PENETRATION AND DE-GASSING OF SO_2F_2 AND CH_3Br DURING FUMIGATION AND AERATION OF CHINESE BAMBOO.

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Bamboo from China has been found to harbor cerambycid wood boring beetles of the genera *Purpuricenus sp., Phymatodes sp* and *Chlorophorus annularis. C. annularis* is an actionable pest Members of the genus *Purpuricenus* that are not recognized as occurring in the U.S. are classified as quarantine pests. Apparently little information is available on the biology of this genus.

The Animal and Plant Health Inspection Service (APHIS) does not have a fumigation schedule specific to borers in bamboo. Schedule T404-d proscribes methyl bromide (MB) but not sulfuryl fluoride (SF) for borers in wood products including containers. There is no information as to the penetration of SF or MB into bamboo and its subsequent de-gassing.

Fumigations were conducted in a 101.532-liter Lexan® chamber at doses of 56 g/m^3. The required volume of pure MB or 99% pure SF gas was calculated from the Universal Gas Law: $V = nRT / P$. A 1-liter gastight syringe was used to administer the calculated dosage of gas. One fumigation was made to measure penetration of MB or SF into the interior of hollow bamboo and its rate of de-gassing. A second was made to determine the de-gassing rate in a simulated chamber fumigation and the time required for aeration to safe fumigant levels. Samples of fresh Chinese bamboo were used.

Gas concentration in the chamber was monitored using a Model D Fumiscope (Key Chemical, Clearwater FL). The inside of the internodes was sampled through a length of 1.5875 diameter TFE tubing which was inserted into the bamboo and then sealed with silicone sealant The other end was inserted through a compression fitting and sealed by a rubber septum. Gas samples were obtained with a gastight syringe and a 26 gauge stainless needle 20.3 cm long, which was inserted through the TFE tubing into the center of the bamboo. Analysis was by gas chromatography.

In the first fumigation, three pieces of bamboo 3.28 cm diam. x 86 cm long were used. The chamber was then charged with the calculated dose of MB or SF. Chamber gas concentrations were measured periodically with a Fumiscope. A final chamber reading was taken after 24 hours at which time the chamber was aerated by pump for one hour and then opened. Internal bamboo gas concentrations were taken at hourly intervals during the first eight hours and at 8-

24 hour intervals during the next 3-6 days. For the second fumigation, 32 bamboo pieces of assorted small sizes were used. The volume of the bamboo was 14.5 liters, a fill rate of 14.3%. The dose of either MB or SF was added, and concentrations were measured after 0.5 hr, hourly for six hours, and at 24 hours. After 24 hours elapsed time, the chamber was aerated by vacuum pump for 5.5 hrs (for MB) and one hour (for SF), but left sealed The chamber was aerated 2-3 times, with gas concentrations allowed to build between aerations.

For MB gas penetration (and de-gassing) was slow, and reached only 51% of the applied dose after 24 hours (Fig. 1). After aeration for 24 hrs, the internal mean MB concentration was still 5.38 g/m^3. Detectable MB (66 ppm) was found after aeration for 142 hours. SF penetrated bamboo more effectively and de-gassed faster than MB (Fig. 2). Inside the bamboo the concentration increased to 82.4% of the applied dose. After aeration for 24 hours internal SF dropped to a mean of 1.09 g / m3, and after aeration for 72 hours to less than 5 ppm.

Fumigant de-gassing is shown in Figs. 3-4. MB degassed slowly compared with SF. After chamber aeration to 0.58 g /m^3 (148 ppm), MB concentration in the closed chamber quickly increased, and after 48 hours elapsed time was 4.09 g /m^3. A second aeration to 0.42 g /m^3 resulted in MB levels which again increased to 2.9 g /m^3. After a third aeration to 31 ppm, gas levels increased to 0.88 g /m^3 (225 ppm) 24 hours later. SF aerated and degassed quickly. After the first aeration to 0.03 g / m^3 (7.22 ppm) the level of SF increased to 2.03 g /m^3. After a second 24-hour aeration cycle at later, the SF again increased to only 5.34 ppm.

The CxT products for the 24-hour fumigation were much less than would be expected given the applied dose of 56 g/m^3. However, sufficient gas was retained internally such that the CxT product (and therefore insect exposure) following aeration after 24 hours increased significantly. The CxT accumulated in the first 24 hours was only 42.1 % of the 49.5 hour total for MB and 51.9% of the 48 hour total for SF.

CONCLUSIONS

- MB does not penetrate bamboo as well as SF.
- Both MB and SF penetrate bamboo and de-gas slowly.
- Significant CxT exposure is accumulated for at least 24 hours after aeration has begun.
- Dangerous levels of fumigant accumulate if fumigated bamboo is not completely aerated for at least several days.
- Caution is needed when inspecting containers of fumigated bamboo, or when bamboo has been stored in an enclosed area before adequate aeration
- SF may be a viable alternative fumigant for wood boring beetles in bamboo.
- Additional efficacy data may be needed.

