SYNERGISM OF METHYL BROMIDE TOXICITY AGAINST TERMITES BY ADMIXTURE WITH CARBON DIOXIDE

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The toxicity of methyl bromide in combination with carbon dioxide (CO_2) was assessed in laboratory exposures against pseudergates ("workers") of the southeastern drywood termite, Incisitermes snyderi (Light), and workers of the Formosan subterranean termite, Coptotermes formosanus Shiraki. Estimates of lethal accumulated doses (LAD, 20-hour exposure at 27°C) of methyl bromide for 99% mortality against I. snyderi were 50, 37, 28, and 28 mg·h/l at 0, 5, 10, and 20% CO_2 (v/v), respectively. LAD_{99} values against C. formosanus with methyl bromide were 38, 32, 24, and 24 mg·h/l at 0, 5, 10, and 20% CO_2, respectively (Table 1). In general, CO_2 enhanced the toxicity of methyl bromide against I. snyderi more than against C. formosanus. Based on LAD_{99} values against I. snyderi, a maximum synergism ratio (SR) of 1.8 was induced by CO_2 in admixture with methyl bromide at 10 or 20% CO_2. For C. formosanus, the maximum SR at the LAD_{99} was 1.6 at both 10 and 20% CO_2. These results indicate that the application rates of methyl bromide can be significantly reduced by the simultaneous addition of 10% CO_2 into fumigated airspace.

The mode of action of low levels (≤ 20%) of CO_2 as a fumigant synergist is uncertain and probably multidimensional although enhancement of respiration rate plays a likely role. In practical terms, a 10% v/v (176 mg/l) CO_2 airspace load would require the addition of about 106 kg of CO_2 to a typical 600 m^3 structure. Given a reasonable gas half-loss time of 10 hours, the mean CO_2 concentration for a 20 hour fumigation would be about 5.6%. The addition of 2.4 kg (4 mg/l) of methyl bromide under these same conditions would yield an accumulated dose of about 45 mg·h/l (= 45 ounce-hours). Our results indicate that, at an exposure temperature of 27°C, this hypothetical fumigation would be successful for both termite species. Upward adjustments from the 4 mg/l rate would be necessary at lower temperatures, shorter exposure periods, shorter half-loss times (i.e. poor seal), or unusual structural conditions. Likewise, reverse conditions would allow for efficacious rates below 4 mg/l (= 4 ounces/1,000 ft^3).

Table 1. Toxicity (mg·h/l) of methyl bromide in admixture with CO_2 against I. snyderi and C. formosanus after 20-h exposure at 27°C.

Carbon Dioxide % (v/v)	n	Day[a]	LAD_{50}[b] (95% FL)	LAD_{95}[b] (95% FL)	LAD_{99}[b] (95% FL)	Synergism Ratios LAD_{50}	Synergism Ratios LAD_{95}	Synergism Ratios LAD_{99}
				I. snyderi				
0	120	7	40.2a (38.1-41.3)	47.1a (45.3-51.9)	50.3a (47.5-58.5)	1.0	1.0	1.0
5	120	11	24.5b (23.5-25.8)	33.0b (29.8-42.0)	37.2a (32.5-52.0)	1.6	1.4	1.4
10	120	7	24.5b (24.1-24.9)	27.1c (26.4-28.3)	28.2b (27.3-30.0)	1.6	1.7	1.8
20	120	11	23.7c (22.0-23.3)	26.4c (25.4-28.2)	28.1b (26.6-30.8)	1.7	1.8	1.8
				C. formosanus				
0	240	8	33.1a (32.6-33.5)	36.4a (35.6-37.5)	37.9a (36.9-39.5)	1.0	1.0	1.0
5	240	11	25.7b (24.3-27.5)	30.0a (27.9-38.1)	32.0ab (29.2-44.3)	1.3	1.2	1.2
10	240	10	17.7c (16.7-18.7)	22.2b (20.6-26.2)	24.4b (22.1-30.5)	1.9	1.6	1.6
20	240	10	19.2c (18.4-20.1)	22.2b (21.0-25.5)	23.6b (22.0-28.3)	1.7	1.6	1.6

[a] Day at which latent mortality had ceased.

[b] LAD, lethal accumulated dose (mg·h/liter) values within a column and fumigant followed by the same letter are not significantly different due to 95% FL overlap.