Navarro, S. and Donahaye, E. [Eds.](1993) Proc. Int. Conf. Controlled Atmosphere and Fumigation in Grain Storages, Winnipeg, Canada, June 1992, Caspit Press Ltd., Jerusalem, pp. 527-532.

PHYTO EXPLO® FUMIGATION APPLIED IN SILOS

B. VACQUER[1], G. ZAKLADNOY[2], A. VASILIEV[2], E. BELOBROV[3], J. ROGERSON[4], B. KUGLER[5] and M. ABDULLAEV[6]

[1] DM France, 34 Rue du Contrat Social, Rouen, 76000, France

[2] Research Institute for Grain and Processed Grain Products (VNIIZ), 11 Dmitrovskoye Chaussee, Moscow 127434, Russia

[3] Research Institute for Navigation Transport Hygiene (VNIIGIVT), 22 Voljski Street, Odessa 270046, Ukraine

[4] Igrox Chemicals Ltd., White Hall Farm, Worlingworth, Woodbridge, Suffolk IP13 7HW, United Kingdom

[5] D.M.I.G., 67 rue de la Servette, 1202 Geneva, Switzerland

[6] Stored Grain Pest Protection Service, 36 Lakhuty, Tashkent, Uzbekistan

ABSTRACT

The use of PHYTO EXPLO® equipment for the application of phosphine or methyl bromide in silo bins is described. For phosphine fumigation, aluminium phosphide packages manufactured specifically for the purpose are inserted into the PHYTO SHAFT® tube, whereas methyl bromide is applied directly to the grain mass and its distribution is achieved using a fan connected to the PHYTO SHAFT® tube for recirculation. The same fan can be reversed for degassing of the bin after fumigation. Trials to determine the time needed for penetration of the PHYTO EXPLO® shaft into the grain mass revealed that between 52 and 79 min were needed to reach a depth of 20 m in a bulk of wheat. The withdrawal of the equipment from the grain mass took from 77 to 85 min.

PHYTO EXPLO® APPLICATION METHODS

Materials and methods

Phosphine

PHYTO EXPLO® fumigation of grain held in silos is carried out using the same equipment as in ship holds (Vacquer *et al.*, 1993). In silo-cells 35-m deep, phosphine fumigation will take no longer than 5 days under standard temperature conditions required for phosphine application. In addition, the PHYTO EXPLO® takes into account explosion risks in the silo environment by using compressed air as the energy source; it can, therefore, be connected directly to the silo compressed air supply, if available. Two manufacturers of aluminium phosphide, CASA BERNARDO and PESTCON, are currentlv

offering aluminium phosphide in a package specifically suited to the PHYTO SHAFT®, thereby eliminating the need to prepare the product before use (Fig. 1). This procedure is particularly useful, especially for the fumigation of exported grain on-board ships, as it avoids loss of time that is undesirable for both vessel owners and grain loaders.

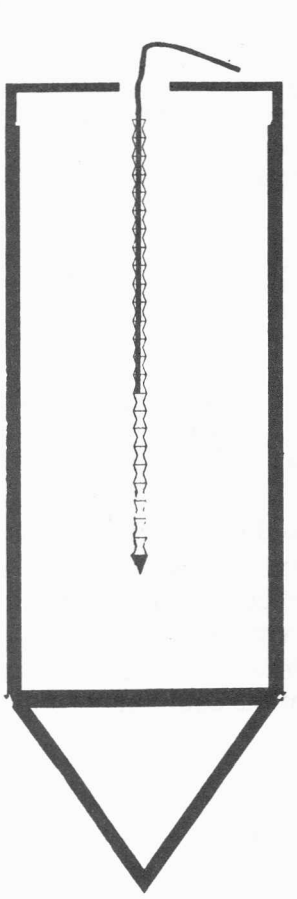

Fig. 1: Insertion of aluminium phosphide package into the PHYTO SHAFT® tube.

