Bulletin OEPP/Bulletin (2012) **42** (3), 504–506 ISSN 0250-8052. DOI: 10.1111/epp.2598

European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

PM 10/23 (1)

Phytosanitary treatments
Traitments phytosanitaries

Phosphine fumigation of dried fruits and nuts to control various stored product insects

Specific scope

This Standard describes the phosphine fumigation of dried fruits and nuts to control various stored product insects. It is an alternative to EPPO Standard PM 3/9 *Methyl bromide fumigation of dried fruits and nuts*.

Specific approval and amendment

First approved in 2012-09.

Introduction

Dried fruits and nuts are often infested by pests.

Experience from across the world has shown that using phosphine products for stored product treatment to control pests is effective. Most of the insects listed below are cosmopolitan and all of them should be removed from consignments.

Commodities/regulated articles

Dried fruits and nuts, for example, raisins, prunes, apricots, almonds and walnuts.

Pests

Stored product pests in general (see Table 1). If resistant strains of any of these species have been found, or are believed to be present, then the highest dose coupled with the longest exposure should be used.

Treatment schedule

Treatment name: phosphine fumigation.
Treatment type: chemical.
Formulation: fumigant, for example packed as a plate.
Active substance: magnesium phosphine 56%, aluminium phosphine 56%.

Treatment conditions

Mode of action: fumigation at atmospheric pressure.

Growth stage: post-harvest pest control.

Number of applications: no regulation, the number of applications depends on reinfestation of the commodity.

Waiting period

Consumption of dried fruits/nuts is allowed only after product (hydrogen phosphine) has completely dissipated.

Efficacy of treatment

Phosphine fumigation has been found to be effective in many countries in the EPPO region and worldwide. Phosphine fumigation is an effective method of eliminating insects in stored commodities (Bell, 2000). Fumigation of stored products with phosphine products as prescribed by the label does not contaminate the commodity.

The schedules described in Table 2 are the result of many years' experience. The trials carried out showed that phosphine treatment helps to provide non-infested material for the food industry with a relatively quick treatment time (Zakladnoi & Ratanova, 1973; Ducom *et al.*, 2004).

In the case of certain commodities in long-term storage, re-infestation may occur. Additional fumigation may be required to treat these commodities.

Fumigation conditions are important; consequently, the dose to be used depends on the conditions, in particular: relative temperature and humidity; commodity temperature and moisture levels; and gas-tightness of the building/container. If the commodities are in bags/sub-containers (e.g. nuts in raffia bags), their permeability should also be

Table 1 Important stored product pests that can be controlled with phosphine

Coleoptera	*Anthrenus museorum*	ANTRMU
	Araecerus fasciculatus	ARAEFA
	Attagenus pellio	ATTGPE
	Caryedon serratus	CARESE
	Cryptolestes ferrugineus	CRYLFE
	Dermestes lardarius	DERMLA
	Gnathocerus cornutus	GNATCO
	Lasioderma serricorne	LASDSE
	Necrobia rufipes	NECRRU
	Niptus hololeucus	NIPTHO
	Oryzaephilus surinamensis	ORYZSU
	Prostephanus truncatus	PROETR
	Ptinus fur	PTINFU
	Ptinus tectus	PTINTE
	Rhizopertha dominica	RHITDO
	Sitophilus granarius	CALAGR
	Sitophilus oryzae	CALAOR
	Sitophilus zeamais	CALAZM
	Stegobium paniceum	STEGPA
	Tenebrio molitor	TENBMO
	Tenebroides mauritanicus	TEBRMA
	Tribolium castaneum	TRIBCA
	Tribolium confusum	TRIBCO
Lepidoptera	*Corcyra cephalonica*	CORRCE
	Ephestia (Cadra) cautella	EPHECA
	Ephestia elutella	EPHEEL
	Ephestia kuehniella	EPHEKU
	Nemapogon granella	TINEGR
	Plodia interpunctella	PLODIN
	Sitotroga cerealella	SITTCE

considered as gas penetration may be less effective. When these conditions are not acceptable, it is important to use a longer exposure times during fumigation. The exposure periods recommended in Table 2 are minimum periods. Most data for the fumigation with phosphine was obtained at 60% humidity and 20°C. Fumigation should not be performed below a temperature of 10°C.

