



# Research Kernels

Our Latest Research Results – July 2014

## Evaluation of potential attractants for *Liposcelis bostrychophila* (Psocoptera: Liposcelidae)

**Authors:** J. Diaz-Montano, J.F. Campbell, T.W. Phillips, J.E. Throne

**Submitted to:** Journal of Economic Entomology  
The psocids, also known as booklice, are worldwide insect pests of stored grains that cause significant economic losses by direct feeding and product contamination, and are difficult to control with insecticides. To effectively guide pest management programs it is critical to have a pest-monitoring program, but tools to attract and trap psocids are currently not available. The response of a major stored grain psocid pest species, *Liposcelis bostrychophila*, to potential attractants (including grains, grain based oils, wheat germ, and brewer's yeast) was studied, and it was determined that brewer's yeast, wheat germ and wheat germ oil had the strongest psocid response. These materials appear promising attractants for incorporation into psocid traps and will be further evaluated for monitoring psocids.

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## Competition of stored-product psocids (Psocoptera) under laboratory conditions

**Authors:** C.G. Athanassiou, N.G. Kavallieratos, C.T. Nakas, J.E. Throne,

**Submitted to:** PLoS ONE

Psocids are pests of stored grain and processed grain products, but we know little about their ecology and how this impacts their pest status. We evaluated the competition among stored-product psocid species in laboratory experiments to help explain their distribution in the field and their pest status. When reared at 30°C with equal starting population numbers, *Liposcelis bostrychophila* was the dominant species, and its presence had a negative effect on the population growth of *L. decolor* and *L. paeta*. In a second series of tests, *Liposcelis bostrychophila* was the dominant species, regardless of the ratio of parental females in the starting mixed populations (*L. bostrychophila* adults:*Lepinotus reticulatus* adults 10:0, 9:1, 7:3, 5:5, 3:7, 1:9 and 0:10). In mixed populations, *L. reticulatus* was present after 175 days only in vials that contained this species alone. Our results help to explain why *L. bostrychophila* is one of the most common pests of stored products because they outcompeted other psocid

species in this series of experiments. Contact James Throne, telephone 559-596-2702, email [James.Throne@ars.usda.gov](mailto:James.Throne@ars.usda.gov)

## Susceptibility of different life stages of *Tribolium confusum* to pyrethrin aerosol: effects of a flour food source on insecticidal efficacy

**Authors:** K. Kharel, F.H. Arthur, K.Y. Zhu, J.F. Campbell, B. Subramanyam

**Submitted to:** Journal of Pest Science

The presence of food material on surfaces can enable adult flour beetles to survive exposure to contact insecticides. Aerosols are commonly used as space treatments for large-scale applications inside flour mills, but the level of sanitation at time of treatment impacts the amount of food material on surfaces and could affect the performance of these aerosols. We placed different life stages of the confused flour beetle in dishes with flour and then exposed them to pyrethrin aerosol. As more flour was added to a dish more larvae and pupae were able to develop to the adult stage after the initial exposure. When little or no flour was in the dish, all exposed adults of both species were immobilized by the aerosol and did not recover, but as more flour was added to the dish less adults were immobilized and more eventually recovered. Results show the effectiveness of aerosol insecticides is clearly reduced when food material is present, and insect management programs for flour mills should emphasize cleaning and removal of food residues prior to aerosol application.

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## Influence of temperature and barriers on the efficacy of pyrethrin aerosol for managing stored product insects

**Authors:** K. Kharel, F.H. Arthur, K.Y. Zhu, J.F. Campbell, B. Subramanyam

**Submitted to:** Journal of Stored Products Research  
Aerosol insecticides are being used to control flour beetles inside mills and warehouses but there is little information regarding aerosol dispersal underneath structural barriers. We built wooden boxes of different heights that were closed at one end and on the top and sides, and conducted studies by placing confused flour beetles in dishes set in the open and at different positions underneath the boxes. Survival increased as box height decreased and as distance from the front of the box increased, indicating little dispersion of the

aerosol underneath the opening. Complete mortality was achieved only when insects were exposed in the open. Results show how barriers and obstructions inside a storage facility may inhibit aerosol dispersal and thus lead to reduced insect control.

