TOXICITY OF ETHANEDINITRILE (C_2N_2) TO TIMBER OR WOOD RELATED INSECT PESTS

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Range finding studies on the toxicity of ethanedinitrile (C_2N_2) to six species of timber or wood related Coleoptera were carried out at different time of exposure and temperature. The species were *Anoplophora glabripennis* (Motschulsky) (Asian Longhorned Beetle), *Anoplophora glabripennis* (Motsch), *Cryptotemes acinaciformis* (Forggatt)*, Mastotermes darwiniensis* (Forggatt), *Cryptotermes brevis* (Walker) and *Rhyzopertha dominica* (Fabricius). The toxicity of ethanedinitrile (C_2N_2) to all tested insect species is discussed as following statements.

Toxicity of ethanedinitrile to termites and a wood related insect pest - *R. dominica*

Exposure for 6 hours to C_2N_2 at 21-25°C, all the larval stages of *A. glabripennis* were completely killed at 11mg L^{-1}, workers of *C. acinaciformis, C. brevis* and *M. darwiniensis* were completely killed at 1.61mg L^{-1}, 3.0mg L^{-1} and 2.3mg L^{-1} respectively and the adult stage of *R. dominica* was completely killed at 1.0mg L^{-1} (Table 1). In general, C_2N_2 showed high toxicity to all immature and adult stages tested and in this respect is more toxic than methyl bromide and sulfuryl fluoride.

Table 1. Dose estimates and parameters of regression of Probit mortality of log concentration with 6 degrees of freedom for exposure of the target insect to C_2N_2 for 6 hours at 21-25°C.

Insect species	Stages	L(Ct)$_{50}$ (mg h L^{-1})	L(Ct)$_{99}$ (mg h L^{-1})
Coptotermes acinaciformis (Forggatt)	Workers	2.87	7.26
Coptotermes brevis (Walker)	Workers	4.56	15.33
Mastotermes darwiniensis (Forggatt)	Workers	5.75	13.82
Anoplophora glabripennis (Motsch)	Larvae	29.51	56.62
Rhyzopertha dominica (F)	Adults	1.92	7.86

Toxicity of ethanedinitrile to the Asian Longhorned Beetle larvae

Mortality of the Asian longhorned beetle larvae exposed to ethanedinitrile varied with temperature, time of exposure and dose of ethanedinitrile. The *Ct* products

of ethanedinitrile treatments over a range of temperatures varied with time of exposure (Table 1). In both cases of 3 and 6 h exposure, the toxicity of ethanedinitrile increased with temperature elevation. For both 3 and 6 h exposure, the Ct products of $L(Ct)_{50}$ values decreased three fold when the temperature increased from 4.4°C to 21.1°C (Table 1). The Ct products of $L(Ct)_{99.5}$ values increased 3 and 6 times for 3 and 6 h exposure respectively. For 3 h exposure the slope increased with temperature, but the increase in slope was much more pronounced for the 6 h exposure (Table 1). The variations of mortality at different temperature and time of exposure are described with a slope ratio ($[Slope]_{6hr}/[Slope]_{3hr}$). This is shown in Fig. 1, which plots the ratio of slope for a 6 h exposure ($[Slope]_{6hr}$) to that for a 3 h exposure ($[Slope]_{3hr}$) against temperature. This ratio doubled over the studied temperature range. It is described by the equations:

$$Y = [Slope]_{6hr}/[Slope]_{3hr} = 0.5685 + 0.0489T \qquad \text{Eq 1}$$

Where: Y is slope ratio
T is temperature (°C)

Therefore, equation (1) indicates three possible conditions that depend on temperature:

a. when temperature T = 9°C, Y = 1 and $[Slope]_{6hr} = [Slope]_{3hr}$ which indicates changing the exposure time will not change $L(Ct)_{50}$ and $L(Ct)_{99.5}$, of ethanedinitrile to the Asian longhorned beetle larvae. That is, concentration and time of exposure play an equal role in killing the Asian longhorned beetle larvae at 9°C. Here, if product of concentration × time (Ct) given by

$$C^m t^n = K \qquad (3)$$

Where: $m = n = 1$

b. when temperature T > 9°C, Y > 1 and $[Slope]_{6hr} > [Slope]_{3hr}$ which indicates the toxicity increases with increasing exposure time. That is, time of exposure plays a more important role than that of concentration. Therefore, $m < 1$ and $n > 1$.

c. when temperature T < 9°C, Y < 1 and $[Slope]_{6hr} < [Slope]_{3hr}$ which indicate the toxicity increases with increasing concentration of ethanedinitrile. that is, concentration of ethanedinitrile plays a more important role than that time of exposure. Therefore, $m > 1$ and $n < 1$.

