EFFICACY OF AEROSOLS FOR MANAGING THE RED FLOUR BEETLE

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Pest management professionals utilize aerosolized liquid application, also known as fogging, ultra low dosage fogging, cold aerosols, or space sprays, for structural insecticide applications to manage stored-product insects. These applications are most common in food and feed processing facilities, warehouses, and mills where the structure is not gas-tight, but are becoming more widely used as managers search for methyl bromide replacements. Aerosolized insecticide applications are part of a potential methyl bromide replacement technology because they could increase the time interval between structural fumigations or heat treatments. However, there are few rigorous studies that document the efficacy of these treatments. The objectives of this study were to examine influence of flour accumulation (0, 0.1, 1 or 2 g), exposure level (open vs. under pallets), life stage (eggs, larvae, pupae, or adults), and insecticide type (esfenvalerate vs. synergized pyrethrins, along with carrier solvent and untreated controls) on the efficacy of aerosol applications for managing the red flour beetle.

Insects were exposed in standard 9-cm dia. plastic Petri dishes. Individual dishes received 25 eggs, 3rd instars, pupae, or adults from a red flour beetle colony isolated from a food production facility in 2001. Previously frozen bread flour (0, 0.1, 1.0, or 2.0 g) was then added to each dish to simulate spilled food accumulation. A complete set of uncovered dishes was located in the open and a second set of dishes was placed under a pallet covered by a cardboard pallet slip sheet and cardboard boxes stacked to a height of 0.6 m. Trials were conducted in pilot-scale warehouses measuring 5.9 m long by 2.8 m wide by 2.2 m tall, with a separate warehouse used for each treatment. Insecticide treatments, applied on five separate occasions using a commercial liquid chemical dispersal unit (model E-2, Whitmire Micro-Gen Research Laboratories, Inc.), included esfenvalerate (Conquer®), synergized pyrethrins (ULD® BP-100), the carrier solvent (Isopar M solvent) used in these two formulations, and an untreated control. The liquid chemical dispersal unit produced 85% of the droplets in the 1 to 20 micron range. Insecticide concentration used was based on the label for each insecticide (0.25% esfenvalerate in solvent or 1% pyrethrins + 2% piperonyl butoxide + 2.94% n-octyl bicycloheptene dicarboximide in solvent applied at a rate of 29.5 ml per 28.3 m^3 (1 oz per 1000 ft^3).

Following insecticide application, pilot-scale warehouses remained closed to allow the insecticide droplets to settle. After 24 h, Petri dishes were removed, covered with their lids, and stored in an environmental chamber maintaining conditions at 28°C and 60%RH. Mortality for individuals exposed as larvae, pupae, or adults was assessed at 3 d, 7 d, and 21 d post-treatment, while individuals exposed as eggs were only assessed at 21 d post-treatment. Individuals were scored as live, dead, or moribund during each assessment. Dishes that did not receive flour prior to the insecticide application received 0.5 g of flour at 3 d post-treatment to support surviving individuals. Raw data, based on counts of surviving individuals, were subjected to a square-root transformation to normalize variances and then analyzed using four-way ANOVA.

Regardless of time interval after exposure, survival was generally >90% in the untreated or solvent treated replicates, but ranged from 0 to 70% following esfenvalerate or synergized pyrethrins treatment. There were no three- or four-way interactions, but interactions including insecticide treatment by insect stage, insecticide treatment by flour amount, and insecticide treatment by exposure under pallets or in the open were generally significant. At 3 d post-treatment, an insect stage by insecticide treatment interaction occurred because <3 adults per dish survived esfenvalerate or synergized pyrethrins treatments, while 16-18 larvae and pupae per dish survived these treatments. Neither amount of flour nor exposure level (open exposure or under pallets) affected survival at 3 d post-treatment. At 7 d post-treatment, more survivors (12-16 individuals) were observed in the synergized pyrethrins- treated dishes than the esfenvalerate-treated dishes (2-10 individuals). Increased survival was observed in dishes provisioned with 1 and 2 g of flour compared to 0 and 0.1 g of flour. There was evidence of adult recovery in replicates treated with synergized pyrethrins but not esfenvalerate. For both esfenvalerate and synergized pyrethrins treatments, beetle survival improved when the dishes were exposed under pallets compared with exposure in the open.

At 21 d post-exposure, larvae, pupae and adults treated with esfenvalerate experienced near complete mortality across flour deposits including 0, 0.1, and 1 g. However, a mean of 3.8 individuals survived in dishes provisioned with 2 g of flour. Individuals treated with synergized pyrethrins experienced 4.5 survivors in the 0 or 0.1 g flour, 9.4 survivors in 1 g of flour, and 14 survivors in 2 g of flour. Regardless of esfenvalerate or synergized pyrethrins treatment, more survivors were observed when dishes were exposed under pallets than in the open. Survival of individuals exposed as eggs ranged from 17.5 to 22.4 individuals in dishes treated with solvent or the untreated control regardless of flour deposit. Few eggs survived exposure to esfenvalerate or synergized pyrethrins when provisioned with 0 or 0.1 g of flour, but >12 individuals survived these treatments when the dishes included 1 or 2 g of flour. Exposure under pallets did not decrease survivorship of individuals exposed as eggs.

These data suggest that aerosolized insecticide applications will provide the highest red flour beetle mortality in empty warehouses with pre-treatment sanitation. Mortality will likely decrease in environments where equipment or product on pallets cannot be removed or residual food patches are present.