

Chemical control of pest insects in stored product protection in Germany - Present situation and challenges -

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Abstract

During the last 15 years the number of authorized active substances and the assortment of Plant Protection Products used in stored product protection has decreased. To avoid resistance and maintain a wide variety of approved chemical methods, uses have to follow best technology and standards available. Above all, efforts have to be made to develop new active substances and Plant Protection Products for the pest control in stored products. An overview of the presently registered and used chemicals and products to control the most important pest insects in Germany will be presented for the most important uses. Still, contact insecticides play an important role in the stored product protection because fumigants are not applicable in many situations in practice, due to lack of gas tightness or other constraints. In this context, fumigation with phosphine remains one of the key methods for the disinfestation of stored products like bulk grain, bagged cocoa beans in sack staples, herbs and spices, and tobacco. For insect control in infested empty structures and food and feed factories, sulfuryl fluoride has taken the place of methyl bromide. Carbon dioxide also serves the purpose in some situations. Fumigation often is the last option after other alternatives of the pest control have failed or do not present feasible options.

Keywords: authorized plant protection products, chemical control, fumigation, contact insecticides, stored product protection, Germany

1. Introduction

The major part of the harvested plant products is used for food and feed – e.g. in Germany about 25 % of the grain harvest (2012: 41.7 Million t) is provided for food and about 50% for feed (Statistisches Jahrbuch, 2012).

In the context of the European approach to food safety ‘From Farm to Fork’ this is one of the reasons why the protection of stored plant products assigned to be food is part of the food and feed production chain and consumer protection. Food and feed safety and hygienic requirements are applied at each stage of production, processing and distribution. Therefore, these standards are also related to stored products of plant origin. The European Regulations (Anonymous, 2004, 2009) and corresponding sector-specific national laws or rules aim to ensure that food is safe and harmless and shall not be placed on the market if it is injurious to health or unfit for human consumption implying also deteriorated, nauseous or contaminated food (e.g. by foreign bodies, death or alive animals/insects, heavy metals, mycotoxins, unacceptable taste or odour, decomposition, mould).

Furthermore, worldwide trading standards also maintain the ‘zero tolerance’ for living insects. A presence of living pest organisms in stored plant products would jeopardize the stock itself and the supply chain for food and feed (Anonymous, 2010). Therefore, the absence of living insects and other contaminants is an important aspect in stock-keeping, trade, and in preservation of crops (Anonymous, 2014c). Harvested crops therefore have to be stored in a

way that ensures high quality and is considering all mentioned requirements and standards and state of technology.

According to Regulation (EC) No. 1107/2009 (Anonymous, 2007) and national plant protection law, pests in simply processed or unprocessed plant products can be controlled by Plant Protection Products (PPP) unless the main purpose is considered to be for reasons of hygiene.

2. Present situation in Germany

In Germany, currently a total of 20 Plant Protection Products are available for the chemical control measures in the field of stored product protection. The number of insecticides is currently 18, with a downward trend having dearly stopped in recent years. Two of the insecticides have an acaricidal effect and are approved for this indication additionally.

