CANADIAN RESEARCH ON METHYL BROMIDE ALTERNATIVES IN POST-HARVEST GRAIN AND IN STRUCTURAL TREATMENTS

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Scientists conducting research on stored-product management in Winnipeg, Manitoba are currently studying several methods of insect control which could be applied to mills or ships or for quarantine use as alternatives to methyl bromide. In Canada, only phosphine and carbon dioxide are registered for use on grains and oilseeds while 55% of all methyl bromide is used as a space fumigant (45% for soil) with a total of 267 tonnes applied annually.

Various projects have involved diatomaceous earth, mill sanitation, heat, and cold. Two examples are the development of: 1) an integrate control program to control Indianmeal moth *Plodia interpunctella* (Hübner) in a seed packaging plant/warehouse; and 2) physical models of CO_2 diffusion to predict the length of time the gas can be maintained at levels high enough to kill pests.

1. Seed Packaging Plant (see figures 1 and 2). An integrated control program was initiated in 1993 using pheromone traps to monitor the Indianmeal moth, sanitation, treating corn with diatomaceous earth, and a cold-temperature "freeze-out" of pests in December.

   Laboratory tests showed a need for 50 days at 0°C, over 10 days at -5°C and 1 day at -10°C, to control unacclimated Indianmeal moth, those that would be found in heated areas of the building. To control the most cold hardy stage that would occur on the seed storage floor in mid winter, over 14 days at -10°C or 1 day at -15°C are needed.

   The 1993 freeze-out on the seed storage floor obtained temperatures of -17°C for seed packets, and -9°C for the middle bag stack made up of 40 bags. By the end of the 10 day freeze-out all insects were killed in the packets, 90% of the insects were killed in a single bag and 65% were killed at the middle of bag stacks.

   The freezing points of the Indianmeal moth larvae range from -7°C for the non-diapausing non-acclimated to -13°C for the diapausing acclimated. This explains why no insects survived one day at -15°C. For the non-diapausing non-acclimated insects, 95% were killed after 1 day at -10°C.

   Treating corn prior to packaging with diatomaceous earth at the recommended rates gave excellent control of the Indianmeal moth.

   For the first 5 months of 1993, there were 631 insects caught in pheromone traps in the plant. For the same period in 1994 there were 13 moths caught, a 98% reduction in insects from the previous year.

2. Prediction of CO_2 Movement. On-going research is aimed at developing and validating a CO_2-loss model based on the measured leakage area of storage structures using fan pressurization tests, and on weather data such as wind velocity, ambient temperature, and pressure. The CO_2-loss model will be integrated with our model of CO_2 movement (Alagusundarum, K., D.S. Jayas, W.E. Muir, N.D.G. White and R.N. Sinha. 1994. A finite element model of three dimensional carbon dioxide movement in grain bins. Transactions of the Am. Soc. Agric. Eng., in press) for use by managers of storage facilities, engineers, and farmers in designing and operating control strategies to kill stored-product insects in welded-steel bins, concrete bins, and railcars using modified atmospheres. The integrated mathematical model will be used for predicting the optimum purging rate required to attain desired CO_2 levels in the storage systems, for assessing the methods of application of CO_2 for uniformity of distribution, and for predicting the maintenance rate required to maintain the CO_2 level. Effects of changes in weather conditions will be incorporated in the model based on the application of fundamentals of physical and engineering sciences. The experiments conducted in welded-steel bins will be used for the validation of the mathematical model. A relationship between insect mortality and CO_2 concentration, time, and temperature will be developed for inclusion in the mathematical model based on our laboratory and small-bin tests.

The replacement of methyl bromide is often best addressed by using physical controls, including sanitation, in a comprehensive integrated pest management system.

