2001 and 2002 and then transported to the Research Division of Yokohama Plant Protection Station. They were putted in the mesh bags with larch or red pine logs (10–15 cm diameter, 50 cm long) and maintained at out side of the laboratory. These logs with larvae, pupae and adults were provided for the test.

Xyleborus pfeili RATZEBURG: Adults were collected in Aichi Prefecture and reared with artificial diet using the same method (MIZOBUCHI *et al.,* 1996) as described by (MIZUNO *et al.,* 1997). Eggs, larvae, pupae and adults were provided for the test.

Xylosandrus germanus (BLANDFORD): Japanese cedar and acer with eggs, larvae, pupae and adults were collected in Hyogo Prefecture in June to October 2001 and then transported to the Research Division of Yokohama Plant Protection Station.

Pissodes nitidus ROELOFS: Adults were collected in Iwate Prefecture in April to May 2001 and 2002. Mated adults allowed to oviposite on the red pine logs (3–5 cm diameter, 25 cm long) for 1–7 days and maintained for appropriate periods for obtaining eggs, larvae and pupae at the Research Division of Yokohama Plant Protection Station.

Shirahoshizo rufescens (ROELOFS): Japanese black pine logs and red pine logs with larvae were collected in Hyogo Prefecture and Chiba Prefecture in May to October 2001 and 2002 and then provided for the test at the Research Division of Yokohama Plant Protection Station.

Fumigation

Fumigation was conducted by using 29.5 and 100 *l* fiber-glass boxes with the same equipments described by SOMA *et al.* (1996).

Eggs on the filter paper, all stages of *X. pfeili* in artificial diet and infesting logs with eggs, larvae, pupae and adults were placed in the fumigation box with filler logs and then fumigated with MI at doses of 5, 10, 15, 30 and 50 g/m^3 with approximately 25% loading for 24 hours at 15℃.

Liquid MI was collected by a gas-tight syringe from a phial of MI (purity; 99% or more) and introduced on a piece of paper in the petri dish. MI was not heated because of a rapid vaporization. Air circulation fan was kept on for 24 hours. Gas concentrations during fumigation were monitored with gas chromatograph (GC-8AIF and 14B with FID: Shimadzu) at time intervals of 0.5, 1, 2, 3, 6 and 24 hours after commencement of fumigation. Temperatures were also monitored with multi-channel automatic temperature recorder (Hybrid Recorder: AH, Chino) during fumigation. After fumigation, the air–fumigant mixture was exhausted for about 3 hours by the exhauster.

Evaluation of mortality

Fumigated and untreated control insects and logs were stored at 25℃ for eggs of *C. rufipenne, M. alternatus* and *S. japonicus* and at ambient temperature for other stages of the pests tested, respectively.

The mortality of eggs of *C. rufipenne, M. alternatus* and *S. japonicus* were evaluated by hatching after 14 days. Another stages of *C. rufipenne, M. alternatus* and *S. japonicus* and all stages of *C. fulvus, I. cembrae, X. pfeili, X. germanus, P. nitidus* and *S. rufecens* were

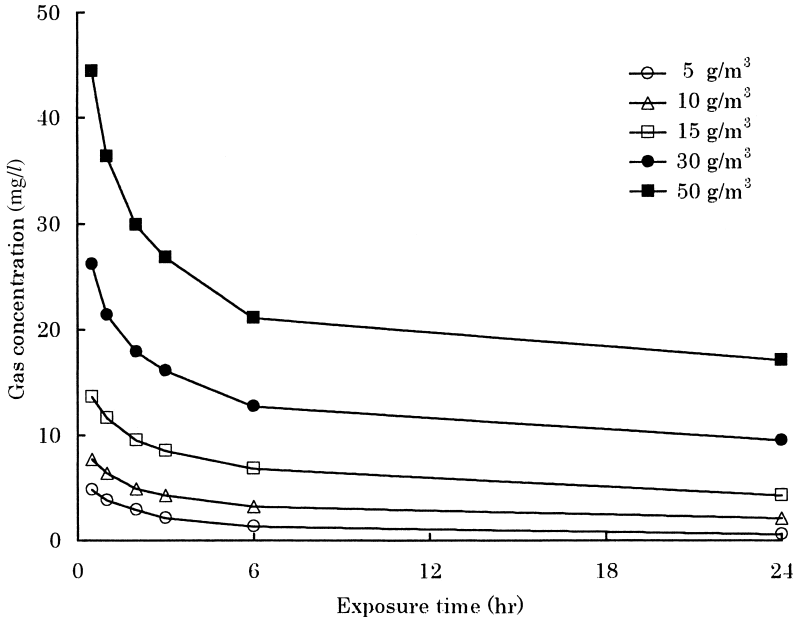

Fig. 1. Progressive gas concentrations during fumigation with methyl iodide at 5, 10, 15, 30 and 50 g/m^3 for 24 hours at 15℃ with approximately 25% loading (v/v).

confirmed their survivors (hatched larvae, emerged adults) by barking, chopping or dissecting logs and artificial diet after 14 or 19 days.

