

Fumigation of Dried Cocoa Beans Against Insect Pests of Storage

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One of the problems during the storage of dried cocoa beans in Malaysia is that due to insect pests. Cocoa beans for export are rejected if there are 10 or more live insects per gunny sack (nett weight 62.5 kg) in a random sample of 16 sacks examined during preliminary inspection at grading centres. Such rejected beans need to be fumigated using methyl bromide (98% w/w methyl bromide + 2% w/w choropicrin), before a certificate for export will be issued.

Despite the extensive and continued use of methyl bromide in cocoa beans, quantitative information on its efficacy against the common insect pests of cocoa beans is lacking. To remedy this, two experiments were conducted: (a) a small-scale experiment at ASEAN-Planti (hereafter called experiment 1; and (b) a commercial scale experiment at the Federal Agricultural Marketing Authority (FAMA) grading centre in Port Kelang (hereafter called experiment 2. In both experiments, the changes in concentration of the fumigant with time were also monitored.

In experiment 1, fumigation was carried out under a wooden structure (2 m × 2 m × 2 m) inside which 20 gunny sacks, arranged in a cross-stack manner, were placed. Four insect species were tested, viz, adults and larvae of *Tribolium castaneum*, adults of *Oryzaephilus mercator*, adults and larvae of *Lasioderma serricorne*, and eggs and larvae of the moth *Corcyra cephalonica*. For each insect species, twenty adults or immatures were used. The insects were confined in plastic cups (8.5 cm high × 4.5 cm diameter, top covered with 18 mesh steel gauze) which was half filled with broken cocoa beans. The cups were randomly placed at various points within the structure and at each point all the above stages and species were represented. To monitor the gas, sampling tubes were inserted at the top, bottom, and middle of the stack. In the last case, separate sampling lines were placed outside (middle 1) and inside (middle 2) the gunny sacks. A thermal conductivity meter (Fumiscope®) was used for recording gas concentration. The structure was then covered with a tarpaulin which was sealed at the base using sandsnakes and soil. Methyl bromide was applied at a dosage of 0.45 kg from the top of the stack. A control (no fumigation) experiment was also set up similar to the one for the fumigant treated stack to evaluate natural mortality of insects.

In experiment 2, two lots of gunny sacks which had been rejected due to high insect counts were used. Each lot contained about 160 sacks weighing a total of 10 tons. The size of the stack was 4.2 m × 4.8 m × 3.5 m. After the introduction of test insects and gas sampling tubes, the stack was covered with a tarpaulin. Methyl bromide was applied from the top of the stack at a dosage of 0.14 kg per tonne of beans.

In experiments 1 and 2, complete mortality was obtained for all test insects in cups

except eggs of *C. cephalonica*, regardless of position within the stack. Thus, in experiment 1, about 40% egg survival of *C. cephalonica* was obtained in the treated sacks, compared with the control where 50% survival was obtained. Insect counts from samples of beans taken after fumigation revealed complete mortality of all insects in fumigated samples in experiment 1 where the mean number of insects before fumigation was 5.0. In experiment 2, however, a few living immature individuals were found in the fumigated sacks (Table 1).

Table 1. Number of live insects in samples of cocoa beans before and after fumigation with methyl bromide at a dosage of 0.14 kg per tonne.

| Sack number | No. of insects | |
|-------------|----------------------------|------------------------------|
| | Prefumigation ¹ | Post-fumigation ² |
| 1 | 5 | 0 |
| 2 | 2 | 0 |
| 3 | 7 | 0 |
| 4 | 3 | 1 |
| 5 | 2 | 2 |
| 6 | 13 | 0 |
| 7 | 4 | 0 |
| 8 | 6 | 0 |
| 9 | 8 | 0 |
| 10 | 7 | 0 |
| 11 | 5 | 0 |
| 12 | 6 | 1 |
| 13 | 3 | 0 |
| 14 | 9 | 0 |
| 15 | 8 | 0 |
| 16 | 7 | 0 |

¹ From sacks examined during preliminary inspection

² Immatures only from another batch of 16 bags excluding those sampled during preliminary inspection.

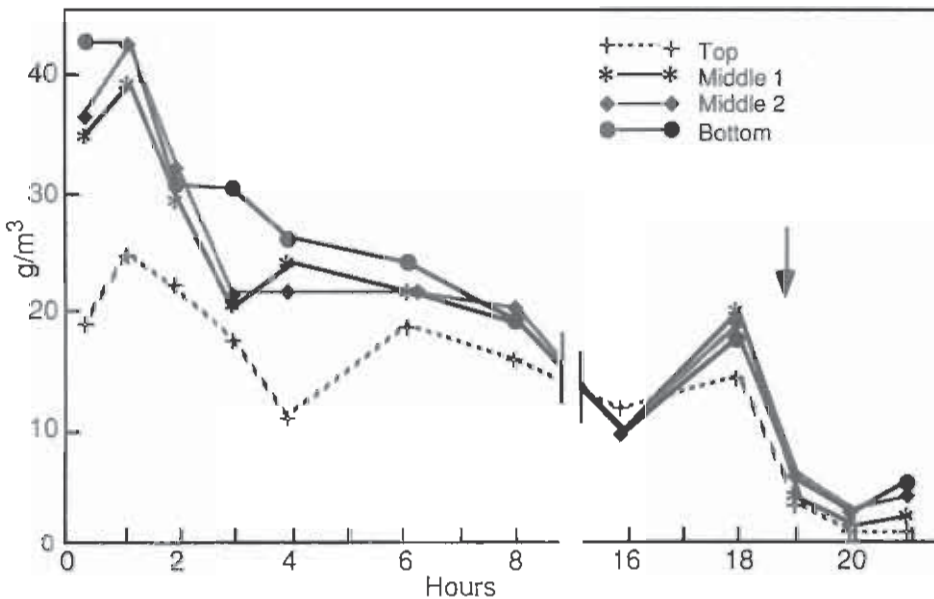


Fig. 1. Changes in methyl bromide concentration at various positions within a stack of cocoa beans fumigated at a dosage of 0.14 kg per tonne. Arrow shows time of start of aeration after removal of tarpaulin. Middle 1 — outside gunny sack; Middle 2 — inside gunny sack.

In both experiments, there were variations in fumigant concentrations between the top and bottom of the stack until about 16 hours after fumigation, with the bottom having a higher concentration than the top. There was little difference in fumigant levels between the Middle 1 and Middle 2 positions. In experiment 2, gas concentrations in all positions dropped rapidly on aeration to a mean level of about 2 g/m³ from a mean level of 15 g/m³ before aeration (Fig. 1).