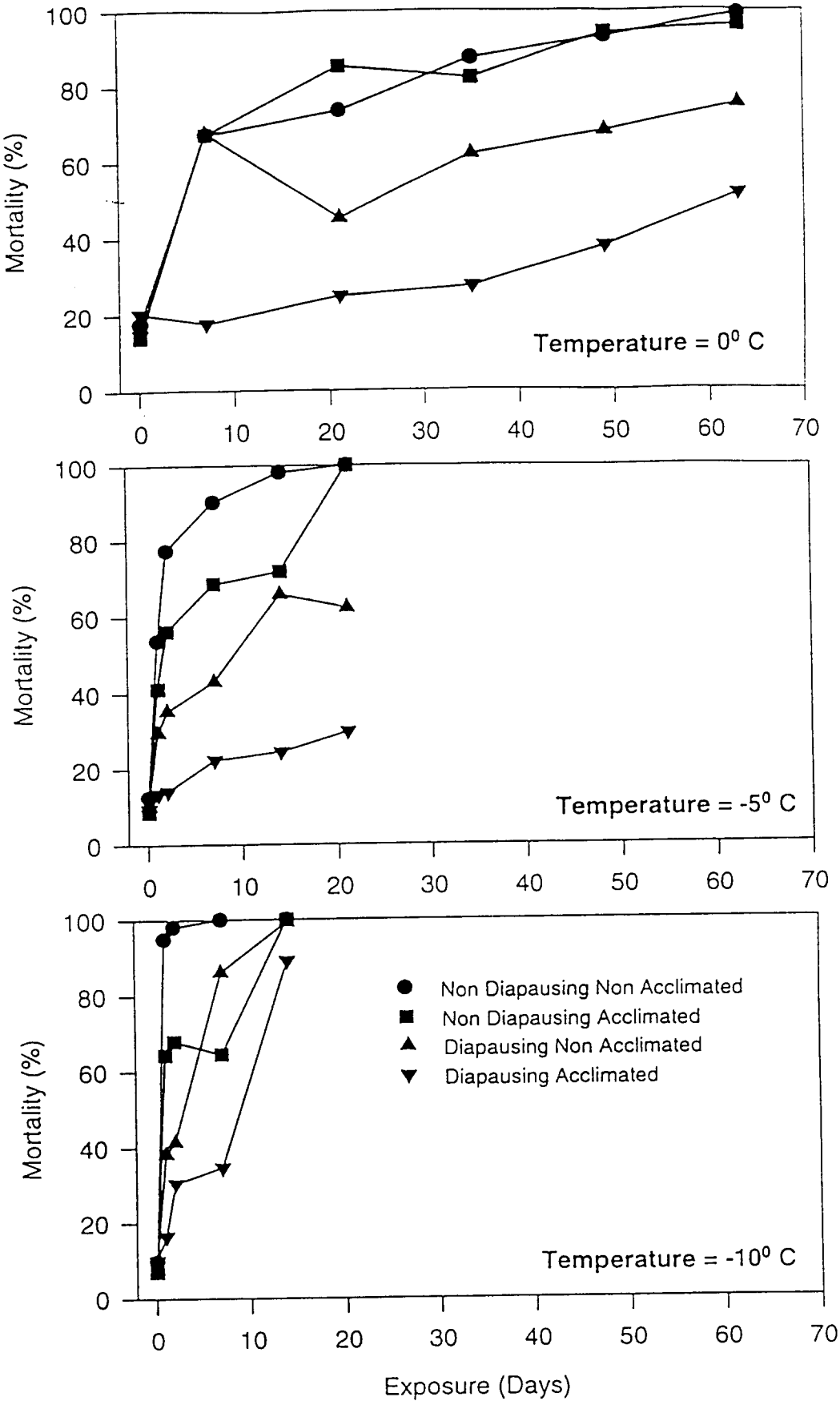

Fig. 1. The effect of low temperature on the survival of Indianmeal moth in the laboratory. All insects were dead after 1 day at -15° C.