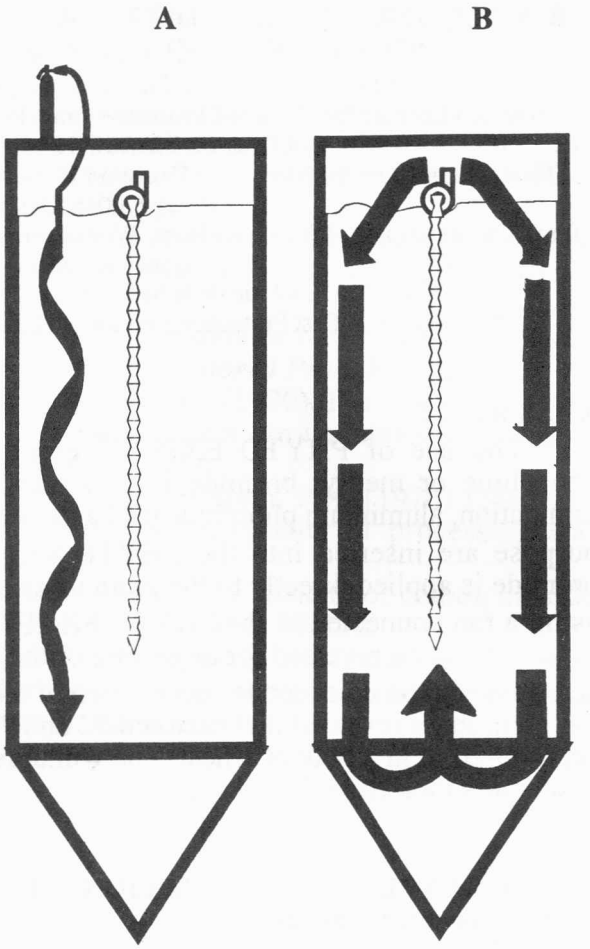

Fig. 2: Attachement of PHYTO SHAFT® tube to fan for methyl bromide fumigation: (A) release of methyl bromide while the fan is off; (B) recirculation of methyl bromide/air mixture using the fan attached to PHYTO SHAFT® tube.

Methyl bromide

The combination of methyl bromide and PHYTO EXPLO® enables the quick treatment of a silo. However, the nature of the gas requires fan-driven circulation in order to ensure fast and uniform distribution of gas throughout the grain mass. The fan may be of conventional design, may be solar-powered, or even pneumatic. The fan shown in Fig. 2 is used for air-suction since methyl bromide penetrates and descends easily into the grain mass.

This configuration has the advantage of facilitating degassing at the end of fumigation. Clearly, the fan can be reversed to blow rather than aspirate the air, should fumigation conditions so require.

Results

Results of experiments with phosphine

A vertical silo containing 900 tonnes of wheat was treated at a dosage of 1.33 g/m^3. The silo was cylindrical in shape and constructed from corrugated and bolted metal plates. The unloading pipe at the base of the silo was sealed. The roof was equipped with ventilation eaves forming a gap between the roof and the silo wall. Therefore, to obtain gastightness a polyethylene liner was used to cover the grain surface. After introduction of the fumigant through the PHYTO SHAFT® tube, the top of the shaft was sealed by inserting a large piece of polyethylene liner into the top of the shaft.

Measured concentration-time (Ct) products of phosphine indicate that lethal dosages were obtained at a depth of 12 m only after 6 days (Fig. 3).