The mortality of naked Asian Longhorned Beetle (ALB) *Anoplophora glabripennis* Motsch. larvae exposed to ethanedinitrile varied with temperature, time of exposure and dose of ethanedinitrile. The concentration × time (Ct) product of ethanedinitrile over a range of temperatures (4.4, 10.1, 15.6 and 20.1°C) decreased with increasing temperature, for both 3 and 6 h exposures. The Ct products varied with time of exposure at different temperatures (Table 1). The variations of mortality at different temperature are described with a slope ratio (Y = $[Slope]_{6hr}/[Slope]_{3hr}$). At different temperatures, the concentration of

ethanedinitrile and the duration of exposure play different roles in killing Asian longhorned beetle larvae (Figure 1). These results suggested the control of Asian longhorned beetle larvae within wood will be achievable.
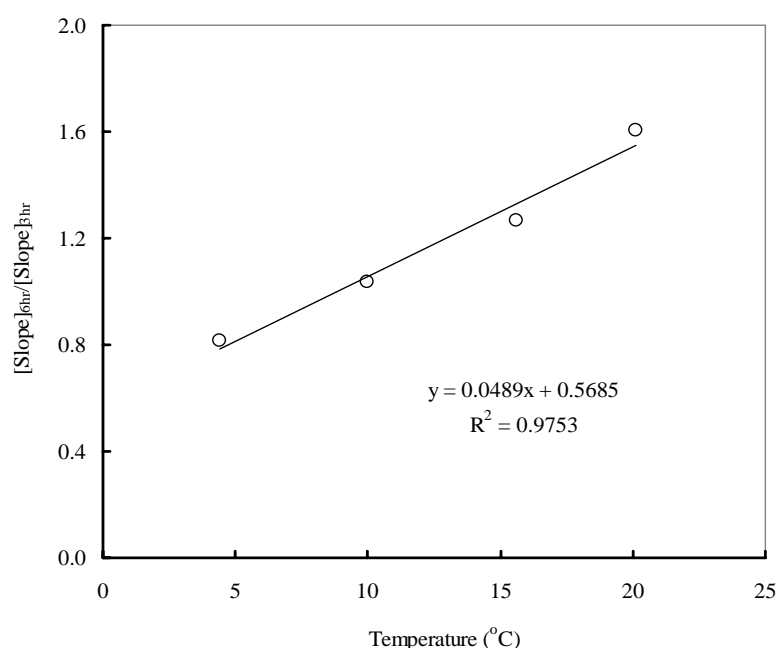

Figure 1. The ratio ([Slope]$_{6hr}$/[Slope]$_{3hr}$) of the slope of the Probit line for a 6 h exposure ([Slope]$_{6hr}$) to slope for a 3 h exposure ([Slope]$_{3hr}$), over the temperature ranges of 4.4-21.1°C or 40-70°F.

Table 1. Dose estimates and parameters of regression of Probit mortality of log concentration with 6 degrees of freedom for exposure of the naked larvae of the Asian longhorned beetle to ethanedinitrile for 3 and 6 h at different temperatures.

Temperature °C (°F)	Time of exposure (h)	L(Ct)$_{50}$ (mg h/l)	L(Ct)$_{99.5}$ (mg h/l)	Slope($\pm SE$)*	Heterogeneity χ^2
4.4 (40)	3	94.41	282.49	4.96 (±0.62)	5.52
	6	101.39	353.38	4.05 (±0.69)	2.68
10.0 (50)	3	72.61	240.99	5.24 (±0.80)	2.17
	6	74.13	221.82	5.42 (±0.47)	3.26
15.6 (60)	3	48.73	130.50	5.42 (±0.64)	4.97
	6	53.46	126.77	6.87 (±0.74)	3.91
21.1 (70)	3	33.57	95.28	5.69 (±0.84)	3.54
	6	29.51	56.62	9.14 (±0.56)	2.92

*SE: standard error.