Results and Discussion

Progressive gas concentration

Figure 1 shows progressive gas concentrations fumigated at several doses for 24 hours at 15℃ with approximately 25% loading. Gas concentrations reduced rapidly within one to three hours after the commencement of fumigation and ratios of residual MI gas (gas concentration at the end of fumigation/applied dose×100) after 24 hours was as low as 12–37% (25.8% on the average). The low ratio shows that MI as a fumigant would be highly absorbed to the log.

Table 1. Mortalities of all stages of 9 species of forest insect pests fumigated with MI at doses of 5, 10, 15, 30 and 50 g/m^3 for 24 hours at 15℃ with approximately 25% loading (v/v).

Species	Stage	*n*	Mortality (%)				
			5 g/m^3	10 g/m^3	15 g/m^3	30 g/m^3	50 g/m^3
Callidiellum rufipenne	Egg on paper	548	100	100	100	—	—
	Larva under bark	523	—	100	100	100	100
	Larva in xylem	75	—	—	—	96.8	95.5
Monochamus alternatus	Egg under bark	39	—	—	—	100	—
	Larva in xylem	67[1)]	—	—	63.3	85.7	100
	Pupa 〃	16[1)]	—	—	62.5	80.0	100
Semanotus japonicus	Egg on paper	895	99.6	100	100	100	—
Cryphalus fulvus	Egg under bark	43	—	100	—	100	100
	Larva 〃	432[2)]	—	100	100	100	100
	Pupa 〃	196[2)]	—	92.3	100	100	100
	Adult 〃	395[2)]	—	100	100	100	100
Ips cembrae	Larva under bark	48	—	—	—	100	—
	Pupa 〃	39	—	—	—	100	—
	Adult 〃	29	—	—	—	100	—
Xyleborus pfeili	Egg in artificial diet	59	—	100	100	—	100
	Larva 〃	580	—	100	100	100	100
	Pupa 〃	227	—	100	100	100	100
	Adult 〃	536	—	100	100	100	100
Xylosandrus germanus	Egg in xylem	11	—	—	—	—	100
	Larva 〃	100	—	—	—	100	100
	Pupa 〃	39	—	—	—	—	100
	Adult 〃	392	—	—	—	100	100
Pissodes nitidus	Egg under bark	598[2)]	99.4	100	100	—	100
	Larva 〃	710[2)]	—	99.3	100	100	100
	Pupa 〃	263	—	99.1	98.8	100	—
Shirahoshizo rufescens	Larva under bark	234[2)]	—	85.7	88.6	92.9	100

[1)] Evaluation was conducted after 19 days.
[2)] The number of test insects was estimated by untreated control.

Effects of MI fumigation

Table 1 shows the mortality of all stages of 9 species of forest insect pests.

Egg stages of 5 species of the pests were completely killed at 5–10 g/m^3 of MI, while larval and pupal stages of all species of the pests under the bark and in xylem and artificial diet were also completely killed at 30 g/m^3 except for *C. rufipenne, M. alternatus* and *S. rufescens*. A 100% mortality of all stages of the pests tested except for *C. rufipenne* larvae in xylem were achieved at 50 g/m^3 for 24 hours at 15℃ with approximately 25% loading.

MI fumigation showed a high efficacy against all stages of forest insect pests, especially ambrosia beetles such as *X. pfeili, X. validus, Platypus calamus* which were more tolerant to phosphine fumigation (OOGITA *et al.,* 1997), sulfuryl fluoride fumigation (MIZOBUCHI *et al.,* 1996) and MITC fumigation (NAITO *et al.,* 1999). MI would be a high potential fumigant for imported logs infested with various species of forest insect pests.

References Cited

ALBRITTON, D. L. and R. T. WATSON (1992) Methyl Bromide and the Ozone Layer: A Summary of Current Understanding. In: Montreal Protocol Assessment Supplement, pp. 1–19. UNEP, Nairobi, Kenya.

INTERNATIONAL LABOR ORGANIZATION (1999) International Chemical Safety Cards: 0509. Methyl Iodide.

KAWAKAMI, F. (1999) Current Research of Alternatives to Methyl Bromide and its Reduction in Japanese Plant Quarantine. *Res. Bull. Pl. Prot. Japan* **35**: 109–120.

