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Research Kernels

Our Latest Research Results - April 2011

A Novel Quantitative Trait Locus for Fusarium Head Blight Resistance in Chromosome 7A of Wheat

Authors: D.V. Jayatilake, G. Bai, Y. Dong
Submitted to: Journal of Theoretical and Applied Genetics
Fusarium head blight (FHB) has caused significant yield losses in most of wheat growing regions in the U.S. The pathogen also produces a toxin called deoxynivalenol (DON) in infected grain, which dramatically reduces the end-use quality. Chinese line Sumai 3 has the best resistance to the disease. In this study, we crossed the FHB resistant Chinese Spring-Sumai 3-7A substitution line to Chinese Spring and developed a Sumai 3-Chinese Spring chromosome 7A recombinant inbred line population. Using this population, we identified a new gene from Sumai 3. This gene was located near the centromere of chromosome 7A (7AC), and controls both low DON content and FHB resistance, and thus has the potential to be used in improving wheat cultivars for both FHB resistance and low DON.
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Single Nucleotide Polymorphism in Wheat Chromosome Region Harboring Fhb1 for Fusarium Head Blight Resistance

Authors: A. Bernardo, H. Ma, D. Zhang, G. Bai
Submitted to: Molecular Breeding
Fusarium head blight (FHB), also called scab, is a destructive disease worldwide that significantly reduces both grain yield and quality of wheat. A gene (Fhb1) resistant to the disease has been found in the short arm of chromosome 3B from cultivar Sumai 3. This gene has shown the largest effect on FHB resistance. In breeding programs, large-scale evaluation of breeding materials for FHB resistance in field conditions is difficult. As a better alternative, molecular markers closely linked to the gene can be used to select for the resistance gene without need of direct field tests. Several molecular markers for the gene have been developed and used in breeding programs, but they only give good prediction in certain groups of breeding materials. Thus better markers are still urgently needed for effective use of the gene to improve wheat resistance to FHB. In this study, a new generation marker called single nucleotide polymorphism (SNP) was developed. This type of marker is suitable for high-throughput analysis. The SNP markers identified in this study should be useful for gene cloning and marker-assisted selection of Fhb1.
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Comparative Evaluation of Phenoloxidase Activity in Different Developmental Stages of Lepidopteran Pests

Authors: J.A. Valadez-Lira, J.M. Alcocer-Gonzalez, G. Damas, G. Nunez-Mejia, B.S. Oppert, C. Rodriguez-Padilla, P. Tamez-Guerra
Submitted to: Journal of Insect Science
Some insect pests can be controlled by microbial bioinsecticides, such as fungi and bacteria, but insects may be able to resist by mounting an immune response. We evaluated the expression patterns of one enzyme involved in insect immune response, phenoloxidase, in four lepidopteran (moth) pests. We found that there were significant differences in the activity of phenoloxidase in different larval stages and between male and female insects. These studies will be used to determine if application timing of a bioinsecticide may enhance its performance.
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Genetic Structure of *Tribolium castaneum* Populations in Mills

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Submitted to: Molecular Biology
Food products made from processed grain can become infested by the red flour beetle, *Tribolium castaneum*, either at the mills where flour is produced or at subsequent points in the food distribution channel, so tools to identify source of infestation would be useful for the targeting of pest management. Variation in molecular markers – variable sections of DNA – was used to estimate how beetle populations from mills differ from each other, and how accurately beetles could be assigned to the mill from which they originated. Red flour beetles collected from nine wheat or rice mills ranging from 0.3 to 5,700 km apart were evaluated. Using molecular population genetic analyses it was shown that populations did differ from each other, but the majority of the variation occurred within a mill, rather than between mills which suggests limited isolation of the populations. It was also found that the difference in variation between

two mills did not increase with how far apart the mills were from each other, which is what would be predicted if beetles were dispersing back and forth between the mills due to their own behavior. Only 56% of the collected beetles could be correctly assigned to their source population. Results of this research show that there is structure to the populations, but either there is significantly more movement of beetles among the mills than was predicted or more suitable molecular markers are needed to accurately assign beetles to their source mill.

