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Efficacy of ethanedinitrile and hydrogen cyanide on wood infesting insects

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ABSTRACT

Two fumigants, EDN (with active substance ethanedinitrile) and BLUEFUME (BF) (with active substance hydrogen cyanide (HCN)) are alternatives to the ozone depleting chemical methyl bromide (MBr). The aim of the study was to measure the concentration-time (Ct) product achieved during the EDN and BF fumigation to examine the efficacy of fumigation through mortality rates of several wood boring pests *(Hylotrupes bajulus*, *Bursaphelenchus xylophylus* and *Anoplophora glabripennis)*. Values of Ct product for EDN (initial dose 50 gm^{-3}) were 105.62 ghm^{-3} and 311.57 ghm^{-3} for larvae of *Hylotrupes bajulus* and of *Bursaphelenchus xylophilus*, respectively. Concerning BF (initial dose 20 g/m^3), the values of Ct product for larvae of *Hylotrupes bajulus* and of *Anoplophora glabripennis* were <18.66 gh m^{-3} and <17.67 gh m^{-3}, respectively. The results showed excellent efficacy of both fumigants against wood boring pests.

Key words: Ethanedinitrile, Fumigant, Hydrogen cyanide , Insects, Wood

As industrial insecticides, both ethanedinitrile (EDN) and BLUEFUME (BF) are fast-acting fumigants (respiratory poisons) with a broad range of pest-control applications. EDN is usually used for fumigation of soil (Mattner et al., 2004). However, Ren et al. (2006) have proven EDN efficiency against e.g *Anoplophora glabripennis* and other timber pests. Another fumigant, HCN, was used for insecticide fumigation of wooden parts of historic buildings, churches in particular. HCN fumigation was used to treat parts of the gallery as well as the structural woodwork, which had been infested by various wood pests. There are data published on the efficacy of HCN for controlling wood-infesting pests of the genera *Anobium* sp. and *Lyctus* sp. under various temperatures, concentrations, and exposures (Parkin and Busvine, 1937; Bletchly, 1953).

In this study, we focused on efficacy of these fumigants against several other wood boring pests (*Hylotrupes bajulus, Bursaphlenechus xylophilus* and *Anoplophora glabripennis*) that were tested in wooden blocks in a fumigation chamber.

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MATERIALS AND METHODS

Larvae of two species of house borer (*Hylotrupes bajulus* and *Anoplophora glabripennis)* and pine wood nematode *(Bursaphelenchus xylophilus)* were tested. House borer exposure was performed in small wooden blocks (1 larva/1 block), while in the case of pine wood nematode, the tests used pine sawdust (20 g) in 50 ml polyethylene ampoules with fabric instead of a cap. The initial dose of EDN was 50 g m^{-3} and of HCN 20 g m^{-3}. Exposure duration of fumigant efficacy measurement was 1, 3 and 6 h for both fumigants and 6, 12 and 18 h for EDN.

After the fumigation, house borer larvae mortality was determined by counting the living and dead individuals, whereas the nematodes were separated by Baermann method and after a 12-h extraction their mortality was determined by microscope. Three time independent trials with five repetitions in each application were performed. During the experiment, the temperature was kept constant. The experiment was conducted under GEP conditions according to officially approved methodology. The results were evaluated statistically by STATISTICA 12 CZ program and Excel (MS Office). The statistical significance of comparing the differences in normally distributed

Table 1 Mortality (%) of larvae of *Hylotrupes bajulus* and *Bursaphelenchus xylophilus* for EDN (50 g m^{-3}) for 1, 3, 6, 12 and 18 h exposure

Insect species	Exposure time (h)			
	Control	1	3	6
House Longhorn beetle *Hylotrupes bajulus*	0±0	73±16	100±0	100±0
	Control	6	12	18
Pine wood nematode *Bursaphelenchus xylophilus*	0±0	100±0	100±0	100±0

Table 2 Mortality (%) of larvae of *Hylotrupes bajulus* and *Anoplophora glabripennis* for BF (20 g m^{-3}) for 1, 3 and 6 h exposure

Insect species	Exposure time (h)			
	Control	1	3	6
House longhorn beetle *Hylotrupes bajulus*	0±0	100±0	100±0	100±0
Asian longhorned beetle *Anoplophora glabripennis*	0±0	100±0	100±0	100±0

variables between the groups was determined by non-parametric Kruskal-Wallis ANOVA test.

RESULTS AND DISCUSSION

We investigated EDN fumigant efficacy on house borer larvae *(Hylotrupes bajulus)* and pine wood nematode *(Bursaphelenchus xylophilus)*. The observed mortality for larvae of *Hylotrupes bajulus* at initial dose of EDN (50 g m^{-3}) was 73.33% after 1 h exposure and 100% mortality was detected already after 3 h exposure. Regarding the effect of EDN on the *Bursaphelenchus xylophilus*, 100% mortality was detected already after 6 h exposure (Table 1). The calculated Ct products for larvae of *Hylotrupes bajulus* and *Bursaphelenchus xylophilus* were 105.62 ghm^{-3} and 311.57 ghm^{-3}, respectively.

Concerning BF fumigant, the biological efficacy of BF on wood infesting house borer larvae *(Hylotrupes bajulus)*and larvae of Asian long horned beetle*(Anoplophora glabripennis)* was estimated. We found 100% mortality of larvae of *Hylotrupes bajulus* and *Anoplophora glabripennis* in 20 $gm^{-3}$of HCN after 1, 3 and 6 h exposure (Table 2). After 1 h exposure to HCN concentration 20 gm^{-3}, the Ct product was <18.66 gh m^{-3} and <17.67 gh m^{-3} for larvae of *Hylotrupes bajulus* and of *Anoplophora glabripennis*, respectively.

Our experimental work has demonstrated that the available but neglected fumigants EDN and HCN might be a promising alternative to timber fumigation technologies and protocols that use MBr.

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