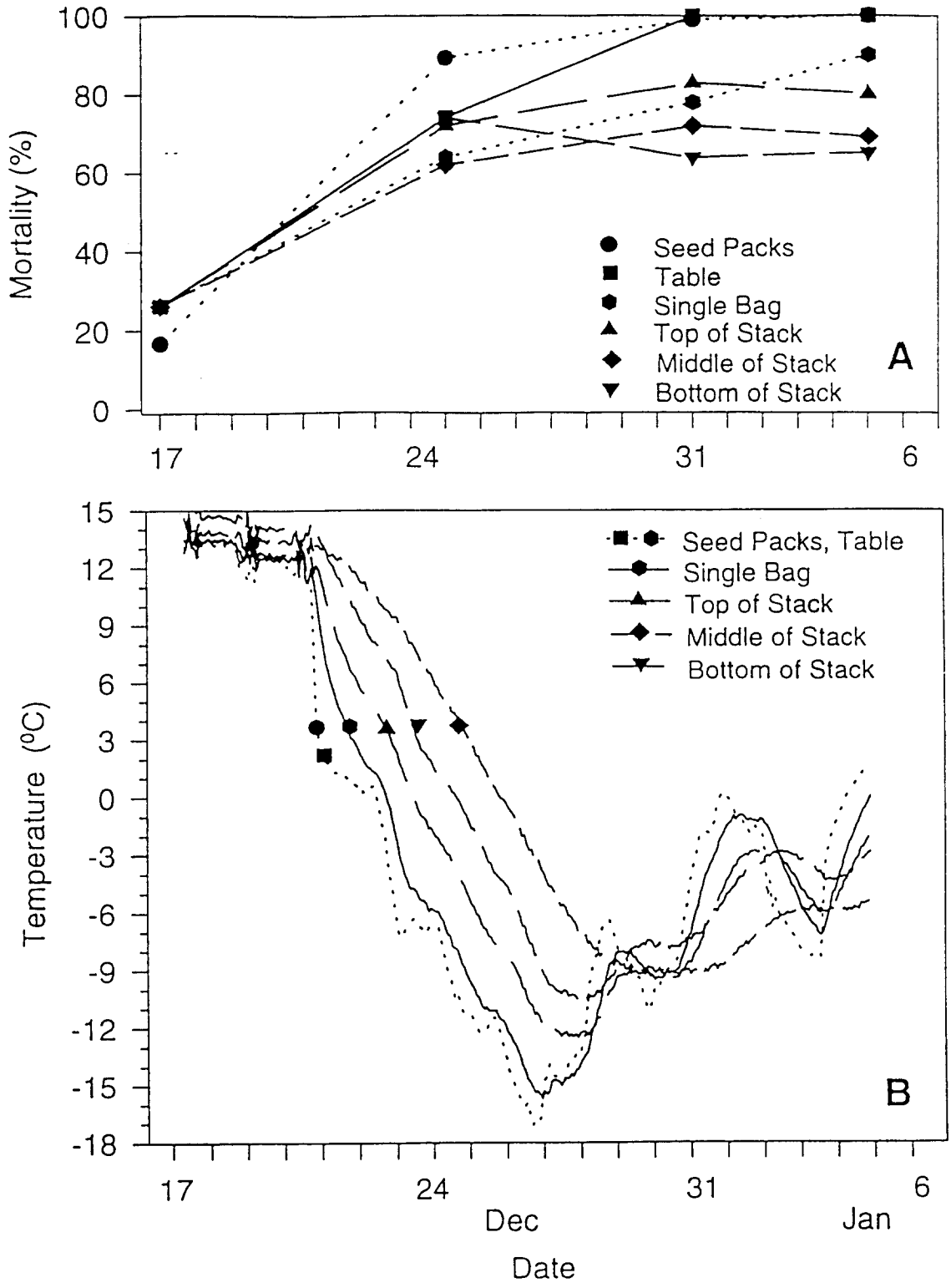

Fig. 2. A - Mortality of Indianmeal moth during the 1993 freeze-out on the seed storage floor. Insects in seed packs were non-diapausing non acclimated, while others were diapausing acclimated. B - temperatures at various locations during freeze out.