THE EFFICACY OF ETHANEDINITRILE TO CONTROL WOOD RELATED INSECT PESTS

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The use of fumigants is the economical and practical method to control stored grain pests, quarantine pests, soil borne pathogens and nematodes. For quarantine purpose, all perishable and durable commodity pests have been fumigated mainly with methyl bromide (MeBr). Under the Clean Air Act and Montreal Protocol on ozone depleting, the use of MeBr as soil fumigant (73% of global MeBr consumption in 2000) is restricted and under scheduled phasing out by 2005 in developed counties and 2015 in developing counties, although there are exemptions for QPS (Quarantine and Pre-shipment) and CUE (Critical Use Exemption). Since MeBr phase out schedule, 72,967tonne of global consumption of MeBr including QPS decreased to 30,030t in 2005. This decrease is mainly due to MeBr alternatives in soil not in QPS. MeBr in QPS use is increasing (16,304t in 2005, approximately 8.7% increase based on 1996) because of increasing of global trades and protection of agro-ecosystem in imported counties against quarantine pest. There are few chemical alternatives commercially available to control wood related pest. Sulfuryl fluoride (SF) is comparative to MeBr in terms of effectiveness and has been extensively studied against various timber pest However, it is relatively ineffective at low temperature and ineffective against internal stages. HCN was widely reviewed and used in cultural artifacts and furniture in Europe but sorption is a major disadvantage. A new alternatives fumigant, ethanedinitrile patented by CSIRO in 1995, was initially investigated because of it's fast response to insects and minimal environmental problems. In Korea, MeBr fumigation is only registered quarantine treatment for imported timbers and wood packaging materials to control foreign wood-destroying pests. For this reason the domestic consumption of MeBr is 938 tonne pa (annual average from 2003 to 2005). A total of 628 tones pa (67%) of MeBr is used to fumigate imported timber and wood packing. Although MeBr is not used as a soil fumigant in Korea, the quarantine purpose of MeBr use is relatively higher than other counties. This study is on the toxicity of ethanedinitrile, a potential MeBr alternative, to control several wood-related insect pests: *Reticulitermes speratus*, *Tomicus piniperda* and *Hyphanria cunea.*

Materials and Methods

EDN (Ethandinitrile, purity=97.3%) was supplied from BOC Australia. *Reticulitermes speratus, Tomicus piniperda* and *Hyphanria cunea* were collected at Andong, Jinju and Suwon, Republic Korea, respectively.

Fumigant bioassay with open cages: Fumigation was carried out in glass desiccators (6-8L) which had lids sealed with glass stoppers containing a septum. Each desiccator had its volume measured by the amount of water it could contain. Samples of glass jars contained 30 insects were placed inside the glass desiccators prior to sealing. Calculated gas volumes (mg/L) of EDN (Temp 25±2℃) were injected into the desiccators. At least, 5 concentrations were tested and each concentration was in triplicate. During the fumigation, concentrations of EDN in each desiccator were measured by Gas Chromatography [GC] using DB-5 Columns. The carrier gas was nitrogen and flow rate was 30ml/min. The GC oven temperature was 150℃ and injector / detector temperature was 200℃. After 6hr exposure the fumigated desiccators were aerated in fume hood for 30 minutes. Alive and dead termites were counted for initial mortality and then live termites transferred to fresh petri dishes containing cut pine chips and stored in 25±2℃ incubation chamber for 24hr post treatment. Insects showing any movement were considered to be alive. The LD_{50} and LD_{95} values were calculated by Probit analysis (Finney 1971).

Fumigant bioassay with enclosed wooden cube: Fumigation bioassay with wooden cube was similar to except prepared wooden cube contained approximately 100 termites inside. The pine wooden cube (10 by 10 by 10cm) was used in modified Su and Scheffrahn (1986). Termites were confined to pine wooden enclosures. Wooden enclosures were cut as 5cm lengths from the heartwood timbers (10 by 10cm) of slash pine. These both half cubes were cut drilled-chiseled along the grain from one side to form square hollows (2.0 by 2.0 by 1.0). One half cubes were used as lids with attached snap latches to firmly compress a lid-mounted rubber seal when closed. Before the fumigation, the cube was tested for watertight seal. Other fumigation process and assessment of toxicity was same as without wooden chips.

Results

The EDN previously showed high toxicity to adult stages of wood related pests at 21-25 ℃ for 6hr (Ren et al. 2005). The LD_{99} values were 1.21, 3.83, 2.30 and 1.31 against *Coptotermes acinaciformis, Coptotermes brevis, Mastotermes darwiniensis*

and *Rhyzopertha dominica*, respectively. The efficacy of EDN to other wood related pests in this experiment is shown in Table 1(open cage) and Table 2(wooden cube). In open cages assay for 6hr exposure at 21±2℃, the LD_{99} value of ethanedinitrile EDN was 0.65, 4.64 and 0.63 mg/L against *R. speratus*, *T. piniperda* and *H. cunea* adult, respectively. In different temperature condition against *R. speratus*, the toxicity of EDN showed no difference (P>0.05). The comparative assay of open cage and enclosed wooden cubes showed EDN was more effective than MeBr in this experiment conditions. These results indicate that EDN appears to have a great potential as the MB alternative to control wood related pest, *R. speratus*. *T. piniperda* and *H. cunea.* Based on accumulated studies of EDN, further commercializing research may proceed for protecting ozone layer.

Table 1. Toxicity of EDN & MB to wood related insect pest for 6hr exposure in open cage.

	Target Pest	LD_{50} (95%CI)	LD_{99} (95%CI)	Slope (±SE)[a]	DF	*X*2	Temp.
EDN	*R. speratus*	0.26 (0.23-0.29)	0.65 (0.53-0.92)	5.79 (±0.75)	29	5.64	21±2℃
EDN	*R. speratus*	0.36 (0.34-0.38)	0.57 (0.53-0.69)	8.04 (±0.68)	29	1.00	4±2℃
MB	*R. speratus*	4.83	13.96	3.56 (±2.17)	14	17.3	21±2℃
EDN	*T. piniperda*	0.64 (0.38-0.89)	4.64 (2.66-16.95)	2.70 (±0.42)	11	1.02	25±2℃
EDN	*H. cunea*	0.19 (0.08-0.29)	0.63 (0.46-0.84)	2.92 (±0.65)	14	4.00	25±2℃

SE: Standard Error, Unit : mg/L

Table2. Toxicity of EDN and MB adult of *R. speratus* with enclosed wooden cube.

	LD_{50} (95%CI)	LD_{99} (95%CI)	Slope (±SE)[a]	DF	*X*2	Temp.
EDN	0.38 (0.32-0.47)	0.62 (0.50-1.46)	7.77 (±1.50)	29	2.00	21±2℃
MB	18.37 (4.59-25.39)	38.10 (27.83-110.73)	5.20 (±1.39)	17	7.12	21±2℃

SE: Standard Error, Unit : mg/L

Reference

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