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Research Kernels

Our Latest Research Results • October 2009

Reactive Oxygen Species are Involved in Plant Defense against a Gall Midge

Authors: X. Liu, C.E. Williams, J.A. Nemacheck, H. Wang, S. Subramanyam, C. Zheng, M.S. Chen
Submitted to: Plant Physiology

Host plant resistance is the most effective and cost efficient means to control Hessian fly, a serious pest of wheat. However, the rapid development of new biotypes has made resistance in host plants short-lived, lasting for only 6-8 years for a specific resistance gene. A better understanding of plant resistance mechanisms is needed to develop more durable resistant wheat. This research investigated the potential role of reactive oxygen species (ROS) in plant defense against Hessian fly. We found that hydrogen peroxide, a major form of ROS, was accumulated to high levels at the feeding site in resistant wheat and in non-host rice plants following Hessian fly attack. Hydrogen peroxide was very toxic to fruit fly larvae, a related insect that belongs to the same order as Hessian fly. This research broadened our understanding of plant defense against different herbivores and provided a foundation for future research that may lead to more effective host plant resistance.

Contact Ming Shun Chen, telephone 785-532-4719, email ming.shun.chen@ars.usda.gov

Large-Scale Insertional Mutagenesis of the Coleopteran Stored Grain Pest, the Red Flour Beetle *Tribolium castaneum*, Identifies Embryonic Lethal Mutations and Enhancer Traps

Authors: J. Trauner, J.B. Schinko, M.D. Lorenzen, T.D. Shippy, E.A. Wimmer, R.W. Beeman, M. Klingler, G. Bucher, S.J. Brown
Submitted to: Biomed Central (BMC) Genomics

No methods exist for high-throughput discovery of essential genes in pest insects. The red flour beetle, *Tribolium castaneum*, was the first agronomic pest insect to have its genome completely sequenced. This resource, in combination with the sophisticated genetic toolkit available for Tribolium, makes it the best laboratory model for gene discovery in pest insect species. In order to further improve the usefulness of Tribolium for new gene discovery and functional analysis we developed highly efficient methods for randomly labeling genes with fluorescent tags. These tags make it possible to determine whether the tagged gene is necessary for insect survival, and also provide clues about gene function. We used the method to identify almost 500 new genes that are required for insect health and survival, as well as more than 500 additional genes whose expression patterns could be identified, giving clues about their likely functions. The method should be applicable to other pest insect species.

Contact Richard Beeman, telephone 785-776-2710, email richard.beeman@ars.usda.gov

Effect of Commodity Characteristics on Population Growth of Four Stored-Grain Psocid Pests (Psocoptera: Liposcelididae)

Authors: C. Athanassiou, G.P. Opit, J.E. Throne
Submitted to: Journal of Economic Entomology

Psocids, or booklice, are emerging pests of stored grains, and little is known about them. Population growth of four psocid species, *Liposcelis bostrychophila*, *L. decolor*, *L. paeta*, and *L. entomophila* was greatest on sorghum, followed by wheat and rice. Progeny production on wheat containing varying amounts of cracked kernels did not increase as cracked kernel content increased; instead, progeny production peaked at 20% cracked kernels for *L. bostrychophila* adults and nymphs, at 10% for *L. decolor*, and at 50% for *L. paeta* adults. No further increases were noted beyond these levels of cracked wheat content. Progeny production on eight classes of wheat was highest on durum wheat. The results indicate that there are considerable variations in psocid population growth among the different commodities tested, and this information may be used to predict the degree to which stored commodities are susceptible to psocid infestation.