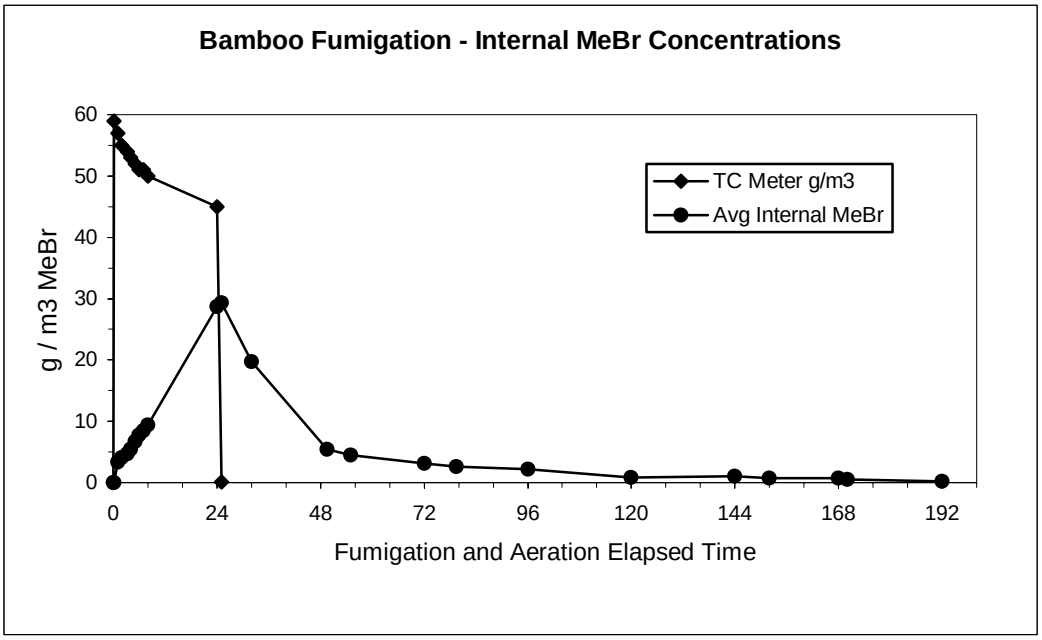

Figure 1. Methyl bromide concentration within inter-nodal void of bamboo during fumigation at 56 g /m^3 for 24 hours, and subsequent aeration. Average of 3 samples.

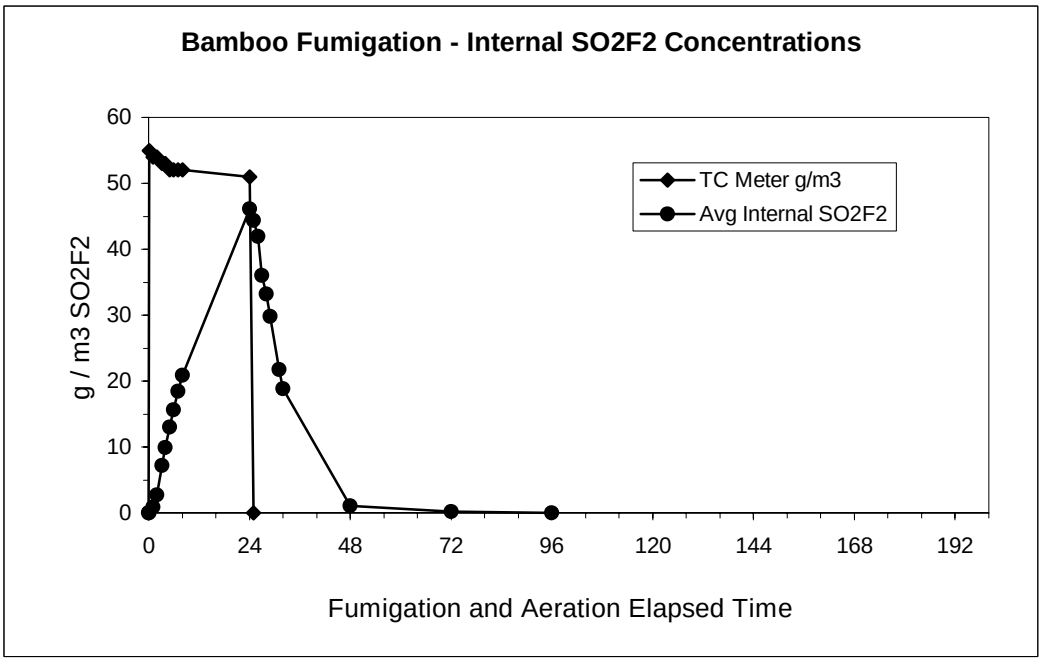

Figure 2. Sulfuryl fluoride concentration within inter-nodal void of bamboo

during fumigation at 56 g /m^3 for 24 hours, and subsequent aeration.