MAKIHARA, H. (1991) Cryptomeria bark borer. In: Rearing methods of Insect. (K. YUSHIMA, S. KAMANO and K. TAMAKI, eds.), Tokyo: Japan Plant Protection Association, pp. 264–266 (in Japanese).

MIZOBUCHI, M., I. MATSUOKA, Y. SOMA, H. KISHINO, S. YABUTA, M. IMAMURA, T. MIZUNO, Y. HIROSE and F. KAWAKAMI (1996) Susceptibility of Forest Insect Pests to Sulfuryl Fluoride. 2. Ambrosia Beetles. *Res. Bull. Pl. Prot. Japan* **32**: 77–82.

MIZUNO, T., S. FUJIWARA and M. MATSUDA (1997) Rearing of Ambrosia Beetle, *Xyleborus pfeili* (RATZEBURG) on Artificial Diet. *Res. Bull. Pl. Prot. Japan* **33**: 81–85 (in Japanese).

NAITO, H., Y. SOMA, I. MATSUOKA, T. MISUMI, T. AKAGAWA, M. MIZOBUCHI and F. KAWAKAMI (1999) Effects of Methyl Isothiocyanate on Forest Insect Pests. *Res. Bull. Pl. Prot. Japan* **35**: 1–4 (in Japanese).

OOGITA, T., Y. SOMA, M. MIZOBUCHI, Y. ODA, I. MATSUOKA, and F. KAWAKAMI (1997) Mortality tests for Forest Insect Pests by Phosphine Fumigation. *Res. Bull. Pl. Prot. Japan* **33**: 17–20.

SOMA, Y., S. YABUTA, M. MIZOBUCHI, H. KISHINO, I. MATSUOKA, M. GOTO, T. AKAGAWA, T. IKEDA and F. KAWAKAMI (1996) Susceptibility of Forest Insect Pests to Sulfuryl Fluoride. 1. Wood Borers and Bark Beetles. *Res. Bull. Pl. Prot. Japan* **32**: 69–76.

SOMA, Y., M. MIZOBUCHI, T. OOGITA, T. MISUMI, H. KISHINO, T. AKAGAWA and F. KAWAKAMI (1997) Susceptibility of Forest Insect Pests to Sulfuryl Fluoride. 3. Susceptibility to Sulfuryl Fluoride at 25℃. *Res. Bull. Pl. Prot. Japan* **33**: 25–30 (in Japanese).

SOMA, Y., T. OOGITA, T. MISUMI and F. KAWAKAMI (1998) Effect of Gas Mixtures of Sulfuryl Fluoride and Phosphine on Forest Insect Pests. *Res. Bull. Pl. Prot. Japan* **34**: 11–14 (in Japanese).

SOMA, Y., H. NAITO, T. MISUMI and F. KAWAKAMI (1999) Effects of Gas Mixtures of Sulfuryl Fluoride and Methyl Bromide on Forest Insect Pests. *Res. Bull. Pl. Prot. Japan* **35**: 15–19 (in Japanese).

TATEYA, A. (1993) Methyl Bromide Use as Fumigants and Protection of the Ozonosphere. *Plant Protection* **47**: 193–195 (in Japanese).

ZHANG, W. M., M. E. MCGIFFEN, Jr., J. O. BECKER, H. D. OHR, J. J. SIMS and R. L. KALLENBACH (1997) Dose Response of Weeds to Methyl Iodide and Methyl Bromide. *Weed Research* **37**: 181–189.

和 文 摘 要

木材害虫に対するヨウ化メチルの殺虫効果

内藤浩光・後藤睦郎・小川　昇・相馬幸博・川上房男
横浜植物防疫所調査研究部消毒技術開発担当

9種木材害虫の各態を供試してヨウ化メチルくん蒸（薬量 5, 10, 15, 30 及び 50 g/m^3, 15℃, 24 時間，収容比約 25%）を行い，殺虫効果を調査した。5 種害虫の卵態は 5〜10 g/m^3 で完全に殺虫された。9 種害虫の幼虫及び蛹は *Callidiellum rufipenne, Monochanus alternatus* 及び *Shirahoshizo rufenscens* を除いて 30 g/m^3 で完全に殺虫された。最多薬量の 50 g/m^3 では，樹皮下及び材中の幼虫及び蛹は *C. rufipenne* の幼虫を除き完全殺虫された。ヨウ化メチルは木材害虫の各態に高い殺虫効果を示し，多種類の害虫が寄生する輸入木材に対するくん蒸剤として高い可能性が示唆された。