Contact James Throne, telephone 785-776-2796, email james.throne@ars.usda.gov

Efficacy of Methoprene for Control of Five Species of Psocids (Psocoptera) on Wheat, Rice, and Maize

Authors: C. Athanassiou, F.H. Arthur, J.E. Throne
Submitted to: Pest Management Science

Insecticides are one tool for controlling insect pests of stored grain, but we are losing many stored-grain insecticides because of insect resistance and registration issues. We evaluated control of five species of pest psocids, which are emerging pests of stored grains, on stored wheat, rice, and corn after 40 days of exposure to an insecticide that is an insect growth regulator, methoprene, which has low mammalian toxicity. Methoprene did not completely suppress progeny production, but did cause a

reduction in adult progeny in all psocid species; however, the numbers of immature psocids in the treated grains generally were not reduced by the methoprene. Our results indicate that the methoprene alone is not effective for control of the five psocid species tested. This information will help grain storage managers select protectant insecticides for control of stored-grain insects.

Contact James Throne, telephone 785-776-2796, email james.throne@ars.usda.gov

Dietary Stress Increases the Susceptibility of *Tribolium castaneum* to *Beauveria bassiana*

Author: J.C. Lord

Submitted to: Journal of Economic Entomology

The fungi that are pathogenic for insects provide a safe approach to controlling pests. The insecticidal fungus, *Beauveria bassiana*, is being considered as non-chemical control for insect pests of stored products including the red flour beetle for which it is less effective than for most insects. Certain stresses on insects render them more susceptible to fungal disease. Restriction of access to food by sanitation is an important stress-inducing means of insect management. Similarly, the nutritional content of various foods is a determinant of insect vigor and success on different commodities. This study investigated the effect of dietary stress on the efficacy of *B. bassiana* for red flour beetles. When beetle larvae were deprived of food for various periods of time they were more susceptible to fungal infection than when provided a constant food supply. Larvae that were reared on a rice diet were more susceptible than those reared on wheat flour. The addition of protease inhibitors to flour did not increase fungal efficacy, perhaps because of inhibition of fungal proteases by inhibitor residue on insect cuticles. Dietary stress, whether by food deprivation, suboptimal food quality or inhibition of gut digestive proteases significantly affected developmental rate and efficacy of *B. bassiana*. This research helps to create strategies for non-chemical methods to control insect pests in stored commodities.

Contact: Jeff Lord, telephone 785-776-2705, email jeff.lord@ars.usda.gov

Functionality of Native Tetraploid Wheat Starches: Effects of Waxy Loci Alleles and Amylose Concentration in Blends

Authors: L.E. Hansen, D.S. Jackson, R.L. Wehling, J.D. Wilson, R.A. Graybosch

Submitted to: Journal of Cereal Science

Durum wheats with “waxy” or amylose-free and “partial waxy” (reduced amylose) starch were developed. The starch of such wheats possesses altered cooking properties. Starches isolated from waxy, partial waxy and normal types were compared to those of commercially available common wheat wild-type and waxy starches, and functionalities compared to blends (inter-granular variants) of durum waxy and wild-type starches of 0, 6, 12, 18, 24, & 30% amylose content. Starch particle size distributions of partial waxy and normal types were similar; the waxy samples had starch granule size. There were large differences in starch gel color and gel strength observed between the waxy samples and normal samples. Numerous differences were observed via Rapid-Visco Analysis (RVA), a technique that measures starch cooking properties under shear or mixing stresses. Pasting peak viscosity and breakdown, measures of starch thickness at various temperatures, were inversely proportional to % amylose. These observations indicate waxy samples would make excellent starch substrates for applications such soups and gravies. One partial waxy type, known as the Wx-B1 null, had final cooking viscosity that from that of all other blends and genotypes, demonstrating that amylose content variation within starch granules does not always mimic the effects observed in mechanical blends of similar amylose concentration. Through use of these genetically-controlled “partial waxy” (reduced amylose) lines, or via the blending of waxy and normal (wild-type) wheats, food processors can develop starches with a wide range of functional properties. The commercial availability of waxy wheat starch would present U.S. gluten protein manufacturers with a novel starch product, which, coupled with the extraction of vital gluten would present a unique product combination.

Contact: Jeff Wilson, telephone 785-776-2763, email jeff.d.wilson@ars.usda.gov

USDA-ARS Grain Marketing and Production Research Center

1515 College Avenue
Manhattan, KS 66502

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