

# Stored product insects in a flour mill: population dynamics, spatial distribution, dispersal behavior and implications for pest management

J. F. Campbell<sup>1</sup> and R. T. Arbogast<sup>2</sup>

<sup>1</sup>USDA ARS, Grain Marketing and Production Research Center, Manhattan, KS 66502 [campbell@gmprc.ksu.edu](mailto:campbell@gmprc.ksu.edu)

<sup>2</sup>USDA ARS, Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL 32604



## Introduction

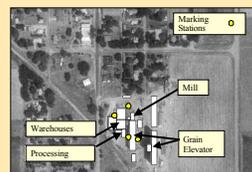
- Methyl bromide is still widely used in food processing and storage facilities for the suppression of stored-product insect pests, but its use is scheduled to be phased out as part of the Montreal Protocol.
- Development of alternative tactics has been hampered by limited information available about pest population dynamics and spatial distribution at food facilities, fumigation efficacy, mechanisms by which populations rebound, and even how best to monitor pest populations.
- It is likely that many stored-product insect populations are made up of sub-populations interconnected by dispersal, therefore an important factor in evaluating management programs is to determine over what spatial scale these sub-populations are interacting.
- Pheromone trapping holds a great deal of promise as a monitoring tool, but because it captures dispersing individuals the relationship between pheromone trap capture and source populations needs to be established.

## Objectives

- Determine population dynamics of three species of stored-product pests at a flour mill and the impact of fumigations on pest populations.
- Assess relationship between pheromone trap capture and product infestation.
- Evaluate the potential for interconnection among populations inside and the outside of the mill and the influence on pheromone monitoring.

## Materials and Methods

- Study site was a five floor flour mill in Kansas. Pest levels at the mill were monitored from June until November 2001 and from July 2002 until October 2003. During this period six fumigations were performed.
- Inside mill, red flour beetle, *Tribolium castaneum* (Herbst) and warehouse beetle, *Trogoderma variabile* Ballion were monitored using Dome traps with pheromone lures and food oil attractant (Trécé Inc., Adair OK) and Indian meal moth, *Plodia interpunctella* (Hübner), was monitored using pheromone lures in Pherocon II traps (Trécé Inc., Adair OK). Eleven trap locations on each floor.



- Outside the mill, *T. variabile* and *P. interpunctella* were monitored using Delta traps (Scentry Biologicals Inc., Billings MT) at eight locations and *T. castaneum* was monitored with Dome traps (four locations).

- Product samples were also collected from five locations along the processing stream each time pheromone traps were serviced. Only combined data from all locations is reported.

- Self-mark/recapture was used to evaluate immigration by *T. variabile* and *P. interpunctella* into the mill. Self-marking stations containing pheromone lures and fluorescent powder were placed at four outside locations. Insects marked with fluorescent powder and captured in pheromone traps were detected using an ultraviolet lamp.

Dome trap in flour mill



Pherocon II trap in flour mill



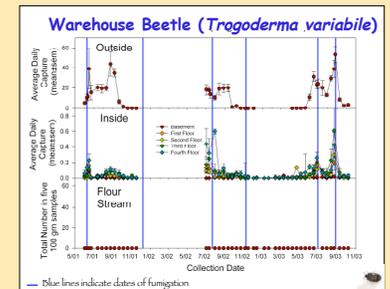
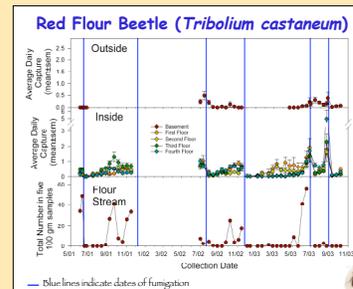
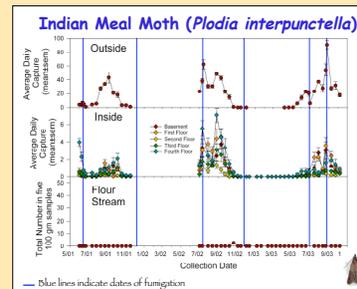
Delta trap used outside mill



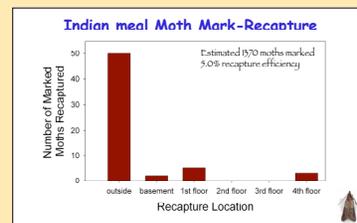
Self-marking station used outside mill



## Results/Discussion



- P. interpunctella* pheromone trap captures in mill were not negatively impacted by fumigations.
- More moths were captured outside compared to inside the mill.
- Trap captures inside the mill followed seasonal patterns in trap capture observed outside the mill. Trap captures inside and outside the mill were significantly correlated. (Spearman rank correlation,  $r_s = 0.901$ ,  $(r_{s,0.05(2)}, 47) = 0.288$ )
- Only one instance when infested product was recovered.
- Greatest trap captures tended to be in the basement, first and fourth floors of the mill.



- Ten moths were marked outside and recaptured inside the mill.
- Recapture locations suggest that the basement, first and top floors are important routes of entry.
- Results suggest that trap captures inside the mill result primarily from immigration by moths from sources outside the mill.

- T. castaneum* trap captures inside sharply declined after fumigations and then increased until next fumigation. This pattern occurred even during the winter months.
- Outside trap captures were correlated with inside captures. (Spearman rank correlation,  $r_s = 0.415$ ,  $(r_{s,0.05(2)}, 29) = 0.368$ )
- Predominate species recovered in product samples.
- Number of beetles captured in pheromone traps and recovered in product samples was correlated. (Spearman rank correlation,  $r_s = 0.605$ ,  $(r_{s,0.05(2)}, 48) = 0.291$ )
- Results suggest that red flour beetle populations are resident within the flour mill and that pheromone trapping is an accurate predictor of product infestation.

- T. variabile* pheromone trap captures in mill were not negatively impacted by fumigations.
- Large numbers of beetles were captured outside compared to inside the mill.
- Trap captures inside mill followed seasonal patterns in capture found outside the mill. Trap catch inside and outside mill were correlated. (Spearman rank correlation,  $r_s = 0.824$ ,  $(r_{s,0.05(2)}, 27) = 0.288$ )
- Never found in product samples.
- No marked beetles were recovered in mill, but the recapture probability inside was low.
- Results suggest that trap captures inside the mill represent primarily immigration from outside sources.

## Conclusions

- Findings from this case study are important for the development of methyl bromide alternatives because they:
  - provide baseline information for evaluating the efficacy of new management tools
  - highlight the challenges in developing monitoring programs to facilitate the movement of pest management in the food industry beyond calendar based applications
- For populations that are primarily confined within a structure, such as *T. castaneum* at this site, pheromone monitoring inside provides a good indication of infestation level, the need to target control tactics at a specific population, and the effectiveness of control tactic.
- For populations that interact over larger spatial scales, such as *P. interpunctella* and *T. variabile* at this site, traps inside captured primarily immigrants and thus provided only a measure of infestation pressure or potential. Control tactics targeted within the mill will be of limited efficacy, without improvements in pest exclusion.