FUMIGATION OF A SILO BIN WITH A MIXTURE OF MAGNESIUM PHOSPHIDE AND CARBON DIOXIDE BY SURFACE APPLICATION

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ABSTRACT

The distribution of a fumigant mixture of magnesium phosphide and carbon dioxide was tested on a 1000 ton barley bulk stored in a 10 m high bin. Very good penetration of phosphine (PH_3) was achieved. High levels of PH_3 were measured at the bottom of the bin already after 24 hours and throughout the 14 days trial. In a similar bin that was fumigated with magnesium phosphide only (without CO_2) very slow penetration was noted. Low PH_3 levels were measured at the bottom of the bulk only 5 days after fumigation and higher levels only after 7 days. The potential use of a PH_3+CO_2 fumigant mixture for surface application is discussed.

INTRODUCTION

The use of phosphine for grain fumigation by surface application is very limited. It may be applied to flat silo bins with a height-to-diameter ratio of not more than 2:1. In those cases an even gas distribution is achieved within approximately 2 weeks and minimum exposure periods, usually at least of 20 days are set to obtain effective results (Banks, 1985).

A possible solution could be by the use of PH_3+CO_2 mixtures. Mixtures of methyl bromide + CO_2 have already been used successfully for fumigation of vertical bins by applying the two gases simultaneously to the surface of the grain in the bins (Calderon and Carmi, 1973; Carmi et al.,1989).

The use of the mixture of PH_3+CO_2 was thought to be inappropriate mainly due to the differences in the rate of generation of the two gases. The development of the magnesium formulation, which generates the PH_3 gas faster than the aluminium formulation, gave hope that the use of PH_3+CO_2 mixtures might be feasible.

MATERIALS AND METHODS

The fumigation was carried out on a metal bin 10 m high filled with 1000 tons of barley at a temperature of 24°C and 13.2% m.c. Magnesium phosphide at a dosage of 2 tablets (3g) per ton was spread evenly on the grain surface after which 200 kg of dry ice in ~ 1 kg blocks (which served as CO_2 source) were placed on the grain surface. After application the bin was well sealed. Gas samples were taken through narrow bore (2 mm i.d.) plastic tubes from depths of 0, 2, 4, 6 and 8 m in the center of the bin and from an opening at

the bottom of the bin. Concentrations of the two gases were determined by Drager detection tubes.
An additional and similar bin was fumigated with magnesium phosphide alone and served as the control treatment.

RESULTS

Tables 1 and 2 give the concentrations of PH_3 in the two bins. The data in Table 1 show that the addition of CO_2 hastened greatly the penetration of PH_3. After 24 h considerable PH_3 concentrations were already measured at the bottom of the mixture treated bin, whereas without CO_2, only after 5 days were low PH_3 concentrations detected at the bottom, and only after 7 days higher levels.

In the mixture treated bin, 2 points (4, 6 m) showed zero concentration after 24 h, apparently due to high amounts of dockage in this area which delayed the gas penetration. Later on, gas levels at these points were the same as the others.

Phosphide levels were generally higher in the upper parts of the bin for 9 days, but insecticidal concentrations were already measured at the bottom after 24 h and throughout the treatment. After 14 days the higher levels were recorded in the center of the bin. In the bin without CO_2 lethal PH_3 levels were found at the bottom only after 7 days. The penetration of the gas to the bottom was slow and gradual. After 14 days PH_3 levels were far lower than those in the mixture treated bin.

Measurement of CO_2 levels (Table 3) showed a good distribution of the gas in the grain bulk already after 24 h and throughout the treatment period.

