METHYL BROMIDE ALTERNATIVES FOR STRUCTURE DISINFESTATION: A EUROPEAN PERSPECTIVE.

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Europe uses approximately 1,000 t of methyl bromide annually for structural pest control. The southern countries, Spain, France, Italy and Greece, are the major consumers. The European Union has proposed to ban the use of methyl bromide by 2001, with some critical use exemptions. The purpose of this paper is to give some concrete examples of methyl bromide alternatives being tested or used under industrial conditions in Europe today.

HIGH PRESSURE CARBON DIOXIDE: FRANCE and GERMANY

Carbon dioxide has been studied as a fumigant for decades in the laboratory, and there are now several examples of it being used to control insects in the food industry. However it still remains slower-acting and more expensive than phosphine or methyl bromide. To address these problems, the Stored-Product Pests Laboratories at Bordeaux and Berlin have investigated the use of high pressure and carbon dioxide (Table 1, Le Torc'h, J. and F. Fleurat-Lessard, 1990; Reichmuth and Wohlgemuth, 1994). After extensive testing in the laboratory, a high pressure fumigation chamber was designed and built in collaboration with MG SIAC (France). The chamber can hold 32 palettes, or the equivalent of the contents of one transport trailer. The unit is designed to recuperate at least 85% of the carbon dioxide used. The pressure rises to 19 atmospheres in 90 minutes, is held there for 60 minutes and takes about 30 minutes to release the pressure. With loading, fumigation and unloading, a full cycle takes approximately four hours. To verify the effectiveness of the unit, red flour beetle adults and Indian meal moth larvae were placed in bags of pet food, the commodity to be fumigated, and the bags placed throughout the chamber. None of the 3200 red flour beetles or the 1600 Indian meal moth survived the fumigation. The unit cost approximately 3,000,000 FF ($750,000 US) to build in 1995, and it uses 300-400 kg of CO_2 per fumigation. This is the first example of high pressure carbon dioxide fumigation at an industrial scale. There is another unit built in Germany by another company that is used for fumigating spices.

SULFURYL FLUORIDE AND CARBON DIOXIDE FUMIGATION: GERMANY

In Germany since 1993, MeBr can only be used in special circumstances, so there has been an active search for alternatives. As a partial replacement for MeBr, sulfuryl fluoride (SO_2F_2, trade name Altarion® Vikane, DowElanco) has been recently registered for use in Germany as a space fumigation in non-food areas (e.g. museums, churches, artifacts). To minimize the amount of sulfuryl fluoride used, a hand-held calculator has been designed to determine the amount of sulfuryl fluoride

needed. It takes into consideration: target insect, stage of development, volume to be fumigated, duration of fumigation, temperature, airtightness of the building, and wind velocity. Carbon dioxide

has also been used to fumigate entire churches. The church is covered with a tarpaulin, the fumigation takes several weeks and requires several tonnes of CO_2. This method is successful at controlling wood boring pests, but is considerably more expensive than traditional fumigations.

SPOT HEAT TREATMENT IN FLOUR MILLS: SWEDEN AND NORWAY

A group in Scandinavia has shown that spot heat treatment controls insects in roller stands in flour mills. Roller stands were covered with a tarpaulin and flexible ducts were used to direct heat into the machinery. High temperatures ranged from 60 to 80°C, and all test insects placed in the machinery were killed. The heating took only four hours and the technique is proposed as a method to control insects in high risk areas, without stopping production for several days, as is needed for MeBr fumigation.

The advantage of the spot treatment is that it is rapid, treats high risk areas, minimizes the amount of heat needed for a treatment. The main disadvantages are that it does not control all insects at once in the mill, allowing the treated equipment to become reinfested after treatment, and requires the installation of heat tarpaulins over the equipment to be treated (Norstein, 1996).

CONTROL OF MOTHS USING PHEROMONES IN FLOUR MILLS: ITALY

Flour mills in Italy have used mass trapping or attracticide to reduce by half the number MeBr fumigations (Trematerra, 1994). The main insect pest in Italian flour mills is the Mediterranean flour moth (*Ephestia kuehniella*). By placing several high capacity pheromone traps throughout a flour mill (one every 260-280 m^3), Mediterranean flour moths were reduced over a three year period (Table 2). Another method, attracticide, was also able to significantly reduce moth populations. Pheromone dispensers are treated with an insecticide, cypermetherin. Male moths are attracted to the lure, and receive a lethal dose of insecticide when they land on the lure. These methods have yet to be attempted against insects that have aggregation pheromones, such as the red flour beetle (*Tribolium castaneum*) or the confused flour beetle (*T. confusum*), insects that are the major pests of flour mills and other food processing plants in Canada and the USA.

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TABLE 1. THE MINIMUM DURATION NECESSARY TO COMPLETELY CONTROL VARIOUS INSECTS AT A GIVEN STAGE UNDER HIGH PRESSURE CO_2 FUMIGATION.

Insect	Stage	Duration (min)			
		CO2 Pressure (atmospheres)			
		10	13	16	19
Red Flour Beetle	egg	>240	ca. 240	120	60
	larva	240	120	120	45
	adult	240	90	90	15
Hide Beetle	egg	>240	60	<60	30
	larva	240	90	30	45
	adult	240	90	60	45
Indian Meal Moth	egg	>240	45	<60	<45
	larva	120	60	30	15
	adult	120	45	30	15

TABLE 2. THE CONTROL OF THE MEDITERRANEAN FLOUR MOTH USING MASS TRAPPING AND ONE FUMIGATION A YEAR.

Year	Moths in Traps (#/trap/year)	Residual Moths (%)	Filth Test
1987	240	3.4	under the limits
1988	62	2.3	under the limits

1989	39	2.3	under the limits

Taken from Trematerra (1990), as well as Trematerra unpublished data

Acknowledgments: We would like to thank, Gerhard Binker, Patrick Ducom, Hakan Kjellberg, Stein Norstein and Pasquale Trematerra ,who provided us with information.