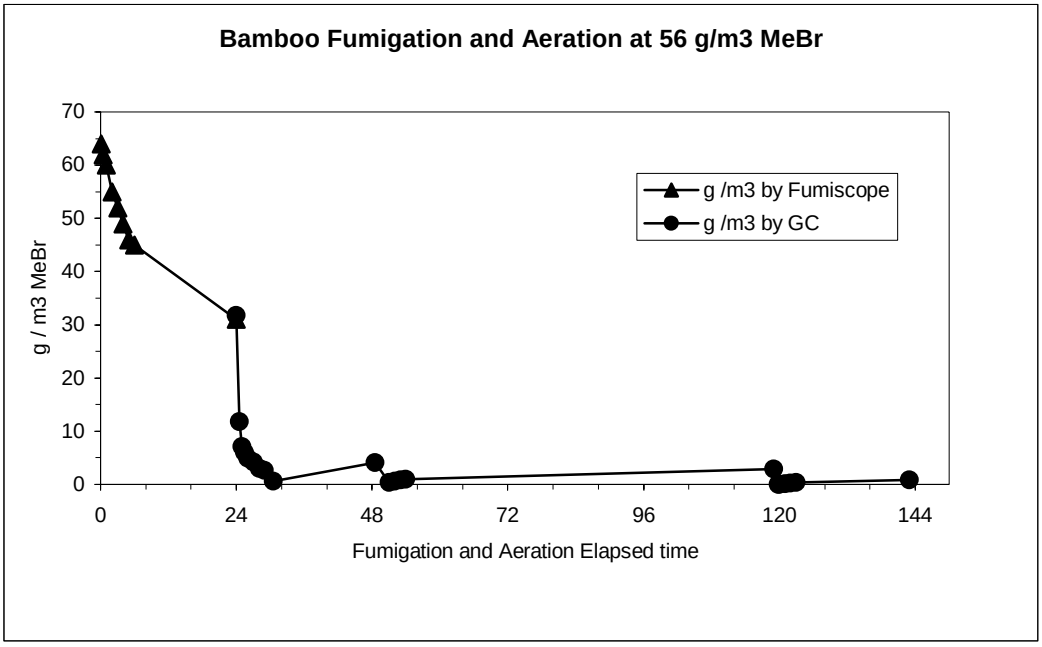

Figure 3. Chamber concentration of methyl bromide during fumigation of bamboo at 56 g /m^3 for 24 hours, and subsequent aeration.

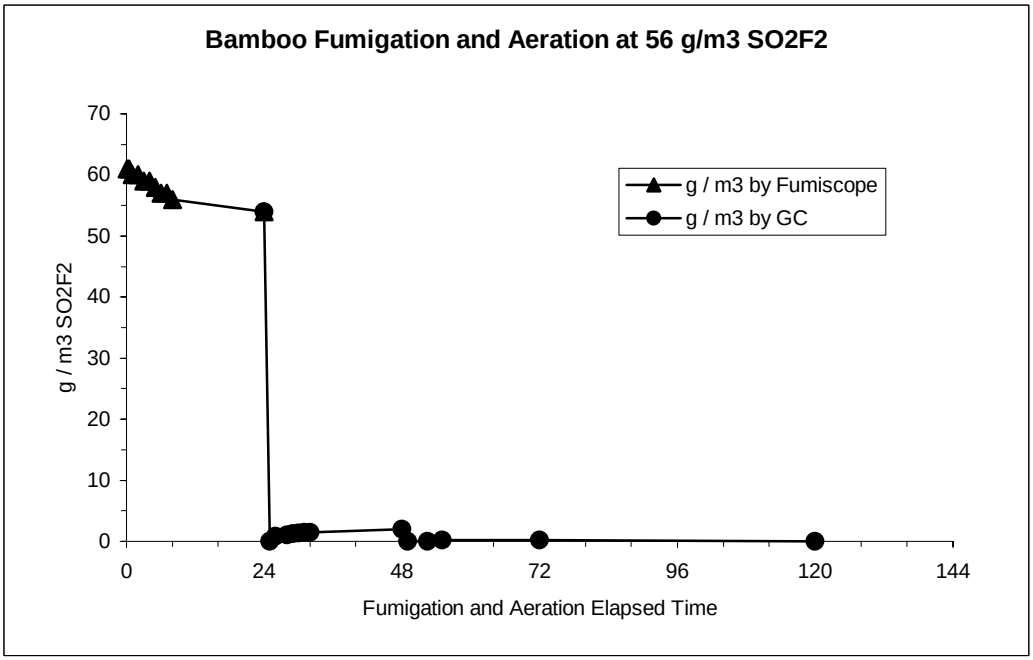

Figure 4. Chamber concentration of sulfuryl fluoride during fumigation of bamboo at 56 g /m^3 for 24 hours, and subsequent aeration.