NOVEL NON-CHEMICAL MB ALTERNATIVES FOR POSTHARVEST TREATMENTS

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Existing gaseous alternatives to methyl bromide (MB) and phosphine suffer from the limitation that they may be useful for treating a particular type of commodity or for application in a specific situation only. Restrictions on the use of fumigants have resulted in efforts to develop new technologies as alternative control methods. The non-chemical alternatives are mainly physically based technologies that include manipulation of temperature, and modified atmospheres (MA). The aim of this paper is to elucidate these new application technologies that are commercially available to replace fumigants and particularly MB in stored products.

a) High temperatures

Thermal Disinfestation of dates

A treatment that causes the insects to abandon the fruit is more important than one that kills them since it actually disinfests the fruit. The effectiveness of heat in causing emigration and mortality of *Carpophilus* spp. larvae from dates was studied. It was shown that the average disinfestation value obtained was greatest at exposure to 50^{o}C and the difference between this value and those at 45^{o} and 55^{o}C was highly significant, the highest mortality values reaching 100% being obtained at 50^{o}. In field trials, the feasibility of applying heat for the disinfestation of dates using a date drying facility was demonstrated. The heat treatment is now being used to replace the conventional fumigation with MB. This technology was employed in three packing houses during the 2005 season and three more packing houses have now arranged to adopt the thermal treatment technology in Israel (Navarro 2006a).

b) Non-residual gaseous treatments, modified atmospheres (MAs):

Disinfestation of dates using MAs

As a potential alternative to MB fumigation, the influence of different CAs in causing emigration of *Carpophilus* spp. larvae from dates was compared with that of MB. A concentration of 35% CO_2 was found to cause a similar emigration to that by MB. This method has been in use in a large packing house in Israel (Navarro 2006a).

Application of MAs at elevated temperatures

The influence of temperature on the length of time necessary to obtain good control with MAs is as important as with conventional fumigants. Laboratory results clearly indicate that raised temperatures could be used to reduce treatment duration. Bell and Conyers (2002), Donahaye et al. (1994), and Navarro et al. (2003), showed the strong influence of increased temperatures on enhanced mortality of storage insects. These works led to the application of MAs at elevated temperatures by ECO_2 in Holland with the objective of reducing the exposure times commercially to control pests in imported tobacco products, cocoa beans, rice, cereals, grains, nuts, peanuts, pulses, seeds and spices, as well as furniture and artifacts.

Vacuum treatment and V-HF technology

In a low-pressure environment, there is a close correlation between the partial pressure of the remaining O_2 and the rate of kill. Until recently, this treatment could only be carried out in

specially constructed rigid and expensive vacuum chambers. A practical solution has been proposed named the vacuum hermetic fumigation (V-HF) process that uses flexible liners (Finkelman et al. 2003). To achieve this, sufficiently low pressures (25-50 mmHg absolute pressure) can be obtained (using a commercial vacuum pump) and maintained for indefinite periods. This technology is currently in use at the commercial level for pest treatment of organic soybeans and flours in Israel.

Narcissus bulbs treatments

The large narcissus fly *Merodon eques* F. attacks narcissus bulbs and also bulbs of other geophytes. This species is a quarantine pest where complete mortality is required prior to export from Israel. Fumigation with MB has been used to eliminate narcissus fly infestation in flower bulbs due to its rapid killing time (4 h). However, MB is also known for its phytotoxic effect on the bulbs and its use is discouraged even for quarantine purposes in developed countries. Donahaye et al. (1997) found extremely rapid depletion of O_2 within the sealed gastight enclosures due to the respiration of the newly harvested bulbs. This procedure also revealed the significant anoxia achieved within less than 20 hours (less than 0.1% O_2 and about 15% CO_2) during treatment at 28°C to 30°C and the possibility of using it alone as a control measure. The possibility of obtaining a bio-generated modified atmosphere utilizing the bulb respiration alone was adopted by Israeli farmers as a practical solution using specially designed flexible treatment chambers (Navarro 2006b; Navarro and Donahaye 2005). This MA method has been successfully applied by the narcissus bulb growers in Israel and fully replaced the use of MB since 2003.

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