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Research Kernels

Our Latest Research Results • November 2009

Functions of Ion Transport Peptide and Ion Transport Peptide-Like in the Red Flour Beetle *Tribolium castaneum*

Authors: K. Begum, B. Li, R.W. Beeman, Y. Park
Submitted to: Insect Biochemistry and Molecular Biology

Water balance is a critical function in insects, especially in extremely dry environments such as those associated with post-harvest pest species. Nevertheless, insect water balance physiology remains one of the major, unexploited targets for biopesticide targeting. The red flour beetle, *Tribolium castaneum*, is a major pest of dry storage and is the best laboratory model for gene discovery in pest insect species. In order to increase our understanding of water balance physiology in this insect, we undertook a functional genomics study of ion transport in relation to fluid retention. We identified three peptide hormones in *Tribolium* that appear to have additional, critical roles in ovarian development and molting, in addition to their probable functions in fluid balance. This research reveals unexpected diversity and complexity in insect neuroendocrinology, and could lead to new ways to disrupt water balance and other critical physiological functions in pest insects.

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Effects of Cry1F and Cry34Ab1/35Ab1 on Storage Pests

Authors: B.S. Oppert, R.T. Ellis, J. Babcock
Submitted to: Journal of Stored Products Research

New control methods are needed for storage pests. Two microbial toxins were evaluated for efficacy in a number of different storage pests. The data suggest that neither toxin had significant activity in the storage pests that were tested. Therefore, the utility for controlling stored product insects with these toxins is predicted to be low. However, the data also suggest that these toxins exhibit a high degree of selectivity and would pose minimal risks to nontarget species.

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Long Term Monitoring of *Tribolium castaneum* in Two Flour Mills: Seasonal Patterns and Impact of Fumigation

Authors: J.F. Campbell, M.D. Toews, F.H. Arthur, R.T. Arbogast
Submitted to: Journal of Economic Entomology

Red flour beetle is a major pest of flour mills, and management has typically relied on fumigation with methyl bromide; but use of this fumigant is being phased out worldwide under the Montreal Protocol. Data on the impact of fumigation on pest populations is limited, and this has hampered the adoption of alternative treatments. Data from five to six years of red flour beetle monitoring in two flour mills was used to evaluate the impact of fumigations on pest populations and the influence of season on efficacy. Two mills differed from each other in mean number of beetles captured per trap and proportion of traps with captures of one or more beetles, and within one of the mills the mean number of beetles captured was reduced following adoption of a more intensive integrated pest management (IPM) program. Mean number of beetles per trap and proportion of traps with captures decreased by 85% and 71%, respectively, following fumigation. Beetle captures immediately after fumigation tended to increase as captures in the period immediately prior to fumigation increased. Inside temperature and reduction in beetle captures was not affected by season. Our results provide baseline information on pest populations and fumigation efficacy to which methyl bromide alternatives can be compared and provides information that can be used to help optimize fumigation and IPM programs.

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Efficacy of Aerosolized Insecticides for Managing All Life Stages of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

Authors: M.D. Toews, J.F. Campbell, F.H. Arthur
Submitted to: Journal of Insect Science

Stored product insect infestation in food processing facilities and storage warehouses is a serious problem and pest management professionals have begun using aerosolized insecticide applications more frequently to mitigate these infestations, although limited information is available on their efficacy. Pilot-scale tests were conducted to determine the effects of two aerosolized insecticides (pyrethrins and esfenvalerate), presence of food, and whether insects were out in the open or sheltered under pallets on all life stages of the red flour beetle. Insect mortality generally decreased as the amount of food (flour) increased, but mortality did not exceed 60% regardless of life stage with 2 grams of flour present. Mortality never exceeded 75% when insects were under pallets, but was never less than 80% when insects were in the open. Because differences in beetle mortality between insecticides were considerably less than differences attributed to amount of food present, this study suggests that sanitation and removal of

obstructions prior to aerosol insecticide treatments was more important than choice of a particular insecticide.
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BeetleBase in 2010: Revisions to Provide Comprehensive Genomic Information for *Tribolium castaneum*

Authors: H.S. Kim, T. Murphy, J. Xia, D. Caragea, Y. Park, R.W. Beeman, M.D. Lorenzen, J.R. Manak, S. Butcher, S.J. Brown
Submitted to: Biomed Central (BMC) Genomics
The red flour beetle genome sequence has created the most comprehensive body of genomic information available for any agricultural pest species, but access to the data can be cumbersome and difficult. We have created "BeetleBase", a user-friendly website for easy access and recovery of all types of genetic and genomic information about this pest insect for use by scientists, researchers, and others. The current version of BeetleBase is of greatest use to genetics and biology researchers, but future versions will include general literature on flour beetles and related insects that will be of interest to pest control specialists, educators, and the general public.
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Prospecting for Cellulolytic Activity in Insect Digestive Fluids

Authors: C. Oppert, W. Klingeman, J.D. Willis, B.S. Oppert, J.L. Jurat-Fuentes
Submitted to: Comparative Biochemistry and Physiology
In the quest for alternative energy sources, enzymes that are efficient and cost effective in degrading plant biomass are critically needed. Insects are an untapped source for novel cellulolytic enzymes. Using two cellulose substrates, we surveyed insects from 68 species belonging to eight different orders for more efficient cellulolytic enzymes. Enzymes with high activity were found in gut and head tissues and were localized to specific orders, suggesting that some insects may have evolved with increased efficiency to digest plant biomass. These studies are the first step in the identification of enzymes for use by the biofuels industry. In addition, identification of insect cellulolytic systems can lead to novel control strategies for pests of plants and cereals.
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High-Speed Sorting of Grains by Color and Surface Texture

Author: T.C. Pearson
Submitted to: Applied Engineering in Agriculture
A low cost, high-speed device was developed to inspect and separate a variety of grains based on color and surface texture. The device was tested on its ability to separate brown and yellow flax seeds, barley from durum, and red from white wheat. All accuracies were greater than 92% in one pass through the sorter, which is considerably higher than what can be accomplished with commercial color sorters. Throughput of the machine is approximately 25Kg/hr for wheat. The sorter uses a specially designed camera linked to a processor to accomplish high seed throughputs, accuracy, and low cost. The machine should find applications with seed breeders and suppliers to purify larger breeding lines. Several machines might also be run in parallel to keep up with some food processing lines.
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Detection of Internal Insects in Wheat using a Conductive Roller Mill and Estimation of Insect Fragments in the Resulting Flour

Authors: D.L. Brabec, T.C. Pearson, P.W. Flinn, D. Katzke
Submitted to: Journal of Stored Products Research
Insects reduce value of grain, cause loss of grain due to consumption by insects and extra cleaning required to remove insects and damaged kernels, and high levels of insects can indicate a general sanitation problem in the grain. However, small insects that bore into wheat kernels are extremely difficult to detect. A recently developed machine was tested for its ability to detect insects living inside of wheat kernels and estimate insect pieces in flour after milling. The machine can inspect a one kilogram sample in less than a minute with very little sample preparation. Results showed high correlation with insect counts by x-ray and with insect fragment counts in resulting flour. The machine should find widespread usefulness where grain is inspected for quality and for determining long term storability.
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