SULFURYL FLUORIDE AGAINST ALL LIFE STAGES OF RUST-RED GRAIN BEETLE (*CRYPTOLESTES FERRUGINEUS*) AND MERCHANT GRAIN BEETLE (*ORYZAEPHILUS MERCATOR*)

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1. Introduction

The rust-red grain beetle (*Cryptolestes ferrugineus*) and the merchant grain beetle (*Oryzaephilus mercator*) belong to the important store product insect pests in stored cereals and oil seeds and other fat containing products. If present, the thorough disinfestation of flour mills, grain elevators as well as food and feed factories must include the complete control of all stages also of these pests. Sulfuryl fluoride (SF) is considered to be the viable alternative for methyl bromide against many pests and in many situations of pest control. Literature data are very scarce on theses two insects.

All life stages of the two species were investigated for their susceptibility towards SF under different conditions. Unlike *O. mercator*, two strains of *C ferrugineus* (phosphine resistant and susceptible) were investigated in this study.

2. Material and Methods

The insects were taken from the long established culture (25°C, 65% r.h., yeast, glycerol, glucose and water) of the Institute for Stored Product Protection in Berlin, Germany. Each life stage was exposed for 24 h, 48 h and 72 h, respectively, to three concentrations (approximately 10 g/m³, 20 g/m³ and 30 g/m³) at 15°C, 20°C and 25°C, respectively, and 65% r.h.. A **F**ourier **T**ransform **I**nfra**r**ed (FTIR) spectrometer served to determine the concentrations (figure 1). Following the exposure the samples were assayed for surviving adults.

3. Results and discussion

A strong correlation was observed between mortality and temperature, concentration as well as exposure times (figure 2, 3 and 4). Adults of all tested insects did not survive the lowest concentration (10 g/m³), temperature (15°C) and shortest exposure time (24 h) (ct = 240 gh/m^3).

72 h were sufficient to control all strains and life stages of the tested insects with the lowest dosage (10 g/m^3) at the lowest temperature (15°C) except for the susceptible *C. ferrugineus* which required 20 g/m³. In all samples and at all tested temperatures, 24 h and 48 h of exposure to 10 g/m³ were not sufficient to achieve complete mortality. Differences in the response of resistant and susceptible *C. ferrugineus* varied at the different fumigation conditions. For the control of both tested strains of *C. ferrugineus* at 20°C and 25°C, 20 g SF/m³ and 48 h exposure period were sufficient.

The susceptible strain of *C. ferrugineus* was more tolerant against 10 g/m³ and 20 g/m³ SF at 15°C in 24 h exposure than the resistant strain. These findings are consistent with previous research (Bell et al. 2003) that demonstrate no cross resistance conferred to SF in phosphine resistant insect strains.
With *O. mercator,* 72 h at 15°C with 10 g/m^3(mortality 100%), 48 h at 20°C with 30 g/m^3(mortality 100%) and 24 h at 25°C with 30 g/m^3 (mortality 98.4%) controlled all investigated insects. All insects were killed within 48 h exposure at 25°C with 30 g/m^3.
The experimental laboratory data support that a ct product of 1500 gh/m³ is sufficient also to control all life stages of the investigated two beetles at all temperatures tested, 15-25°C. The inverse relationship between increasing temperature and decreasing ct product requirements for SF has been well documented. (Bell et al. 2003, 2004) (Reichmuth et al. 2003).

4. References

Reichmuth, Ch., Rassmann, W., Binker, G., Fröba, D., Drinkall, M. J. (2003): Disinfestation of rust-red flour beetle (*Tribolium castaneum*), saw-toothed grain beetle (*Oryzaephilus surinamensis*), yellow meal worm (*Tenebrio molitor*), Mediterranean flour moth (*Ephestia kuehniella*) and Indian meal moth (*Plodia interpunctella*) with sulfuryl fluoride. In: Credland, P. F., Armitage, D. M., Bell, C. H., Cogan, P. M., Highley, E. (Eds.). Proc. 8th Int. Work. Conf. St. Prod. Prot., York, UK, 22-26 July 2002, 736 - 738.

