Efficacy of Aerosols for Managing the Red Flour Beetle

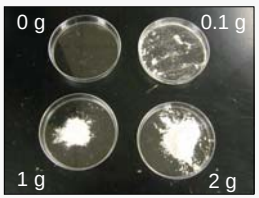
Michael D. Toews, Frank H. Arthur, and James F. Campbell
USDA-ARS Grain Marketing and Production Research Center, Manhattan, Kansas

This research was jointly funded by USDA-CSREES-PMAP, and USDA-CSREES-Methyl Bromide Transitions

Summary

Pest management professionals commonly utilize aerosolized liquid applications, also known as fogging, for management of stored-product insects including the red flour beetle. These applications are part of a potential methyl bromide replacement technology because they may increase the time interval between structural fumigations or heat treatments. The objectives of this study were to examine influence of flour accumulation (0, 0.1, 1 or 2 g), exposure location (open vs. under pallets), life stage (eggs, larvae, pupae, or adults), and insecticide (esfenvalerate, synergized pyrethrins, and untreated controls) on the efficacy of aerosol applications. Data show that aerosolized insecticide applications in dishes without food residues placed in the open produced the highest red flour beetle mortality. Conversely, mortality significantly decreased with food and exposure under pallets.

Materials and Methods



Dishes with flour

E2 Applicator

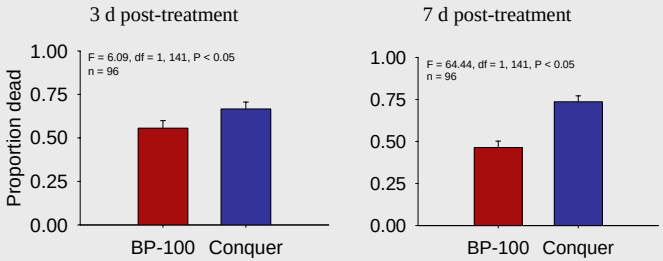
Pallet

- Standard 9-cm plastic petri-dishes were washed and then provisioned with 0, 0.1, 1, or 2 g of wheat flour.
- 25 *Tribolium castaneum* (red flour beetle) eggs, larvae (3rd instars), pupae, or adults were introduced into each dish.
- Aerosol applications were conducted with a commercial applicator in climate controlled 36.3 cubic meter (1281 cubic feet) pilot-scale warehouses.
- In each warehouse, one set of dishes was placed in the open (no pallet) while a separate set of dishes was hidden under a wooden pallet covered with a cardboard slip sheet and cardboard boxes.
- Individual warehouses were treated at the label rate with esfenvalerate (Conquer®), synergized pyrethrins (ULD® BP-100), or untreated on four separate occasions.
- Warehouses remained closed for 24 h and then dishes were covered. Insect mortality in the same dishes was observed at 3 and 7 d post-treatment. Eggs were assessed at 21 d only.
- Data (proportion dead) were corrected for control mortality using Abbott's correction, arcsine transformed, and analyzed using SAS.

Results and Discussion

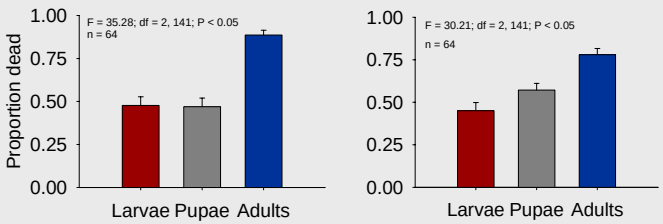
Larvae, Pupae, and Adults

Comparison of Insecticides



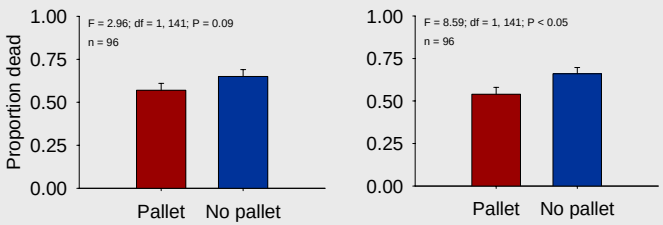
- Across all other treatments, esfenvalerate caused greater mortality than synergized pyrethrins. Mortality increased by 7% between 3 and 7 d with esfenvalerate, but decreased by 9% with synergized pyrethrins in the same time period.

Comparison of Life Stages



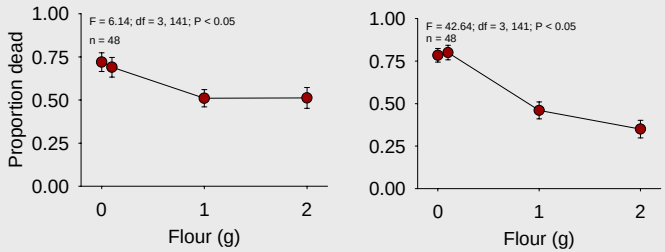
- Across other treatments, adults were always more susceptible than immature stages. Efficacy assessments based on observation of dead adults following treatment may not reflect similar mortality across immature life stages.

Comparison of Exposure Locations



- Across other treatments, mortality of individuals hidden under pallets was ~10% less than when individuals were exposed in the open, but this factor was only significant after 7 d. Other types of cover (i.e. milling equipment, mechanical equipment) need to be considered when treating with aerosols.

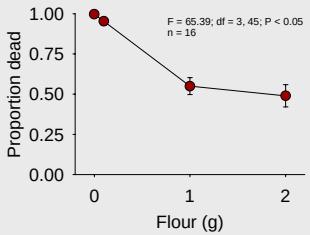
Comparison of Flour Accumulation



- Across other treatments, the addition of 1 g of flour decreased mortality by 21% (3 d counts) and 32% (7 d counts) compared to exposure with no flour. These data suggest that sanitation *before* aerosolized insecticide applications could significantly improve efficacy.

Eggs

Comparison of Flour Accumulation



- Across all other treatments, exposure in dishes not provisioned with flour gave complete mortality of eggs, but exposure with 1 g of flour reduced mortality by ~45%.
- There were no significant effects attributed to insecticide or exposure under pallets for egg mortality.

Conclusions

- In general, the highest insect mortality was observed when we applied esfenvalerate to the adult life stage, in petri-dishes with no flour present and located out in the open.
- The fact that adults were more susceptible than immature life stages is important because adults are often the most visible sign of insect infestation, thus dead adults may not accurately confirm the general population impact.
- In practice, eggs and small immatures are probably never found in the total absence of food because gravid females actively seek favorable habitats for oviposition.
- We are currently evaluating the long term population trends in pilot-scale warehouses under 2 and 4 wk aerosolized insecticide application regimes.