higher ozone concentrations to elicit similar effects (Hassan et al., 2012). Longer exposure durations and or higher concentrations will also be required to be able to control *S. oryzae* adults placed at the 25 cm depth of the PVC pipes. Ozone adsorption in grain layer depends on factors such as the ozone concentration supplied to the layer, ozone degradation rate, and the exposure duration to ozone (Tojanowska, 1991). Hence, longer exposure periods and or higher ozone concentrations may be required to control *S. oryzae* adults placed in deeper depths of a wheat column.

Germinations tests

Wheat germination was not adversely affected when seeds were exposed to 200 ppm up to 24 hours (Fig. 2). However, percentage germination was reduced, when compared to control germination at 5 cm depth, beyond the 36 hour-exposure to ozone at 200 ppm. Germination of wheat seeds considerably decreased when wheat was exposed to 60 hours at depths of 15 or 25 cm. Seeds collected and germinated from the 5 cm depth at 60 hours of exposure had germination closer to 0%. To our knowledge this is the first experiment to report effect of ozone on germination of wheat seeds in relation to insect mortality. It is clear with this study, that prolonged exposure of grain to ozone may adversely affect the germ quality. If grain is stored for seeding and cultivation purposes, or extracting germ for commercial uses, care must be taken if ozone treatment is an option for stored insect management.

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References

HASSAN, M., PHILLIPS, T. W. & M. J. AIKINS, 2012: Potential for ozone fumigation against anobiids beetles infesting stored products as an alternative to methyl bromide – conference proceedings of the 9th International Conference on Controlled Atmosphere and Fumigation in Stored Products, Pp 260-265. October 15-19. Antalya, Turkey.

MAHROOF, R., AMOAH, B. AND J. WRIGHTON, 2018. Efficacy of ozone against the Life stages of *Oryzaephilus mercator* (Coleoptera: Silvanidae). Journal of Economic Entomology **111**: 470-481.

SAS Online Document 9.4. 2013: SAS Institute, Cary, NC, USA.

TROJANOWSKA, K. 1991: Evaluation of cereal grain quality using mycological methods: Cereal Grain Mycotoxins. Fungi and Quality in Drying and Storage (ed. Chełkowski, J.) 1991,185-215. Elsevier, Amsterdam.

Update on ProFume® gas fumigant (sulfuryl fluoride) use for post-harvest pest control

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ProFume® gas fumigant (99.8% sulfuryl fluoride), first registered in 2003, is a broad spectrum, non-ozone depleting fumigant for the control of rodent, insect and other invertebrate pests. It is used to treat a wide range of stored products and structures which transport, store, and process commodities and is currently registered in 22 countries. Sulfuryl fluoride is not cross-resistant with phosphine and has been documented to effectively control quarantine pests, including the pinewood nematode and brown marmorated stinkbug.

Continued reduction of methyl bromide availability for non-quarantine fumigations coupled with the emergence of phosphine tolerant or resistant populations has led to increased interest in registration of sulfuryl fluoride in several tropical and sub-tropical countries. As part of the registration effort additional efficacy data has been developed to support the use in these countries. hile found in temperate zones, both Flat grain beetle (*Cryptolestes pusillus* (Schönherr)) and Maize Weevil (*Sitophilus zeamais* (Motschulsky)) are more problematic in tropical environments. As

sulfuryl fluoride was developed mainly for use in temperate zone countries, limited efficacy data has been developed for these pests. In 2018, laboratory studies were conducted in California by the Dried Fruit and Tree Nut Association (DFA, Fresno, CA, USA) to determine the dosage required for control of all life stages of these pests. The results of this study coupled with earlier work may allow for inclusion in the Fumiguide® program.

The Fumiguide program is required for use with ProFume to calculate dosage and dose requirements. The program allows users to tailor applications based on job specific parameters to best meet customer needs for cost and time. The new Fumiguide includes improvements in the underlying algorithms, additional functionality for fumigators and the ability to easily add new pests.

Since the purchase of sulfuryl fluoride from The Dow Chemical Company in 2015, Douglas Products has continued to expand product use through new country registrations, expanded efficacy data and development of an updated Fumiguide program. This presentation provides updates on registrations for ProFume, details efficacy work for two insect species of interest in tropical regions, and reviews the updated Fumiguide program, a required tool for dose and dosage determination.

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Nitric oxide as a new fumigant for postharvest pest control

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Abstract

Nitric oxide (NO) is a new fumigant for postharvest pest control. It is effective against all pests tested to date, including external and internal pests of fresh and stored product insects, and mites. Efficacious treatment time ranges from 2 h to 72 h, and NO concentrations range from 0.1% to 5%, depending on species and life stages of the pests.

Nitric oxide fumigation must be conducted under ultralow oxygen conditions because NO reacts with O_2 spontaneously to produce nitrogen dioxide (NO_2), which is toxic to perishable fresh products. Fresh product fumigation must, therefore, also be terminated by flushing with N_2 to dilute NO at the end of fumigation to avoid damage to delicate products by NO_2. Nitric oxide fumigation was safe in small-scale tests to postharvest quality of all fresh commodities when terminated with N_2 flush. In addition, NO fumigation resulted in better postharvest quality of strawberries and apples as compared with controls, indicating its beneficial effects on postharvest quality of fresh products.

Twenty fresh fruit and vegetables and 10 stored products were fumigated with NO to determine residue levels of nitrate and nitrite. When terminated properly with N2 flush, NO fumigation does not increase nitrate or nitrite levels in fumigated products. NO fumigation was demonstrated to be effective against all pests, safe to fresh products, and has no toxic residues and, therefore, has the potential to be a practical alternative to methyl bromide fumigation for postharvest pest control on both fresh and stored products.

Keywords: Nitric oxide, fumigation, quarantine treatment, residue, postharvest quality.

Introduction

There is a severe lack of safe and effective alternative treatments for postharvest pest and disease management after phasing out of methyl bromide. The current main alternatives, including phosphine and sulfuryl fluoride, have difficulties in meeting the need for postharvest pest control on stored products or fresh commodities. Phosphine fumigation typically has long treatment time and is not effective against some pests due to tolerance or resistance (Hole *et al*., 1976; Benhalima *et al*., 2004). Sulfuryl fluoride is not effective against insect eggs (Bell *et al*., 1998) and therefore has limited efficacy in addition to its phytotoxicity to fresh products (Aung *et al*., 2001). Nitric oxide (NO) is a newly discovered fumigant for postharvest pest control and has high efficacy against insects