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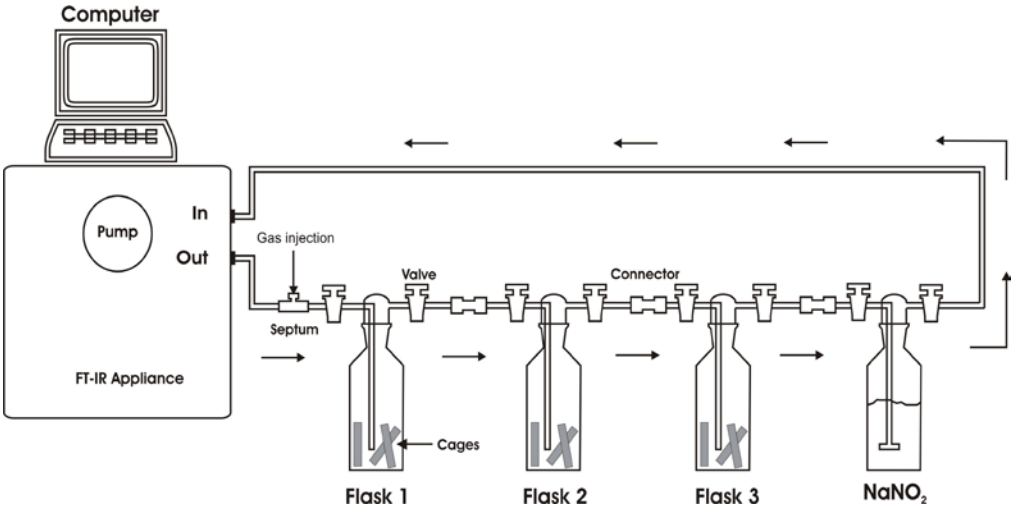
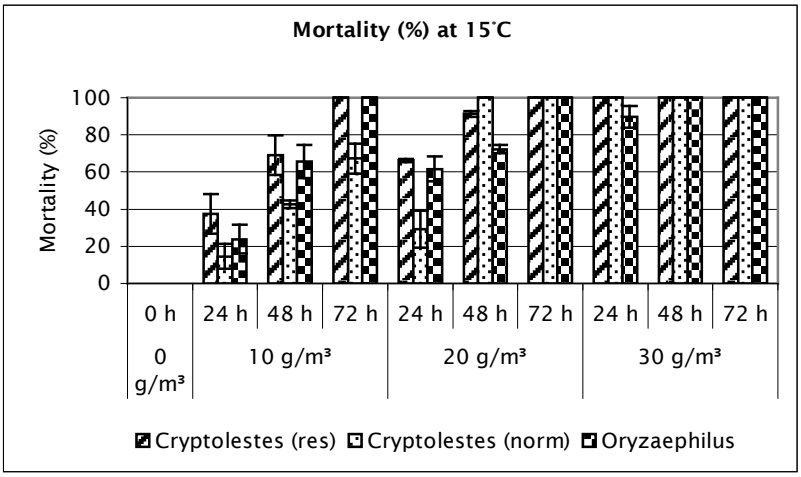
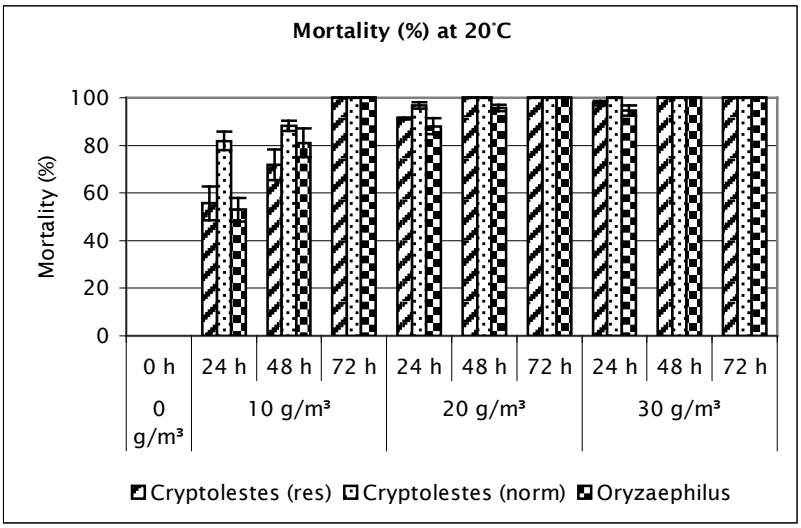
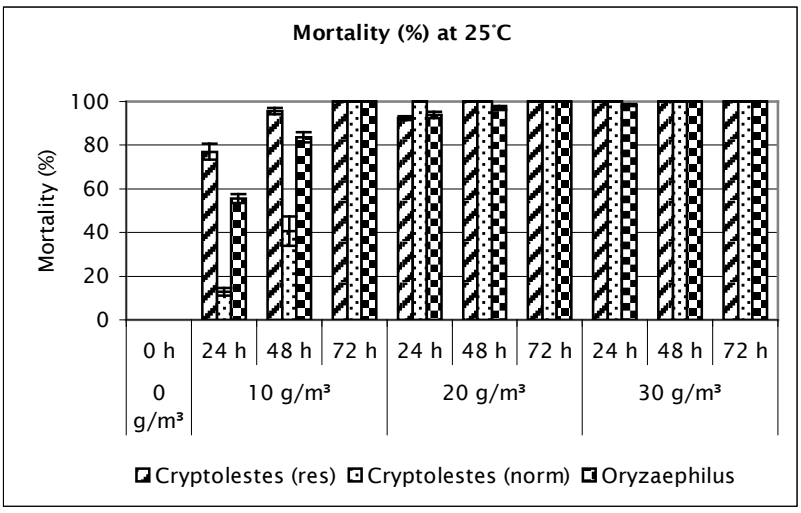


Figure 1: The method for SF fumigation: The gas was injected through the septum into the circulating air/gas-mixture. The mixture was re-circulated through the flasks by use of the pump within the FT-IR. The FT-IR apparatus determined the concentration of SF in the gas tight system and transferred the concentration data each 20 seconds into the linked computer.







Figures 2 to 4: Mortality of all life stages of susceptible (norm) and phosphine resistant rust-red grain beetles (*Cryptolestes ferrugineus*) and merchant grain beetles (*Oryzaephilus mercator*) after exposure to sulfuryl fluoride (10 g/m³, 20 g/m³, 30 g/m³, at 15°C, 20°C, 25°C for 1 day, 2 days and 3 days)