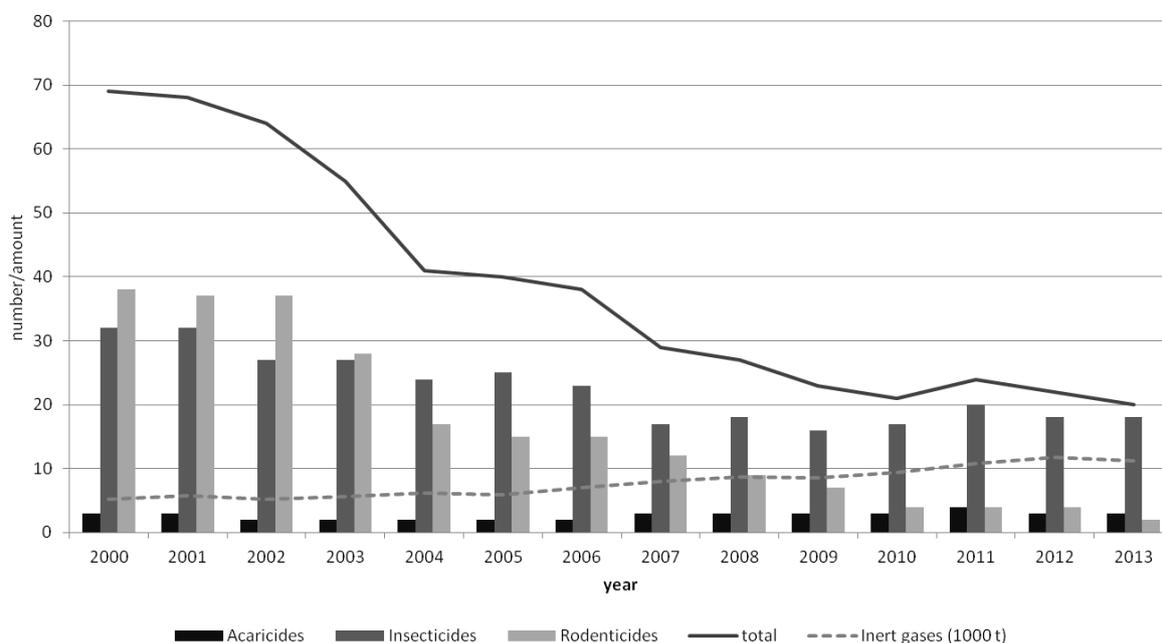


Figure 1 PPP authorized for uses in stored product protection.

In the recent years, the number of active substances also stabilised; currently just nine insecticides, two acaricides and two rodenticides are authorized for applications in stored product protection. Nevertheless, there have been cuts in the last ten years such as the non-inclusion of active ingredients proven as PPP in stored product protection, e.g. methyl bromide, dichlorvos, nitrogen and hydrogen cyanide in the European Union's (EU).

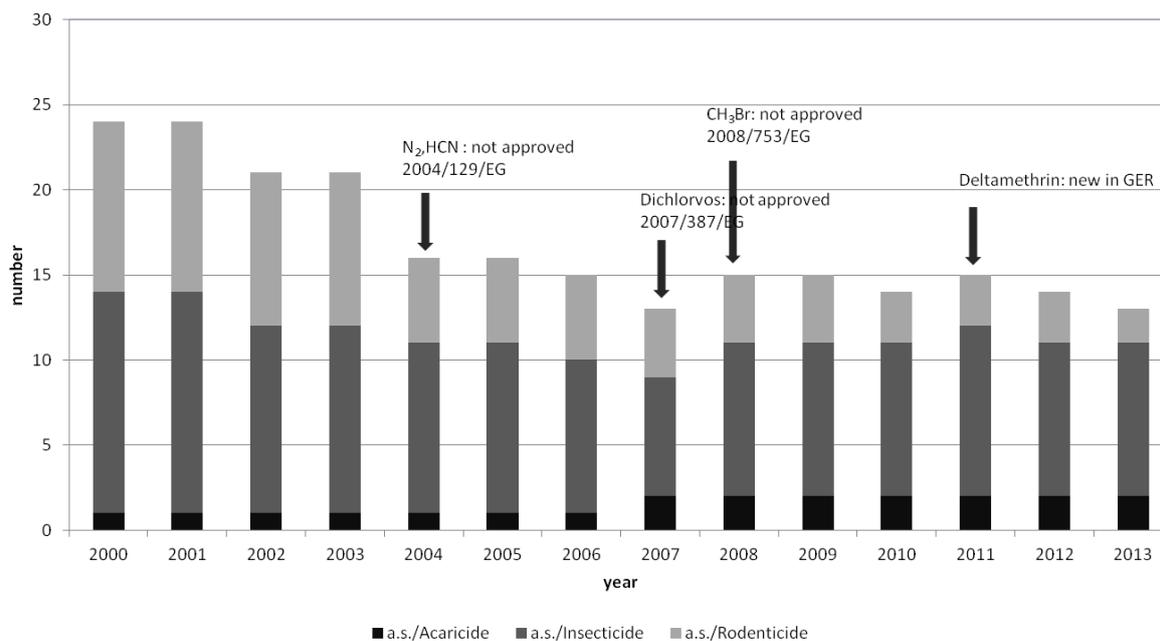


Figure 2 Active substances in authorized PPP for uses in stored product protection.