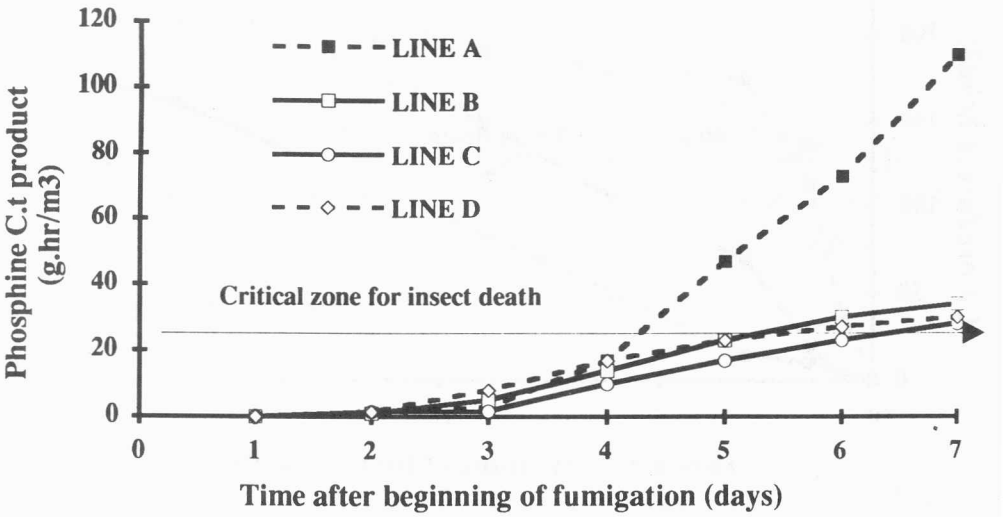

Fig. 3: Ct products (g.hr/m3) of phosphine measured at four different depths of a 12 m high silo containing wheat after the application of the fumigant using PHYTO EXPLO®. Line A = grain surface; Line B = 1 m deep: Line C = 10 m deep; Line D = 12 m deep.

Results of experiments with methyl bromide

This trial was carried out using methyl bromide at Wallingford, Oxfordshire, England in 1992 using the silo PHYTO EXPLO re-distribution system. The silo was one of a block of 92 bins, each measuring 30-m depth and 6-m in diameter, and containing barley. The partially-perforated PHYTO EXPLO® shaft was driven into the grain bulk to a depth of 20 m. A gas sampling line was inserted to the center of the silo, a line was placed at the bottom of the silo, and a line was located near the upper surface. During fumigation, gas samples were withdrawn from these lines and concentrations were recorded by a thermal conductivity meter.

A fan assembly was located in the head-space above the surface layer of the barley and was attached to the PHYTO EXPLO® shaft. The fan was set to draw air from the head-space and pump it down the shaft towards the perforated section at the bottom of the shaft.

The methyl bromide was passed through a vaporiser and then applied to the head-space at a rate of 20 g/m^3.

Results of this trial indicate that a lethal Ct product for methyl bromide, at the bottom of the 30-m high silo, was obtained after 13 hr (Fig. 4).

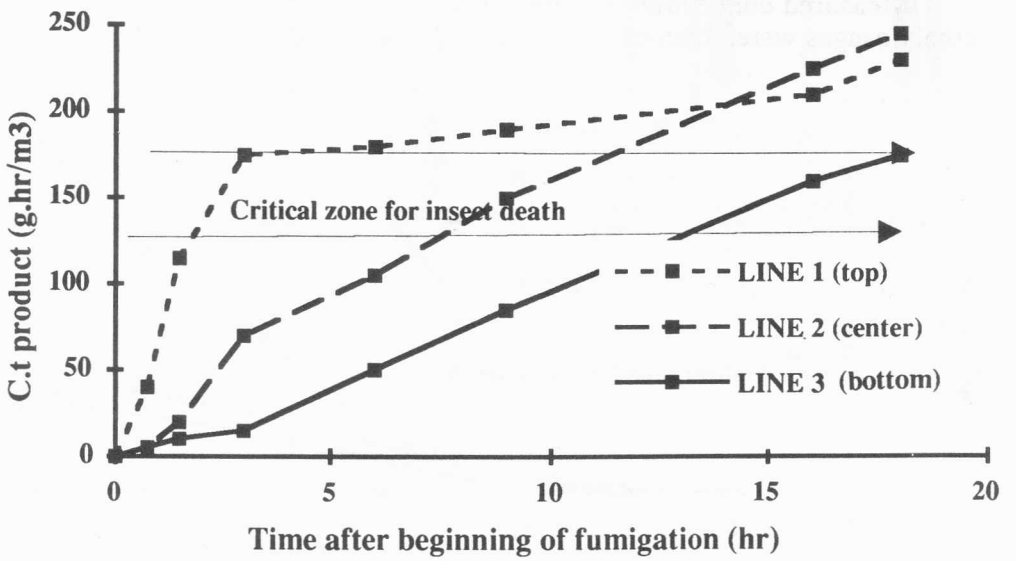

Fig. 4: Ct products (g.hr/m^3) of methyl bromide measured at three different depths of a 30 m high silo containing barley after the application of the fumigant using PHYTO EXPLO®.