DISCUSSION

Treatment with magnesium phosphide + CO_2 shows the potential of this mixture for grain fumigation. The fumigation procedure is simple and enables us to treat large grain bulks without moving them, using the surface application method. The rapid distribution of phosphine in the grain achieved by using this mixture is advantageous, as it can shorten the long exposure time needed now for effective fumigation of large bulks, which is a limiting factor. A reduction in treatment time is achieved also by the effect of CO_2 on phosphine, which acts more quickly on stored product insects (Desmarchelier and Wohlgemuth, 1984). Although this trial was conducted in a 10 m high bin only, it was subsequently shown that this mixture was very effective also for fumigation of a 22 m high silo bin (unpublished data).

The method presented here can change the approach to phosphine as a fumigant for large grain masses by opening up a new avenue for application.

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REFERENCES

1. Bank, H.J. 1985. Application of fumigants for disinfestation of grain and related products. ACIAR Proceedings No. 14, 291-298.

2. Calderon, M. and Carmi, Y. 1973. Fumigation with a mixture of methyl bromide and carbon dioxide in vertical bins. J. Stored Prod. Res. 8: 315-321.
3. Carmi, Y., Klein, L. and Cohen, S. 1989. Fumigation of wheat in a high vertical bin with a mixture of methyl bromide and carbon dioxide. ACIAR Int. Conference on Fumigation and Controlled Atmosphere Storage of Grain. Singapore.
4. Desmarchelier, J.M. and Wohlgemuth, R. 1984. Response of several species of insects to mixtures of phosphine and carbon dioxide. In: Ripp B.E. et al. ed. Controlled atmosphere and fumigation in grain storages. Amsterdam, Elsevier, 75-81.

Table 1 - Concentrations of phosphine (ppm) after fumigation of a barley bin with PH_3+CO_2.

	Days after fumigation						
Depth (m)	1	2	3	5	7	9	14
0	1500	2100	1950	1500	1300	1100	420
1	1500	1200	1200	1400	1200	1200	600
2	850	500	800	1050	1250	1200	520
4	0	300	600	900	1100	1100	600
6	0	200	500	650	800	850	320
8	200	320	320	400	450	600	200
10(bottom)	600	550	400	400	500	400	350

Table 2 - Concentrations of phosphine (ppm) after fumigation of a barley bin with PH_3 alone.

	Days after fumigation						
Depth (m)	1	2	3	5	7	9	14
0	1500	2100	1800	900	450	300	40
1	1800	1950	1500	1050	800	200	60
2	1200	2100	1900	1200	700	500	100
4	5	700	1500	1600	920	520	100
6	0	0	500	1050	1200	700	100
8	0	0	200	900	900	600	100
10(bottom)	0	0	0	200	500	600	200

Table 3 - Concentrations of CO_2 (%) after fumigation of a barley bin with PH_3+CO_2.

	Days after fumigation						
Depth (m)	1	2	3	5	7	9	14
0	20	6	4	4	3	4	4
1	16	5	4	5	4	5	3
2	12	3	5	5	5	5	3
4	0	5	6	6	5	4	3
6	0	6	6	6	6	6	4
8	4	9	9	8	7	6	5
10(bottom)	14	12	10	8	5	6	4

LA FUMIGATION DES CELLULES DE STOCKAGE AVEC UN MELANGE DE PHOSPHURE DE MAGNESIUM ET DE DIOXYDE DE CARBONE A PARTIR DE LA SURFACE DU STOCK

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RESUME

La distribution d'un mélange de phosphure de magnésium et de dioxyde de carbone a été étudiée sur 1.000 tonnes d'orge en vrac stockées dans un silo de métal de 10 m de hauteur. On a obtenu une très bonne pénétration de la phosphine dans le grain et, après seulement 24 heures, on en enregistrait déjà des taux élevés dans le bas du silo et ceci, pendant une période de 14 jours.

Dans un silo identique traité au fumigant sous forme de phosphure de magnésium seul (sans CO_2), on a enregistré une très lente pénétration de phosphine dans le grain. On a mesuré des taux réduits dans le bas du silo et ceci, après 5 jours seulement. Des taux supérieurs ne sont apparus que 7 jours après application.