MONITORING THE EFFICACY OF FLOUR MILL FUMIGATIONS

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Methyl bromide is still widely used in food processing and storage facilities for the suppression of stored-product insect pests. Development of alternative control tactics has been hampered by the limited information available about the impact of fumigation on pest populations, the mechanism and timing of population rebound, and how best to monitor these factors. In flour mills, monitoring information primarily comes from directly counting insects obtained from product samples or sieved from the product stream and from pheromone baited traps. Pheromone trapping holds a great deal of promise, but because it captures dispersing individuals the relationship between pheromone trap capture and level of infestation within the building is not well established. There is a need for more information about pest populations in food facilities and the effectiveness of current management and monitoring tactics to facilitate the development of alternatives.

Stored-product insects tend to be patchy in distribution and can be highly mobile. It is likely that stored-product pest populations are made up of subpopulations that are interconnected by dispersal. Therefore, an important factor in evaluating management and monitoring programs is to determine on what spatial scale these sub-populations is interacting. If subpopulations are interacting over spatial scales larger than an individual structure such as a flour mill, then during a whole structure treatment, such as fumigation, only some of the subpopulations will be affected and pheromone trapping may not accurately indicate the infestation level or the efficacy of the treatment. Therefore, it is important to assess the relationship between populations inside and outside of a food processing facility as part of a monitoring program. This way the appropriate spatial scale at which to monitor and manage a pest can be determined.

In this study the long-term population dynamics of three species of stored product pest (the red flour beetle, *Tribolium castaneum* (Herbst), the Indianmeal moth, *Plodia interpunctella* (Hübner), and the warehouse beetle, *Trogoderma variabile* Ballion) were evaluated inside a flour mill using pheromone traps and product sampling and outside the mill using pheromone traps. The mill was sampled from June until November 2001 and from July 2002 until September 2003. During this period the mill was fumigated six times. Marking stations with pheromone lures for *P. interpunctella* and *T. variabile* and fluorescent powder were used to evaluate the movement of insects into the mill.

Comparing the population trends inside the mill versus outside the mill indicated that *P. interpunctella* and *T. variabile* pheromone trap captures inside the mill were correlated with pheromone trap captures outside the mill and tended to cycle according to seasonal trends. Fumigation treatments did not influence pheromone trap captures of these two species inside the mill. This suggests that captures in the mill were a result primarily of immigration into the mill from outside sources. The mark-recapture data indicated that *P. interpunctella* marked outside were readily recaptured inside the mill – primarily on the first and top floors of the mill. No marked *T. variabile* were recaptured, but they were present in lower numbers. These two species were also never recovered in the samples taken from the product.

Tribolium castaneum trap captures, in contrast to the other two species, tended to follow a pattern of sharp decline after fumigation treatment and then steady increase in numbers until the next fumigation. This pattern occurred regardless of the weather conditions or trap capture levels outside the mill. This pattern is consistent with the pheromone trap captures being correlated with the trends in a population that is primarily residing within the mill. *T. castaneum* was the primary species found in the samples collected at different points in the product stream within the mill. Although the number of beetles in the product counts was highly variable they did generally follow the patterns in pheromone trap capture.

The type of information generated in this case study is important in the development of methyl bromide alternatives because it provides baseline information for evaluating the efficacy of new alternative management tools and because it suggests what management approaches may be best for a particular species. Pheromone monitoring for red flour beetles at this facility does provide a reliable picture of the population trends within the mill and good method of evaluating the effectiveness of treatments and the timing of subsequent treatments. However, for *P. interpunctella* and *T. variabile*, the use of pheromone traps does not provide a good indication of the population trends within the mill. For these species, pheromone trapping does provide a measure of infestation pressure and suggests that preventing immigration using exclusion or perimeter treatments may be more effective than structural treatments. Further research is needed on pest population structure and movement patterns and the best way to monitor populations in order to facilitate the adoption of methyl bromide alternatives.