THE POTENTIAL FOR REDUCING METHYL BROMIDE EMISSIONS ASSOCIATED WITH THE FUMIGATION OF DURABLE COMMODITIES IN DEVELOPING COUNTRIES.

R W D Taylor, Natural Resources Institute, UK

Introduction

Most developing countries have climates that allow insects to cause extensive damage to stored commodities. Although some cereals are bulk-stored, a high proportion of commodities in developing countries continues to be stored in bags, and fumigations are predominantly of bag stacks. Methyl bromide is still used for the routine disinfestation of cereals in several countries in eastern and southern Africa, and in Southeast Asia. It is also used widely for pre-shipment and quarantine purposes. Opportunities to reduce atmospheric emissions of methyl bromide may be available in some circumstances through dosage rate reductions or by using alternatives.

Techniques and fumigant dosage rates used in developing countries

Techniques employed vary considerably; for example, fumigant application may be through a branched piping system or via a single pipe inserted through a hole cut in the fumigation sheet. The types and condition of sheets used vary greatly. They are often damaged because of age or mishandling, or are of unsuitable material and incapable of forming a gas-tight enclosure. The effectiveness of sealing sheets to the floor also varies from satisfactory to very poor. Factors such as these are dependent on the management interest in providing proper equipment, and on the degree of training and awareness of pest control personnel.

In some countries in Africa and Asia little account is taken either of the commodity treated or of other relevant factors in calculating the quantity of methyl bromide used. A single dosage rate is frequently employed for most if not all commodities, 32 g/m^3 being a rate widely used irrespective of the exposure period. In some countries rates may be adjusted to take account of the level of infestation or whether commodities are to be exported.

Scope for reducing methyl bromide dosage rates

Currently, little if any monitoring of methyl bromide concentrations takes place during fumigations in developing countries. Because pest control personnel do not have access to data on the amount of gas routinely retained in stacks, dosage rates used are frequently higher than recommended to improve the chances of an effective treatment. Scope may already exist for reducing the rates for commodities such as milled rice, that are not particularly sorbtive of methyl bromide, yet rice is regularly fumigated at 32 g/m^3 in some countries even though the schedules of FAO and EPPO recommend rates of only 50% of this amount. Since fumigation is more effective at high temperature, wider scope may exist for dosage rate reductions in the tropical climates of developing countries, particularly if concentration monitoring were introduced to confirm effective gas retention, and fumigant-tolerant species such as the Khapra beetle are absent.

Experimental work on sheeted-stack fumigations with methyl bromide

In milled rice, fumigated in Thailand with methyl bromide at 32 g/m^3 and at 28 °C, minimum concentration x time products (CTP) of 300

mg/l/h were recorded in 300-tonne stacks by NRI for 24-hour exposures. These CTP values were very much in excess of the minimum requirement of 125 mg/l/hr (at 25°C) for controlling *Tribolium castaneum* pupae, the insect most tolerant of methyl bromide commonly found in milled rice. A dosage rate reduction of at least 50% (to 16 g/m^3) appears justified for milled rice in well sealed stacks. According to FAO schedules, extending exposure periods to 48 hours could allow a further reduction by 30%, resulting in a dosage rate of approximately 11 g/m^3. In Zimbabwe, NRI research showed that the 40 g/tonne (28 g/m^3) rate of methyl bromide routinely used by the Grain Marketing Board could be reduced to 30 g/tonne (22g/m^3) to treat large (5000-tonne) well-sealed maize stacks outdoors, over 48 hours (Table 1). In Kenya, results from a series of investigations at 25-30°C indicate that a reduction of up to 50% of the rate (30 g/m^3) currently used by the Cereals and Produce Board might be possible for treating bagged maize. A second series of trials during late 1994 should confirm possible rate reductions. A programme to examine further the potential to reduce the dosage rates for milled rice and other commodities is currently being planned for commencement during early 1995.

Alternatives to methyl bromide in developing countries

Phosphine has replaced methyl bromide for some types of treatment in many developing countries and is the chemical of choice where fumigation has been recently introduced. Ease of application, requiring minimal equipment with consequent lower costs, is a major reason for the popularity of phosphine. Its use by those with little awareness of the need for completely gas-tight conditions has, however, resulted in insect resistance. Although carbon dioxide cannot be used where rapid disinfestation is essential, it may be possible to use the gas as a replacement where the treatment period is not critical, and sealing to the high standards necessary is possible. Contact insecticides may also be an alternative to methyl bromide in some situations, such as the treatment of bulk grain.

Investigation of alternatives

Concerns regarding the spread of insect resistance have caused NRI to determine major reasons for ineffective phosphine fumigations in developing countries. These include lack of training and incentive among pest control personnel and, in some instances, poor quality of equipment. Pest control personnel and management are probably unaware of the poor fumigation standards prevailing because of lack of gas monitoring. Raising the standard of fumigation through training and practical demonstrations is a major feature in NRI's programme of approach to improving phosphine use (Figure 1). Trials to evaluate the effectiveness of carbon dioxide in large-scale silos are currently in progress in East Africa and will demonstrate the potential for this gas as a substitute fumigant.

Conclusion

There is scope to reduce the dosage rates of methyl bromide used in developing countries, but concentration monitoring would probably need to be introduced. Further research is necessary to confirm these reductions. On a technical basis alone, phosphine could probably be substituted for methyl bromide in most of the current non-urgent commodity treatments in Africa and Asia. Improvements to phosphine use to avoid insect resistance are essential to retain the fumigant at its optimal effectiveness. Carbon dioxide may also be substituted for methyl bromide in certain circumstances where time is not a limiting factor, although the cost of sealing to the level required might be too high in some countries.

Table 1. Concentration x time products (mg/l/hr) recorded in Zimbabwe during the treatment of 5000 tonnes of maize fumigated with methyl bromide at a dosage rate of 30 g per tonne (22 gm/m^3)

Stack position	24-hour-CTP	48-hour CTP
Corner		
-top	328	522
-middle	296	495
-bottom	307	499
Centre		
-top	301	464
-middle	118	280
-bottom	261	425

Note Grain temperatures in Zimbabwe can be of the order of 20°C or lower during some seasons, and a CTP of at least 150 mg/l/hr is therefore generally recommended for effective control of insects.

Figure 1. Phosphine retention in poorly sealed and in well sealed stacks