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### **Glutathione Is Involved in Plant Defense against the Gall Midge *Mayetiola destructor***

**Authors:** X. Liu, S. Zhang, J. Whitworth, J. Stewart, M. Chen

**Submitted to:** Plos One

Hessian fly is a destructive pest of wheat. The insect pest is mainly controlled by deploying resistant wheat cultivars. Although effective, resistance conferred by major resistance genes is usually short-lived, lasting only for 3-8 years. To develop more durable resistant cultivars, we need a better understanding of the resistance mechanism in wheat to Hessian fly. Glutathione is a small peptide that plays a role in various physiological processes in nearly all organisms. In this study, we examined the changes in glutathione abundance and metabolic pathways in both resistant and susceptible plants following Hessian fly attack. We found that the abundance of total glutathione increased up to 60% in resistant plants within 72 hours following Hessian fly attack, but no increase in susceptible plants. We also found that the metabolic and recycling pathways of glutathione were unevenly regulated in infested resistant plants. Specifically, the activity and transcript abundance of glutathione peroxidases, which convert reduced glutathione (GSH) to oxidized glutathione (GSSG), increased in infested resistant plants. However, the enzymatic activity and transcript abundance of glutathione reductases, which convert GSSG back to GSH, did not change. This unbalanced regulation of the glutathione oxidation/reduction cycle indicates the existence of an alternative pathway to regenerate GSH from GSSG to maintain a stable GSSG/GSH ratio. We hypothesize that GSSG is transported from cytosol to apoplast to serve as an oxidant for class III peroxidases to generate reactive oxygen species for plant defense against Hessian fly larvae. Our results provide a foundation for elucidating the molecular processes involved in glutathione-mediated plant resistance to Hessian fly and potentially other pests as well.

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### **Avirulence Effector Discovery in a Plant Gall and Plant Parasitic Arthropod, the Hessian fly (*Mayetiola destructor*)**

**Authors:** R. Aggarwal, S. Subramanyam, C. Zhao, M. Chen, M. Harris, J. Stuart

**Submitted to:** Plos One

The Hessian fly is a major pest of wheat and is mainly controlled by deploying resistant wheat cultivars. However, wheat resistance to the Hessian fly is often short-lived, lasting for 3 to 6 years. To produce more

durable resistance, we need to understand the molecular basis for Hessian fly resistance in wheat and for virulence in Hessian fly. This study identified an avirulence gene, named *vH13*, in Hessian fly. The gene encodes a small protein with a secretion signal peptide. Wild-type *vH13* gene results in Hessian fly avirulence (death of insects) to plants containing the *H13* resistance gene, whereas a mutated gene through various insertions confers Hessian fly virulence (survival of insects) to the otherwise resistant plants. These data clearly support the hypothesis that effector-based strategy has evolved in multiple lineages of plant parasites, including arthropods, and enhance our understanding of the molecular mechanism for insect virulence/avirulence phenotypes.

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### **Efficacy of aerosol applications of methoprene and synergized pyrethrin against *Tribolium castaneum* (Herbst) adults and eggs**

**Authors:** A. Tucker, J. Campbell, F.H. Arthur, K.Y. Zhu

**Submitted to:** Journal of Economic Entomology

Aerosol insecticides are being used to control insect pests in flour mills. The red flour beetle is a major pest of flour mills, and the presence of available food material often compromises control. We exposed adults and eggs of the red flour beetle to single applications of pyrethrin aerosol, pyrethrin with the insect growth regulator methoprene, or just to the oil carrier that was in the pyrethrin formulation, all in the presence of a flour food source. Adults were initially incapacitated by pyrethrin aerosol but recovered and were able to reproduce in the flour. Beetle eggs were also exposed to the different treatments in the presence of flour, and as the amount of flour increased adult emergence increased, however, overall emergence was less than in untreated control, which indicated the aerosols had some effect on development. Results show the immature stages of the red flour beetle is more susceptible to pyrethrin aerosol than the adult. Pest managers can use this information to help improve insect pest management programs in flour mills.

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