IN NUTS AND DRIED FRUIT

IN NUTS AND DRIED FRUIT conditions, the management of dosage/exposure time and the monitoring of gas concentration have to be taken into consideration such as the importance of temperature and moisture stored nuts and dried fruit. A successful fumigation depends on various parameters that stored products. Therefore, it is also an indispensable tool for the control of insect pests in stored products. Hence, it is also an indispensable tool for the control of insect pests in stored products. Therefore, it is also an indispensable tool for the control of insect pests in stored products. Hence, it is also an indispensable tool for the control of insect pests in stored products.

Phosphine gas is the most important active ingredient worldwide used for protecting stored products. Therefore, it is also an indispensable tool for the control of insect pests in stored nuts and dried fruit. A successful fumigation depends on various parameters that have to be taken into consideration such as the importance of temperature and moisture conditions, the management of dosage/exposure time and the monitoring of gas concentration. Recommendations for better fumigation practice in regard to these parameters are given.

In order to prevent loss in quality and quantity of nuts and dried fruit caused by stored product insect pests, it is necessary to take measures against an existing pest infestation in good time. The most important pests which can pose a major threat to stored nuts and dried fruit include various moth species such as the Indian meal moth (Plodia interpunctella) or the Chocolate moth (Ephestia cautella) (Fig. 1). Several beetle species such as the Sawtoothed grain beetle (Oryzaephilus surinamensis) or the Red flour beetle (Tribolium castaneum) can also cause considerable damage in nut and dried fruit stores (Fig. 2).

Despite all preventive measures, it is not always possible to entirely prevent invasion or infiltration of these insect pests. Once the infestation exists, effective extermination measures have to be carried out as soon as possible.

The most important agent used for exterminating insect pests in many areas of stored products protection is the fumigant phosphine. Also in nut and dried fruit storage, this substance is tested and approved with regard to its efficacy against stored product insect pests found there and is applied very successfully.

The advantages of this gas are its excellent penetration capacity and its extremely high efficacy against all stored product insect pests. Therefore, extermination of the pests including all of their developmental stages is possible without any problem. Developmental stages that live hidden in the goods are also reliably destroyed thanks to these properties.

Phosphine also stands out due its favourable properties with regard to innoxiousness and residue formation in treated food and feed. The gas does not have any negative effects on products that were treated with it and evaporates very quickly after application. So there is no reason to fear the presence of residues in fumigated goods.

Its positive properties with regard to eco-toxicity also speak for this agent. The simple gas molecule is quickly degraded into harmless metabolites in the atmosphere. So there is no danger of an accumulation of the substance in the environment.

In spite of all these positive aspects, phosphine and phosphine products are hazardous substances which make it necessary to ensure maximum user safety and worker protection during use. Therefore, phosphine products should only be used by qualified personnel who have been trained to use them.

With regard to requirements which aim for good and sufficient efficacy of the gas during practical application, the factors described below must be considered. In practice, these factors are frequently not observed adequately and can have a negative impact on fumigation success.

The goal of fumigation is to achieve a sufficiently high gas concentration for a specified exposure time. That is the only way to ensure that all developmental stages of the corresponding pests in the stocked goods are safely eliminated.

With regard to the gas concentration, it should be a given that the dosages recommended by the manufacturers are always observed. They have been tested in elaborate efficacy trials which verify their effectiveness against pests and guarantee successful elimination.

Another important factor in this connection is the quality of the sealing measures. Because insufficiently sealed locations are frequently used for fumigation purposes, gas is lost to a large extent despite sufficient gas dosage. Therefore, it is often not possible to reach a completely effective gas concentration. Such objects have to be sealed with suitable measures before fumigation. The properties of the sealant are very important in this aspect. For example, it should be ensured that fumigation sheets meet the criteria with regard to sufficient impermeability to phosphine gas. Not every seemingly gas-tight sheet is also suitable for sealing purposes during phosphine fumigation.

For the most part, phosphine fumigation is performed with products that consist of aluminium or magnesium phosphide. In the form

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Fig. 1. Indian meal moth infestation of dried apricots.

Fig. 2. Sawtoothed grain beetle infestation of dried figs.
of pellets, bags or plates, these products are chemical precursors and develop the effective phosphine gas after application (Fig. 3). This process requires sufficient humidity and an appropriate minimum temperature. With regard to humidity, product moisture or general relative humidity suffices to trigger the development of the gas from the metal phosphide formulations. Generally, temperature is rather the limiting factor. It is recommended performing fumigation at best in a temperature range between 15 and 30 °C. Due to the lower biological activity of the pests at low temperatures and the resulting lower intake of phosphine, fumigation is generally not recommended at temperature conditions below 10°C in the stocked goods to be treated.

Another important factor for successful fumigation is the exposure time. A sufficiently long exposure time is just as important as a sufficiently high gas concentration. Therefore, compliance with manufacturer specifications must be ensured in this area as well. Generally, the exposure time of the gas to the pests should be extended as long as possible within the specified limits and should not be shorter than a period of 2.5 days for magnesium phosphide fumigation and a period of 5 days for aluminium phosphide fumigation.

To ensure that fumigation proceeds successfully and that no gas is lost due to possibly occurring leaks, it is necessary to monitor the gas concentration in the fumigated goods. For this purpose, measuring lines can be laid inside the fumigation object or the treated goods in the run up to fumigation prior to sealing to easily enable measurement of the gas concentration during the fumigation phase.

Furthermore, it is necessary to monitor the gas concentration in the area surrounding fumigated objects. This ensures reliable protection of workers and surrounding areas and also makes it possible to determine whether and in which areas gas is potentially lost. In this case, additional sealing measures can be performed if necessary in order to safely reach the required gas concentration in the fumigated goods.

Past experience shows that insufficient gas concentrations are frequently applied in phosphine fumigation. The reasons for this are primarily insufficient dosage or inadequate sealing measures. In addition, short exposure times can be the reason why fumigation often does not achieve one hundred percent efficacy in all pest stages. Whilst the visible active developmental stages such as imagines or larvae are eliminated, more inactive developmental stages such as eggs or pupae can partially survive the treatments and cause renewed infestation.

Ultimately, these surviving insects not only pose a risk with regard to renewed infestation; they can be the source of less sensitive insect populations if fumigation fails repeatedly and therefore also be a hazard with regard to the development of phosphine tolerance. This gas is one of the few substances still available for stored product pest elimination. For this reason, every effort should be made to preserve this active substance and not jeopardise another possibility for successful stored product protection through incorrect application in the long run.

In conclusion, it should be noted that phosphine products should only be applied by specialist companies or adequately qualified personnel according to proven best professional practice. At the same time, it is also necessary to consider the above-mentioned factors with regard to sufficient efficacy and appropriate user safety.