
A Study on Stored Wheat Grain Insects and Observing the Effect of Phosphine Gas (PH₃) on Their Viability

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ABSTRACT

This study was conducted during November and September 2025 on stored grain insects (wheat) to determine the effect of phosphine gas (PH₃) on these insects. The results obtained after fumigation showed the death of all insects subjected to the experiment (100%). Approximately one month later, the infestation returned, with the rust beetle and grain borer observed, but their presence was very low, ranging between 4% and 8%. The results confirm that this gas is effective and can be used to control stored grain insects.

KEYWORDS

Warehouse insects, phosphine gas, rusty flour beetle, grain borer.

INTRODUCTION:

Stored grains are important materials in the lives of many people around the world and may be their main source (Athanassiou *et al.*, 2019). These stored materials (which include grains or others) are exposed to damage or loss due to the lack of suitable storage conditions, the most important of which are the surrounding environmental conditions of temperature and humidity (inside the grain). The lack of these conditions leads to these grains losing their nutritional and economic value (Banga *et al.*, 2020). One of the most important of these pests is insects, which are among the most dangerous pests that lead to significant economic and food losses. These insects cause a deterioration in the (quality and quantity) of stored grains (Beloshapka *et al.*, 2019). The losses caused by insects to stored materials have been estimated at about 4-10% of the global production rate. The presence of insect remains among the stored grains leads to an increase in the percentage of urea in the micro-products. This substance is considered toxic and leads to changes in the living components, thus affecting the milling processes. This results in difficulty in aeration and moisture absorption, and increases the percentage of water content in the grains, which leads to a weakening of the effect of powders added to the stored materials to control pests. The fumigant phosphine insecticide has been used in preventive treatment methods. It is a chemical substance that forms under a specific temperature and pressure in the gaseous state. One of its advantages is that it leads to a decrease in the respiration of insects, thus causing them to die by suffocation. It is highly toxic to insects and is recommended for use and safe according to the dosages (Abels and Ludescher. 2022).

MATERIALS AND METHODS:

1-Research Location: This study was conducted at the Tikrit silo, and the results were analyzed in an external laboratory.

2-Sampling Method: Samples (experimental samples) were randomly collected from three areas (top, middle, and bottom) of the materials before and after evaporation, with one kilometer taken from each sample.

3- Method of using PH₃ phosphine pesticide: This pesticide was used by adding phosphine pesticide tablets via a dispenser device. This is done by mixing this pesticide with the wheat during the stage of filling the experimental container or (tank) with wheat. Approximately 4 tons of wheat subjected to fumigation were used. As for the amount of pesticide used, it is 14 tablets = $0.6 \times 14 = 8.4$ kg per ton. The gas will be released half an hour after opening the container containing the pesticide tablets. The grains used in the experiment are remnants of materials found inside the warehouses, which were then collected inside the experimental tank. They were also exposed to contamination due to their presence for long periods of time.

4-Methods used to estimate the degree of infestation:

A- Method of estimating the apparent infestation percentage: In this method, a 2 mm diameter sieve was used because it allows some insects to pass through, while larvae and other larger insects will remain inside the sieve. During the process of moving the sieve, the insects will fall onto the surface of a plastic container prepared for storage. The wheat grains will remain inside the sieve, after which the insect stages are sorted and counted.

B- Method of estimating the percentage of internal infestation: In this method, the manual method was followed to identify light infestations and to estimate the percentage of infestation thereof. One kilogram of the sample was taken from three locations (top, middle, and bottom) of the material that was studied and was divided into 12 parts weighing 100 kg. Each 100 kg of the material (the grains) was placed inside a container containing boiling water. The grains were observed floating on the surface of the container. After that, the floating grains were taken and dissected to detect larvae, pupae, and adult insects. Then the counting process was carried out using either a light microscope or a hand lens. When the internal infestation is combined with the external infestation, the true infestation will be obtained (Ahmady *et al.*, 2016).

RESULTS AND DISCUSSION:

The results obtained from collecting samples from the Tikrit silo to assess visible and infestations within the grains, which were very numerous before fumigation with phosphine, show that many grain insects were found, including the grain borer (*Rhizopertha dominica*), the wheat weevil (*Sitophilus granaries*), the rusty flour beetle (*Tribolium costaneum*), and the grain borer (*Trogoderma granarium*). The examination results showed that the most prevalent and damaging insects to the grains were the rusty flour beetle and the grain borer. This study is consistent with Al-Hakimi and Rajih (1993), who observed a large number of these insects before treatment with phosphine gas. The results of Table No. (1) show the presence of insects according to the number per kilogram and according to the severity of the infestation, from the absence of any insects (clean) to the presence of large numbers (very high

infestations). These results are consistent with (Matlaha, 2002) according to taking samples from the same places (from three locations for one pile or one ton).

Table (1): Shows the damage per kilogram and the actual damage to the material

ت	Number of injuries per kilogram	The actual injury of the grains
1-	Free from insect infestation	Clean (no injuries)
2-	1 - 4	minor injury
3-	5 - 6	moderate injury
4-	7 - 10	severe injury
5-	Large numbers of insects	very serious injury

The results showed that phosphine gas (fumigation) at concentrations of 3, 5, and 7 grams per ton can be used consistently. These concentrations will lead to a 100% insecticide kill without affecting the stored grain; it will only eliminate the insects present. These results are consistent with Abbott (2019), who confirmed the elimination of all insects present in one ton of grain. The presence of these insects (rust flour beetles, grain borers, and grain weevils) leads to the spoilage of a large number of grains, in addition to altering the taste of the grains and creating moisture between the grains, which in turn leads to the presence of bacteria and fungi. When used, phosphine gas eliminated all these problems, provided that it is reapplied periodically to control these insects (Clarke, 2022). The experiment was repeated several times on 4 tons of infested grain at the same concentrations, and the results showed 100% elimination of all present insects. These results were consistent with Robinson and Bond,(2019)

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