Any further loss of active substances with a knockdown effect will make it difficult to manage infestations especially in the context with the ‘zero tolerance’. For this reason, the development of pest resistances against contact insecticides and other widely used compounds (e.g. phosphide degassing hydrogen phosphine) could occur even faster than before. According to the marginal options of chemical methods, pest control has to strengthen the role of prevention and monitoring methods. Pest control itself has to be efficient and combined with the Good Agricultural Practice (GAP) defined for all authorized uses and Good Hygiene Practice (GHP) for primary production (Anonymous, 2004).

Five of the insecticidal active substances used in the products for stored product protection, authorized in Germany, are gases and more than half of these products work on the base of hydrogen phosphine. Fumigation with phosphine remains still one of the key methods for disinfestation of stored products like bulk grain, bagged cocoa beans, herbs spices, and tobacco.

Sulfuryl fluoride is one of the other fumigants, in addition to carbon dioxide as an inert gas in stored product protection. For insect control in food and feed factories and other infested empty structures, sulfuryl fluoride has taken the place of methyl bromide. Fumigation often remains the last option if other alternatives of the stored product protection-system have failed or do not represent feasible options. When using the authorized ProFume (containing sulfuryl fluoride) it has to be mentioned that most of the uses only imply the control of post-embryonic stages that are larvae and imago. In Germany, eggs are excluded because the total mortality during applications could not always be ensured under practical conditions. Especially at temperatures below 20°C re-infestation by hatching can occur (Flingelli et al., 2014). Results showed that - under practical conditions and when used in accordance with the proposed label - ProFume can be an effective fumigant for the control of stored product pests. However, the results reflect that the mortality of pests in all stages depends on the sensitivity of the organisms and stages, as well as the conditions of the particular fumigation (e.g. the structure of the facility, leaking rate, temperature) and cannot be easily extrapolated to other situations.

In Germany carbon dioxide is approved as an insecticide and acaricide, but only for uses in stored product protection. The merchandized domestic amount of this inert gas has increased in stored product protection over the last ten years. The actual volume of 11,713 t carbon dioxide in 2012 represents 25% of all active substances in Plant Protection Products emitted in Germany.

The uses of four contact insecticides remain on the German market, they contain diatomaceous earth, deltamethrin, pirimiphos methyl and pyrethrins as active substances. Beside this small number of substances, contact insecticides play an important role in stored product protection because in many practical situations fumigants are not applicable due to lack of gas tightness or other constraints.

The European Directive (Anonymous, 2011) restricts Plant Protection Products containing pirimiphos-methyl to applications with automated systems, hand-held application shall not be authorized. Therefore, the use is limited to the direct treatment of grain in Germany, excluding corn, on conveyors during putting into stock. At the end of 2013 further variations excluded applications on rice, rye and buckwheat.

In 2011 two Plant Protection Products containing the active ingredient deltamethrin were approved; these authorized spray applications could partially compensate the limitations for pirimiphos-methyl containing Plant Protection Products, especially considering agricultural storages and smallholders.

In accordance with Regulation (EC) No 834/2007 (Anonymous, 2007) only indoor applications using Plant Protection Products containing pyrethrins against beetles and moths are available for organic farming.

To control rodents in the agricultural area two Plant Protection Products containing difenacoum (against Brown rat, House mouse, - rat) respectively zinc phosphide (against House mouse) are on the market, but in some regions of Germany genetic resistance against difenacoum has already occurred. The approvals for these uses expire at the end of 2014. Without replacement or new registrations no rodenticides for applications in stored product protection would be available to protect the stored plant product itself. Also, most of the commensal rodents are classified as vectors for pathogens. Therefore, one of the main purposes of using pesticides in this field is the control of organisms that are harmful to human health. For these hygiene uses a lot of biocides are on the market and cover the mentioned gap of Plant Protection Products when it is not intended to reduce direct damage to natural plant products.

Table 1 Active substances in PPP and authorized uses.

