EFFICACY OF INSECTICIDE TREATMENTS ON RESIDENT POPULATIONS OF THE RED FLOUR BEETLE

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Residual contact and aerosol insecticides are receiving increased use in commercial mills as alternatives to whole-plant fumigations with methyl bromide. Laboratory studies have shown that if adult red flour beetle (*Tribolium castaneum* (Herbst) are given access to a flour food source during or after insecticidal exposure, survival often increases relative to beetles not given access to food. It is challenging to assess the efficacy of these applications in mills due to the difficulty in accurately determining population levels and in replicating treatments. As an alternative, we have conducted simulated field studies in five sheds that are part of the USDA ARS Center for Grain and Animal Health Research. Three sheds are approximately 1,150ft^3 (32 m^3) and two sheds are slightly wider and higher (1,450 ft^3 or 36 m^3). These sheds enable us to create hidden refugia where red flour beetle populations can develop as well as enabling us to be able to directly sample the insect populations before and after treatment and conduct long-term population studies to evaluate the cumulative impacts of aerosol treatments. In one test we utilized a series of three small metal shelves inside each shed, placed a food source underneath the shelves, and provisioned the food sources with different life stages of the red flour beetle. We then sprayed the insecticide Tempo® at the labeled rate around the shelves in a banding treatment. Observations of insects in traps and dead insects on the floors of the sheds with the insecticide treatment indicated a strong treatment response, but beetle populations in food refuges under the shelves were similar in treatment and control sheds. This study revealed how field evaluations of pesticide applications based on trapping or observations of mortality in open areas may be misleading.

Similar experimental protocols are now being used to evaluate the effectiveness of multiple aerosol insecticide applications that have limited penetration ability in suppressing pest populations. The same experimental design described above was utilized in a study assessing the effectiveness of esfenvalerate (Conquer®) aerosol on resident red flour beetle populations. The food patches infested with different life stages of the red flour beetle were placed underneath the shelves inside each shed. One shed was the untreated control, two sheds were sprayed bi-weekly with the labeled rate of Conquer®, and two sheds were sprayed every four weeks. Two separate blocks were performed. In general, the bi-weekly spraying appeared to dampen the population fluctuations compared to the untreated control and the sheds sprayed every four weeks. However, resident populations were still maintained at some level in the food patches in all sheds.

A new experiment has been initiated to evaluate the combination treatment of pyrethrin + methoprene (Diacon II®) aerosol using a similar experimental approach, but using a different design for the refugial areas that enables the percentage coverage to be evaluated. Preliminary results indicate that the combination treatment gives population suppression, but the presence of refugial areas with food sources still allows some continued development of resident populations.

To accurately evaluate residual and aerosol insecticide efficacy it is important to determine the impact of the treatments on the hidden refugial populations not just rely on trap captures or assessment of dead insects in open areas. It is also important to look at the long-term cumulative impact of these treatments on pest population levels. Shed studies such as those reported here will complement ongoing evaluations of insecticide efficacy in commercial mills and provide insight into how these management tools can be integrated into an overall IPM program.