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Efficacy of Heat Treatment for Disinfestation of Concrete Grain Silos

Authors: G.P. Opit, F.H. Arthur, E.L. Bonjour, C.L. Jones, T.W. Phillips

Submitted to: Journal of Economic Entomology

Heat treatments are being used to disinfest flour mills but there is no information on the utility of this technique to disinfest empty grain silos. We conducted field trials by placing live lesser grain borers, red flour beetles, or two psocid species inside containers with wheat and/or flour media and suspending those containers at different heights inside empty silos. Propane heat was generated from commercial equipment and introduced into the bottom of the silos. When temperatures exceeded 122°F for at least 6 hours, complete mortality of all insects and life stages generally occurred. The wheat inside the containers did provide some insulating effect from the heat. The lesser grain borer was more heat-tolerant than the red flour beetle, and one of the psocid species was more tolerant than the other. Most of the insect survival occurred in the containers that were in the top or mid-points of the silos. Results show heat could be used to disinfest empty silos, but cleaning and sanitation prior to heat treatment might be necessary to maximize effectiveness.

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Two Major Structural Proteins are Required for Rigid Adult Cuticle Formation in the Red Flour Beetle, *Tribolium castaneum*

Authors: Y. Arakane, J. Lomakin, S.H. Gehrke, Y. Hiromasa, J.M. Tomich, S. Muthukrishnan, R.W. Beeman, K.J. Kramer, M.R. Kanost

Submitted to: Biochemical Journal

Chitinous structures on insects such as the exoskeleton and digestive sac are vital for insect survival and could be exploited by appropriately-targeted biopesticides. We identified two new structural proteins in the red flour beetle exoskeleton that are important for conferring strength and rigidity to the adult cuticle. The proteins are the major protein components of wing covers, but are also found in other rigid portions of the exoskeleton. Absence of the proteins in wing covers through genetic manipulation leads to dehydration and death of the insect. Our ongoing gene discovery efforts in this pest insect continue to reveal new weaknesses that may lead to new methods of insect control.

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Effectiveness of Sulfuryl Fluoride for Control of Different Life Stages of Stored-Product Psocids (Psocoptera)

Authors: C. Athanassiou, T.W. Phillips, M.J. Aikins, M.M. Hasan, J.E. Throne

Submitted to: Pest Management Science

With the impending phase-out of methyl bromide, sulfuryl fluoride is among the most promising alternative fumigant insecticides. It has been evaluated for control of several insect species, but there are few data available on its efficacy for control of stored-product psocids (Psocoptera). Psocids (insects which are also called booklice) are pests of stored grains and grain products in most of the world, and they have natural tolerance to some of the insecticides used for control of stored-product insects. We evaluated sulfuryl fluoride for control of different life stages of the psocids *Liposcelis paeta*, *L. entomophila*, *L. bostrychophila*, *L. decolor*, and *Lepinotus reticulatus* (psocids generally are known only by their scientific names). Adults and nymphs were very susceptible to sulfuryl fluoride. Complete adult and nymphal mortality was recorded at concentrations between 4 and 8 g/m^3, except for *L. decolor* where all adults were killed at 24 g/m^3. Eggs were tolerant to sulfuryl fluoride. Complete egg mortality was achieved at 24 and 72 g/m^3 for *L. reticulatus* and *L. decolor*, respectively. Survival of *L. paeta* eggs was recorded even after exposure to 96 g/m^3. Given that the highest label concentration for sulfuryl fluoride for a 48-h exposure interval is 31.25 g/m^3, our study indicates that high doses and/or longer exposures are needed for complete mortality of eggs of *L. decolor* and *L. paeta*.

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