The longer the fumigation time, the more effective the fumigation. Exposure time should be lengthened to allow for penetration of gas throughout the commodity, particularly when the fumigant is not uniformly added to the commodity mass, for example, by surface application or shallow probing. This is particularly important in the fumigation of bulk commodities contained in large storage areas. It should be noted that there is little to be gained by extending the exposure period if the structure to be fumigated has not been carefully sealed, or if distribution of gas is poor and insects are not subjected to a lethal concentration of phosphine (Zakladnoi & Ratanova, 1973). Exposure periods of more than 10 days are not normally recommended because of the difficulty of retaining the fumigant for long periods. However, in some cases, for example, with careful sealing or polythene-wrapped goods, longer exposure periods may be possible. Above 12% relative humidity, problems of phytotoxicity can appear.

The schedules provided in Table 2 were tested at the All-Russian Plant Quarantine Centre. The results show that these schedules are acceptable (100% mortality of pests in Table 1 was achieved). Fumigation to control *Trogoderma granarium* should follow EPPO Standard PM 10/22. Because of the high level of resistance of diapausing larvae of this pest, treatments require a longer exposure time (Shamilov & Mordkovich, 2012).

Notes

- To prevent the development of resistance, it is essential to avoid applications with sublethal doses (Fields & White, 2002). Depending on fumigation circumstances, in particular low temperature and poor gas-tightness of the building/container, it is important to use longer exposure to achieve pest mortality in all parts of the fumigated commodities.
- Additionally, the fumigation period should be long enough to allow for almost complete reaction of phosphine products with moisture in the products so that little or no non-reacted phosphine product remains (Noack *et al*., 1983). This will minimize worker exposure during future storage and/or processing of the treated bulk commodity as well as reducing hazards in the disposal of partially spent phosphide products remaining after space fumigation.

Table 2 Application rate per treatment (gas dose)*

Active substance	Dose (g PH_3 m^{-3})	Minimum exposure time (days)	Minimum temperature (°C)	Implementation
Magnesium phosphine	3	8	10	Premises, containers
		5	20	covered under
Aluminium phosphine	3	9	10	tarpaulin
		6	20	

*The table lists minimum exposure periods in days for a dosage of 3 g PH_3 m^{-3}. One day should be added to exposure times to allow for development and distribution of the fumigant. The dose may need to be increased to 5 g PH_3 m^{-3} if the fumigation conditions are poor (e.g. not very gas tight conditions, or low relative humidity), or if resistant species are found, or believed to be present. However, it is good practice to perform phosphine fumigation only in gas-tight conditions.

Enquiries

Further information may be obtained from the national authorities responsible for the registration of this fumigant.

All-Russian Plant Quarantine Center, Disinfection Department, Dr Artur S. Shamilov e-mail: artshamilov@mail.ru.

References

Bell CH (2000) Fumigation in the 21st century Crop Protection. *Crop protection* **19**, 563–569.

Ducom P, Roussel C & Stefanini V (2004) Quick stored products disinfestation before processing one or two day phosphine fumigation. *Proc. Int. Conf. Controlled Atmosphere and Fumigation in Stored Products, Gold-Coast Australia*. FTIC Ltd. Publishing, (IL) August 8–13 (1): 47–52.

Fields PG & White NDG (2002) Alternatives to methyl bromide treatment for stored products and quarantine insects. *Annual Review of Entomology* **47**, 331–359.

Noack S, Reichmuth C & Wohlgemuth R (1983) PH3 Rückständebei Vorratsschutzbegasungen in Abhängigkeit von der Konzentration, Einwirkzeit und Lagerdauer nach der Begasung. *Z.Lebensmittel-Untersuchung und-Forschung*, **177**, 87–93.

Shamilov AS & Mordkovich YaB (2012) Conclusion on phosphine fumigation standards (in press) 4p.

Zakladnoi GA & Ratanova VF (1973) Vrediteli khlebnikh zapasov [Stored product pests] (in Russian), M. Kolos, Moscow 275p.