At the end of the fumigation period the fan was connected to the PHYTO SHAFT® tube for degassing. Fig. 5 shows that only 6 hr of fan operation were needed for the concentration of methyl bromide to drop from about 2,000 ppm to <5 ppm.

PENETRATION TIME FOR PHYTO EXPLO®

Trials were carried out in the silo of CUVA in Uzbekistan to determine insertion and withdrawal times of the PHYTO EXPLO® in heavily insect-infested wheat grain undergoing heating. Results of the trials show that the time needed for penetration of the equipment to a depth of 20 m in the grain mass varied from 52 to 79 min while the time needed for withdrawalof the equipment ranged between 77 and 85 min (Table 1).

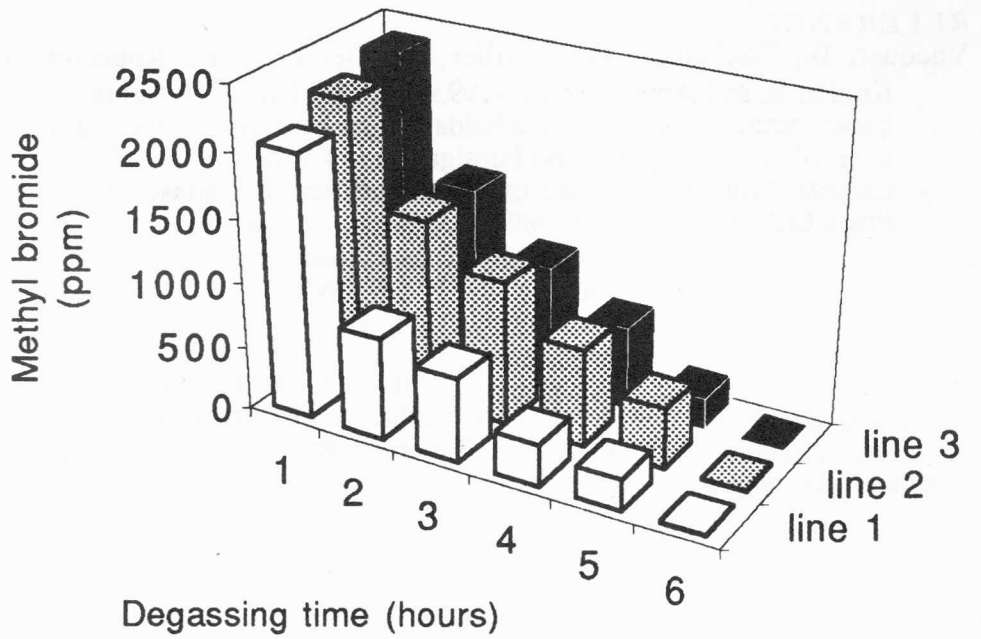

Fig. 5: Methyl bromide concentrations measured at three different depths of a silo containing barley after operation of the fan attached to PHYTO SHAFT® tube for degassing.

Table 1: Insertion and withdrawal times (min) of the PHYTO EXPLO® in heavily insect-infested wheat at different temperatures. Tests were carried out in vertical bins 6 m in diameter and 35 m high.

Depth (m)	Temperature of grain (¤C)							
	35		40		50		55	
	Insertion	With-drawal	Insertion	With-drawal	Insertion	With-drawal	Insertion	With-drawal
5	1	2	1	2	1	1	1	3
10	11	18	11	14	10	16	9	16
15	32	35	32	33	26	41	42	30
19				85		85		
20	76	77	79		52		74	79

REFERENCE

Vacquer, B., Zakladnoy, G., Vasiliev, A., Belobrov, E., Rogerson, J., Kugler, B. and Abdullaev, M. (1993) PHYTO EXPLO® fumigation: in transit grain fumigation in the holds of a tanker/bulker. Proc. Int. Conf. Controlled Atmosphere and Fumigation in Grain Storages, Winnipeg, Canada, June 1992 [Edited by Navarro, S. and Donahaye, E.], Caspit Press Ltd., Jerusalem, pp. 489-493.