POTENTIAL FOR USE OF PHOSPHINE AS AN ALTERNATIVE TO FUMIGATION WITH METHYL BROMIDE

Donald G. Shaheen

Phosphine fumigants have been used extensively in the United States beginning in about 1960. Since then, uses of phosphine have increased markedly as producers of agricultural commodities realized the advantages of this excellent fumigant and as a host of other fumigants were removed from the marketplace as a result of regulatory actions inspired by numerous health and environmental considerations. The food production industry is now faced with the loss of methyl bromide, another excellent fumigant, and alternative chemicals and pest control techniques are presently being considered as replacements. The industry and the consuming public should not lose sight of the very high probability that a significant price will be paid for many of the alternatives to methyl bromide in terms of actual cost and/or decreased efficacy. Given the present day state-of-the-art of pest control in the agricultural industry, loss of methyl bromide will be calamitous, at the very best. Neither phosphine nor any other single fumigant or pest control technique will be able to supplant in an economical or effective manner all uses of methyl bromide. However, phosphine is superior to methyl bromide in some applications and can serve as an adequate replacement in a number of other situations. And, of course, there are fumigations in which phosphine will not serve adequately as a replacement, soil fumigation, as an example.

Fumigation of bulk stored commodities such as grain, milled grain fractions, seed, tobacco, animal feed and others is an area in which the loss of methyl bromide would have least impact. The majority of these treatments are already being performed with phosphine fumigants.

Spot fumigation, that is, the short term treatment of food processing equipment and machinery such as mills, transfer lines, sieves, etc. is another area which is served admirably by phosphine fumigants. A magnesium phosphide-based spot fumigant has been in use in the United States since 1987. This product provides results at least as good as those obtained with methyl bromide.

Space fumigation of warehouses is another long standing use of phosphine fumigants. Phosphine is approved for use on a wide range of food and nonfood commodities and virtually all of these have been fumigated in warehouses at one time or another. A problem has arisen within recent times which relates to the corrosion of copper and copper alloys by

phosphine. Light fixtures, switches, older model telephones and other copper containing equipment found in older warehouses are not particularly sensitive to this type of corrosion and so few problems of this nature were encountered in these fumigations. Repair or replacement of these components was required infrequently and was relatively inexpensive. More recently, however, more expensive and corrosion sensitive equipment such as computers, bar code readers, modern telephone systems and speaker systems have become commonplace in modern warehouses. Because of their extreme sensitivity to phosphine corrosion and their high cost, these items must be removed prior to fumigation or protected in some fashion from contact with the fumigant gas.

Formerly, many mills were fumigated with phosphine. However, the introduction of corrosion sensitive electrical and electronic equipment into mills has been even more rapid and extensive than in warehouses. This factor, plus the longer exposure period required with phosphine has resulted in the use of methyl bromide in the large majority of mills at the present time. Recently, however, investigators have been experimenting with shorter term fumigation of mills using low concentrations of phosphine in combination with high temperature and carbon dioxide[1]. Early results have been very encouraging in terms of insect control, greatly reduced corrosion and a sufficiently short exposure time that generally fits into the logistics of milling operations. While it is too soon to estimate with accuracy the applicability of this combination fumigation, it appears very likely that it will be able to replace methyl bromide in some mills.

Thus far, only applications of phosphine have been discussed here which will serve adequately as replacements for methyl bromide, or have a high probability of doing so. This discussion will conclude with two areas in which the outlook is not so optimistic. The first of these is the fumigation with phosphine of sensitive commodities such as fresh fruits and vegetables. There have been numerous published and unpublished articles citing very encouraging preliminary results for the treatment with phosphine of citrus, sweet potatoes, tomatoes, peppers, bananas, and others[2][3][4]. However, further research has in each case revealed a moderate phytotoxic effect which has eliminated or greatly diminished the size of the potential market for the fumigant. The effect has generally manifested itself in the form of reduced shelf life or accelerated ripening. In some cases off-odors and off-flavors have been produced by the phosphine treatment. Recently some very promising results have been obtained in the short term fumigation of grapes with phosphine at low temperature[5]. The problems with

phytotoxicity appear to have been overcome using this technique. Additional studies will be required to determine the applicability of this method to control insect pests in other sensitive commodities.

Finally, we come to consideration of the field of quarantine fumigations in which methyl bromide has served so well for so many years. Presently, there are no existing techniques that will attain adequate efficacy with phosphine within the same time frame as required for methyl bromide. Scheduling and demurrage on vessels and other transport vehicles requires short exposure periods in order that fumigation fit into the commercial handling of import/export commodities. In addition, some particularly troublesome pests, i.e. those with diapausing larval stages, require even longer than normal fumigation in order to obtain satisfactory control with phosphine.

This completes the survey of the potential for phosphine to serve as a replacement for methyl bromide. Perhaps some as yet unseen scientific breakthrough will enable the fumigator to expand further the uses of phosphine. Until that time, we must actively pursue our research effort and, pray that the loss of methyl bromide is not so near as it now appears to be.

REFERENCES

1. Mueller DK, Phosphine, heat and carbon dioxide deliver death punch to insects. Pest Control March 1994; 42-48.

2. von Vindeguth DL, Arner A, Burditt AK, Spalding, DH. Phosphine as a fumigant for grapefruit infested by Caribbean fruit fly larvae. Proc Fla State Hort Soc 1977; 90: 144-147.

3. Rolston LH, Wilson PW, Riley EG, Wright ME. Phosphine fumigation of sweet potatoes. Louisiana State University Agricultural Center Report. August 1989.

4. Seo ST, Akamine EK, Goo TTS, Harris EJ, Lee CYL. Oriental and Mediterranean fruit flies; fumigation of papaya, avocado, tomato, bell pepper, eggplant, and banana with phosphine. J Econ Entomol 1979; 72; 354-359.

5. Horn F. Test on fumigation of table grapes with magnesium phosphide. Degesch de Chile Ltda Internal Report. August 1993.