USDA Research Kernels

Our Latest Research Results – March 2014

Impact of Temperature and Relative Humidity on Life History Parameters of Adult *Sitotroga cerealella* (Lepidoptera: Gelechiidae)

Authors: J.E. Throne, D.K. Weaver
Submitted to: Journal of Stored Products Research
The Angoumois grain moth is a pest of stored corn and other grains throughout the world. They are routinely exposed to temperatures below 70°F in regions of the U.S. where corn is grown, yet there are no data describing adult life history below 70°F. We determined longevity, fecundity, and survivorship of eggs at a range of temperatures that represent environmental conditions to which Angoumois grain moths are exposed in corn stored in the U.S. (50 to 105°F). Females and males lived as long as four weeks at 50°F. Females laid eggs at all temperatures tested, but fewer eggs were laid and hatched at temperatures below 70°F. Our results show that Angoumois grain moths can live and reproduce at temperatures below 70°F. These data will be used to develop computer models for simulating Angoumois grain moth population growth at the complete range of environmental conditions at which these insects are exposed in stored grain, and the simulation models will be used to aid in making pest management recommendations.
Contact James Throne, telephone 559-596-2702, email James.Throne@ars.usda.gov

Spatial Pattern in Aerosol Insecticide Deposition Inside a Flour Mill

Authors: J.F. Campbell, F.H. Arthur, K.Y. Zhu
Submitted to: Journal of Economic Entomology
Aerosol insecticides are applied as small droplets into the air, which then settle onto surfaces to provide control of stored-product insects inside food facilities such as mills and warehouses. Features inside a room such as mill and processing equipment, bins, columns and pallets of food are predicted to impact how these droplets disperse, potentially creating zones within a room with lower droplet deposition and lower insect mortality. We used a high density grid of dishes containing confused flour beetle as a means to determine the amount of insecticide being deposited at a given location and developed a new efficacy index to show that two pyrethrin aerosols did exhibit zones with high and low efficacy within a flour mill. However, rather than the obvious physical barriers it tended to be along walls and in corners where lower efficacy occurred. The temperature when the aerosol was applied also impacted efficacy. A third insecticide, DDVP, an organophosphate that readily vaporizes and can cause mortality in the vapor phase was very consistent in causing insect mortality throughout the flour mill. We also used boxes of different heights and open on only one end to evaluate aerosol dispersal under a horizontal surface. Aerosol dispersal under the box decreased with decreasing box height and distance under the box in a way that could be quantified and used to predict where low efficacy is likely to occur within a food facility. These results show the potential for spatial variation in aerosol efficacy within a food facility and identify locations that are likely to receive lower dosages of insecticide and need supplemental treatment to maximize overall efficacy.
Contact Jim Campbell, telephone 785-776-2717, email James.Campbell@ars.usda.gov

An Evaluation of Genotyping by Sequencing (GBS) to Map the *Breviaristatum-e* (ari-e) Locus in Cultivated Barley

Authors: H. Liu, M. Bayer, A. Druka, J. Russell, C. Hackett, J. Poland, L. Ramsay, P. Hedley, R. Waugh
Submitted to: BMC Genomics
We explored the use of genotyping by sequencing (GBS) on a recombinant inbred line population (GPMx) derived from a cross between the two-rowed barley cultivar 'Golden Promise' (*ari-e.GP*/*Vrs1*) and the six-rowed cultivar 'Morex' (*Ari-e*/*vrs1*) to map plant height. We identified three Quantitative Trait Loci (QTL), the first in a region encompassing the spike architecture gene *Vrs1* on chromosome 2H, the second in an uncharacterized centromeric region on chromosome 3H, and the third in a region of chromosome 5H coinciding with the previously described dwarfing gene *Breviaristatum-e* (*Ari-e*).
Contact Jesse Poland, telephone 785-532-2709, email Jesse.Poland@ars.usda.gov

Temporal Changes in Stored-Product Insect Populations Associated with Boot Pit and Load-out Areas of Grain Elevators and Feed Mills