Active substance	Function	Summary of approved uses: 'crop/object'
Aluminium phosphide	Insecticide	Empty rooms, sacks, stored cereals, dried fruits, dried vegetables, coffee, cocoa, tea, cereal products (flour, flakes), starch, expeller, spices, pulses
Deltamethrin	Insecticide	Empty rooms (before taking dried pulses and cereals into storage), cereals on the conveyor (during stock transfer and filling)
Diatomaceous earth	Insecticide/Acaricide	Rooms, stored cereals (during filling)
Carbon dioxide	Insecticide/Acaricide	Stored cereals, oily seeds, medicinal plants, tobacco, cereal products, dried fruits, tee, spices, stored goods
Magnesium phosphide	Insecticide	Empty rooms, sacks, stored cereals, dried fruits, dried vegetables, coffee, cocoa, tea, cereal products (flour, flakes), starch, expeller, spices, pulses, oilseeds, medicinal plants, tobacco, hay, nuts
Phosphane	Insecticide/Acaricide	Stored cereals, dried fruits, coffee, cocoa, oily seeds
Pirimiphos-methyl	Insecticide	Stored cereals (excluded corn, rye, rice, buckwheat) direct application on the conveyor during filling
Pyrethrine	Insecticide	Empty rooms (pyrethrum also used in organic farming)
Sulfuryl fluoride	Insecticide	Empty rooms (no co-treatment of cereal or cereal products), dried fruits, nuts, walnuts, hardwood and pinewood (round timber and package/dunnage in containers, for shipment)

Table 2 Authorized uses to disinfest storage facilities in Germany.

Plant Protection Product*	Area of use: 'room'	Notes on the use/situation/restriction
DETIA-GAS-EX B Aluminium phosphide	empty silo cells/compartments empty rooms	-
K-Obiol EC25 Deltamethrin	empty rooms	before taking dried pulses and cereals into storage
SILICO-SEC Kieselgur (diatomaceous earth) *mites	empty rooms mills and storage rooms/granaries rooms	- in the presence of stored goods -
DEGESCH-PLATE Magnesium phosphide	empty rooms	-
INSEKTENIL-Naturpyrethrum-Spray Pyrethrine *plus moths	rooms in mills and storages/granaries	in the presence of cereals, cereal products, products of oilseeds (expeller), nuts, dried fruits, tobacco
INSEKTENIL-Raumnebel-fuerte Pyrethrine *only beetles, moths	rooms in mills and storages/granaries horizontal grain storage	in the presence of cereals, cereal products, products of oilseeds, nuts, dried fruits, tobacco in the presence of bulk grain
INSEKTENIL-Raumnebel-Spray Pyrethrine *Only beetles, moths	rooms in mills and storage rooms/granaries <u>mills</u> : rooms in food processing businesses where plant products were stored and simply processed <u>storages/granaries</u> : incl. storages of food processing businesses and agricultural storages	in the presence of cereals, cereal products, products of oilseeds, nuts, dried fruits, tobacco
ProFume Sulfuryl fluoride * Larvae and imagos, except eggs	rooms in mills and storages/granaries empty rooms, storages and silo cells rooms in mills	- - During fumigation: keep cereals that are stored inside the mill safe under gastight coverage/conditions; keep away milled or husked cereal products

* special other target organisms

3. Challenges and future prospects

Since having only a few active substance classes and a small number of Plant Protection Products it is necessary to step up efforts in research and development of new efficient and sustainable compounds, even if it takes about 10 years between finding and first research tests of a new active substance and the authorization of products. The rising costs of agrochemical research and development at an average of 200 Million Euro (€) make it increasingly difficult

for applicants to justify this effort in the European Union (EU), especially in smaller business domains like stored product protection. At the same time the global challenges like climate change and invasive species need plant protection solutions to establish sustainable intensification of production and to harvest and save yields for about 9.5 Billion people in 2050 (Anonymous, 2000b) worldwide.

Beside efficient prevention and monitoring methods and other non-chemical controlling methods (e.g. heat, cooling) chemical compounds keep their important part within stored product protection even if already infested stored products or storage facilities have to be disinfested. In this context it is important to mention that due to the precautionary principle (Anonymous, 2000a) Plant Protection Products have to be evaluated and undergo a risk-based authorization process. Therefore, authorized Plant Protection Products can be considered 'safe' and do not adversely affect human health. To support this intention Plant Protection Products have to be applied according to integrated pest management, the best available technology and good agricultural practice.

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