TEMPORAL AND SPATIAL PATTERN IN AEROSOL INSECTICIDE DROPLETS

James F. Campbell*, Daniel Brabec, Deanna S. Scheff, Frank H. Arthur,

USDA ARS Center for Grain and Animal Health Research, 1515 College Ave, Manhattan KS USA 66502

Food processing and storage facilities have historically relied on structural fumigation treatments to reduce or eliminate stored-product insect infestations. Methyl bromide (MB) has been the predominant structural fumigant used in food facilities, but it is an ozone-depleting substance and its use worldwide is being phased out. With the phase out of methyl bromide, there has been reduced reliance of fumigation and more frequent treating of spaces with aerosol insecticides as part of Integrated Pest Management programs. While aerosol treatments don't have the penetration ability of a fumigant, they do have the ability to distribute through a space and deposit on surfaces. However, the physical layout of the structure, the distribution of equipment and other items within the space, and the application method and location may all cause spatial variation in how the insecticide is deposited. This can result in areas with insufficient insecticide applied to be efficacious and other areas where excess insecticide is applied. Therefore, there is a need to evaluate how insecticide droplets are distributed during an aerosol treatment and how these distributions could be optimized to provide more consistent efficacy within a space.

To investigate how aerosol insecticide application position and dispersal method/formulation impacts distribution of droplets, a series of aerosol applications were conducted within the same room within a pilot scale milling facility at Kansas State University. Aerosol applications were made using labeled rates of two different formulations and application methods. TurboCide Py-75 with IGR (Chem-Tech Ltd., Des Moines, IA), a combination of pyrethrin and the IGR pyriproxyfen, was formulated in a CO_2 compressed gas cylinder for application. Pyrethrin (BP-100, BASF Corp., Research Triangle Park, NC) and the IGR methoprene (Diacon® IGR, Wellmark International, Schaumburg, IL) was applied using a handheld applicator (Aerojet Fogger (Fogmaster, Deerfield Beach, FL, USA)). To determine how release position effects the spatial pattern of droplet distribution, applications were made from one of three positions on the floor or from all three locations, with one-third of the aerosol released from each position.

Measurements of droplet concentration and size were made using Aerodynamic Particle Sizers (APS, model 3321, TSI Incorporated, Shoreview, MN, USA) placed at nine locations on the floor. The APS units were spaced so they provided good coverage of the whole floor and included open and obstructed locations. The APS units count particles and measure their sizes within the range of 0.5 to 20 µm by drawing air samples from the aerosol cloud. Some of the parameters measured include the total count of particles within a size range, the geometric mean diameter (GMD), and the mass concentration of the aerosol (mg/m^3) per sampling period. We also calculated how much aerosol is predicted to be deposited during the treatment at a given location. Bioassay plates with insects were also placed near each of the APS units so droplet characteristics could be correlated with efficacy against insects.

Results from this experiment showed that there was variation in aerosol concentration and droplet size distributions among the APS unit locations and that the application position had an impact on the spatial pattern of aerosol droplets. As would be expected the further way and more obstructed by structural features a location was the lower the aerosol concentration. But there was also a tendency for lower aerosol deposition to the side and behind the release point. The different insecticide formulations and application methods also differed in their distribution of droplets. Evaluation of the temporal pattern in droplet deposition shows that most larger droplets settle out of the air relatively quickly, supporting that idea that shorter shutdown times are be possible. The overall conclusion is that there can be considerable variation in distribution of aerosol insecticides and as a result considerable potential for improvement in the effectiveness of these applications. Implications of these findings for developing more effective application strategies will be discussed.