Authors: D.R. Tilley, M.E. Casada, B. Subramanyam, F.H. Arthur
Submitted to: Journal of Stored Products Research
Stored grain insect infestations in elevator boot pits areas can spread throughout grain storage and

processing facilities, reducing grain quality, contaminating the grain, and causing economic losses. The effect of time of year on insect infestations in elevator boot pit areas has not been studied before. We determined the types and numbers of stored-grain insect species found in the boot (pit) area and in grain stored in silos of commercial elevator and feed mill facilities. The number of insects found in residual grain samples was low in the cool winter months and peaked during the warm summer months. These results showed regular boot and pit cleaning is critical in preventing pest population outbreaks during the warm summer months. New facility pest management sanitation guidelines were developed including boot residual grain clean-out every 30 days, removal of grain spillage and floor sweepings from the pit area, and proper disposal of boot and pit residual grain. Grain handling facilities following the frequent clean-out of the boot residual grain and general sanitation of the pit area should reduce the number of insects that are picked-up in the boot area and transferred to other locations of a facility, which will reduce the damage and losses that would occur if insects are allowed to proliferate in the boot area and spread elsewhere.

Contact Mark Casada, telephone 785-776-2758, email Mark.Casada@ars.usda.gov

Pseudomonas aeruginosa in *Musca domestica* L.: Temporospatial Examination of Bacteria Population Dynamics and House Fly Antimicrobial Responses

Authors: C. Joyner, M.K. Mills, D. Nayduch
Submitted to: PLOS ONE

Bacteria ingested by adult flies enter the digestive tract and face a hostile environment including antimicrobial defenses. Because the outcome of this interaction impacts bacterial survival and dissemination, our primary objective was to understand the dynamic association between house flies and ingested bacteria over time. We concurrently examined the fate of green fluorescent protein (GFP)-expressing *Pseudomonas aeruginosa* (GFP-*P. aeruginosa*) in the house fly gut along with antimicrobial peptide (AMP) gene and protein expression. Motile, viable GFP-*P. aeruginosa* were found in all regions of the gut and were culturable throughout the observation period (2-24 h). A significant decrease in recoverable bacteria occurred between 2-12 h, followed by an increase between 12 and 24 h. The antimicrobial genes *cecropin*, *diptericin*, and *defensin* were upregulated both locally (gut) and systemically in the body of flies. Furthermore, these genes were induced in all tissues of the gut, which correlated with the presence of bacteria in those same regions. Interestingly, the decrease in recoverable *P. aeruginosa* was associated with a peak in the antimicrobial gene products (proteins) in the gut, which implies that these products may be involved in killing bacteria. Flies excreted GFP-*P. aeruginosa* in feces and vomit throughout the 24 h period, serving as both reservoirs and disseminators of this bacterium. Collectively, our data show that flies can harbor and transmit *P. aeruginosa*, and that the interactions of fly defenses with bacteria can influence vector competence.

Contact Dana Nayduch, telephone 785-537-5566, email Dana.Nayduch@ars.usda.gov

Using RNA-Seq to Understand Insecticide Resistance in the Red Flour Beetle, *Tribolium castaneum*

Authors: B.S. Oppert; R.N.C. Guedes; M.J. Aikins; L.C. Fallis; Z. Chen; T.W. Phillips; K.Y. Zhu; G.P. Opit; K. Hoon; Y.M. Sun
Submitted to: PLoS ONE

Phosphine is the most popular and economical fumigant, but insect resistance to phosphine is increasing. We studied the genetic differences in a phosphine-resistant strain of the red flour beetle from Brazil and compared it to a phosphine-susceptible laboratory strain. We found differences in expression levels of 53 genes in the resistant strain. However, reducing expression of the most highly expressed gene, a cytochrome P450, in the resistant strain did not prevent resistance. We also tried to mimic the resistant strain by reducing expression of another gene in the susceptible strain, but they were still susceptible to phosphine. We studied a known phosphine resistance gene and found mutations associated with phosphine resistance in the resistant strain. The phosphine-resistant strain was cross-resistant to a pyrethroid, suggesting that multiple resistance genes may be accumulating in stored product insects with increased insecticide exposure. These data provide valuable insights into phosphine resistance and how management strategies may need to be adjusted to maintain efficacy of insecticides.

Contact Brenda Oppert, telephone 785-776-2780, email Brenda.Oppert@ars.usda.gov

USDA-ARS Center for Grain and Animal Health Research

1515 College Avenue
Manhattan, KS 66502

800-627-0388
ars.usda.gov/npa/cgahr