Evaluation of five sampling methods for the psocids *Liposcelis entomophila* and *L. decolor* in steel bins containing wheat

Psocids, or booklice, are emerging pests of stored grain and processed stored products, but we know little about how to sample them to determine their population levels to aid in making pest management decisions. We compared five methods for sampling psocids in wheat stored in steel bins – cardboard refuges on the surface of the grain and on the bin hatch, grain samples taken using a grain trier probe, and automated sampling using StorMax Insector™ electronic probe traps. Two species of psocids were identified during the study: *Liposcelis entomophila* in 2005 and *L. decolor* in 2006. In general, the five sampling methods reflected similar patterns in seasonal abundance of psocids in both years, except that no psocids were found in the hatch refuges in December to February when temperatures were low. Psocid densities in cardboard refuges and in Insector™ probes correlated well with psocid densities in grain samples in both years. The results indicate that cardboard refuges or Insectors™ may provide an effective method for sampling psocids in bins of wheat. This information should be useful for the development of sampling plans which can be used to time psocid management in stored wheat.
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Sampling plans for the psocids *Liposcelis entomophila* and *L. decolor* in steel bins containing wheat

Psocids, or booklice, are emerging pests of stored grain and processed stored products, but no sampling methods for estimating their population levels have been developed to aid in making pest management decisions. We developed methods for sampling *Liposcelis entomophila* and *L. decolor* in wheat stored in steel bins using cardboard refuges placed on the surface of the grain. Numerical sampling, where psocids found in refuges are counted, and presence-absence sampling, where the proportion of infested refuges is determined, were found suitable for estimating psocid population levels. We recommend that numerical sampling be used at densities of less than 10 psocids/refuge, and that 20 refuges be placed in each bin. At densities higher than 10 psocids/refuge, we recommend that presence-absence sampling be used with 20 refuges/bin. In a mixed infestation of the two species, we suggest that only numerical sampling be used because of the large number of samples required. The sampling methods we have developed based on the use of cardboard refuges are convenient for use in steel bins containing wheat because they are inexpensive, provide a rapid assessment of psocid population incidence, and are easy to implement. These sampling plans can be used to monitor psocid populations and the efficacy of management strategies used against *L. entomophila* and *L. decolor*.
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Analysis of functions of the chitin deacetylase gene family in *Tribolium castaneum*

Insects must shed their old skins as they grow in size, but the behavior and physiology of this delicate and complex process of metamorphosis is still only poorly understood. In cooperation with Kansas State University, we identified a group of "chitin-trimming" enzymes in flour beetles that are needed to confer the proper degree of stiffness or flexibility on the raw chitin, and we showed that inactivation of these enzymes results in defects in the chitinous exoskeleton. Each of these newly-discovered enzymes represents a potential target in screening assays for new biopesticides that disrupt insect growth and development.
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Near-infrared versus visual sorting of Fusarium-damaged kernels in winter wheat

Fusarium head blight (FHB), or scab, is a destructive disease of wheat. FHB causes yield reductions of up to 50% and crop losses in the US have exceeded $1 billion in some years. In addition, FHB can produce the toxin deoxynivalenol which must be below FDA guidelines. Visible detection of FHB is laborious and subjective and

we evaluated the use of automated near-infrared (NIR) technology to detect FHB. Results showed that visual detection was strongly correlated to NIR detection and that the NIR method was more repeatable. This technology should help the grain industry more consistently detect FHB and thus improve the safety of the US food supply. The technology can also be used to rapidly screen new wheat lines for FHB resistance.

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Hardware-based image processing for high-speed inspection of grains

Electronic color sorters are widely used on many commodities to remove discolored and defective product. These systems are robust and can have high throughputs, as much as 2000 lb/hr of wheat can be processed in these machines. However, there are many defects, or attributes, that these color sorters cannot detect with necessary accuracy. This study resulted in the development of a prototype that enables sorting of many defects and attributes that current color sorters cannot is currently detect. The new system combines imaging technologies with advanced image sensors and processing hardware. Even though the system is more accurate than traditional electronic color sorters, the cost and throughput should be similar. The developed system was tested for its ability to separate red and white wheat and popcorn with blue-eye damage. The new, image based system was 10 to 20% more accurate than commercial color sorters for separating red and white wheat. For popcorn with blue-eye damage, the system had an overall accuracy of 83% whereas color sorters cannot detect this defect at all. The system should find uses for a variety of crops such as for separating fungal damaged grain, mottled durum, and various defects found in tree nuts. This will lead to higher quality and safer food products and possibly open international markets where quality is a key factor.

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Digestive proteolysis organization in two closely related tenebrionid beetles: red flour beetle (*Tribolium castaneum*) and confused flour beetle (*Tribolium confusum*)

Little is known about the specifics of food digestion in *Tribolium* spp. beetles. We provide a detailed and thorough characterization of protein digestion in the red and confused flour beetles, two important pests of stored-products. Proteins in food are digested primarily by a specific class of enzymes called cysteine peptidases, with a minor contribution by serine peptidases. Understanding the complex system of digestion in flour beetles will improve their control using digestive inhibitors or microbial toxins.

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A BAC-based physical map of the Hessian fly (Mayetiola destructor) genome anchored to polytene chromosomes

The Hessian fly (Mayetiola destructor) is one of the most destructive insects of wheat world-wide. Resistant wheat is the best strategy to control the damage caused by this pest. The challenge for the use of resistant wheat is the ability of the insect to develop new populations that can overcome resistance once a resistant wheat is deployed to the field. To find how the insect can overcome wheat resistance, the genes that are responsible for the Hessian fly to attack wheat need to be identified. This work is to provide a detailed map of the Hessian fly genome with specific markers. The work provides a foundation for identification of specific Hessian fly genes and for whole genome sequencing.

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