GMPRC
GRAIN MARKETING AND PRODUCTION RESEARCH CENTER

RESEARCH Kernels

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New Center Director. Greetings. On 1 April, I became the Director of the Grain Marketing & Production Research Center. I'm very excited about the new job. Here's a bit about my background. I spent nine years at the USDA-ARS Northern Plains Agricultural Research Laboratory in Sidney, MT, including seven years as Research Leader of the Pest Management Research Unit. Prior to that, I worked for 10 years at international agricultural research centers in India and Bénin, West Africa. I have degrees in entomology from the University of California-Berkeley (PhD) and the University of Illinois (MS), and in biology from Marietta College. I look forward to getting to know the readers of "Research Kernels." Please fee free to contact me with questions, suggestions or comments. Telephone: 785-776-2702; email: tom.shanower@ars.usda.gov.

New Sources of Aluminum Resistance in Wheat Identified. Aluminum (Al) toxicity is a major constraint for wheat production in acidic soils. An Al-resistance gene from Brazilian wheat has been extensively studied, but information on Al resistance genes in other wheat varieties is lacking. ARS researchers evaluated 590 wheat accessions from the USA and several other countries and identified 88 accessions having at least moderate resistance to Al toxicity. Marker analysis of selected resistant accessions indicated that many of the selected Al-resistant accessions from East Asia did not have the Al-resistant marker allele of gene ALMT1, a gene that was reported to be responsible for Al resistance in Brazilian wheat. Most of the cultivars derived from Jagger and Atlas 66 from the USA have the Al-resistant marker for the ALMT1 gene, therefore, this marker can still be used to select Al resistance from Jagger or Atlas 66 and their derivatives. New sources of Al resistance different from those derived from Brazil can be used in breeding programs to increase aluminum tolerance. (Guihua Bai, telephone: 785-532-1124; email: guihua.bai@gmprc.ksu.edu)

Single Wheat Kernel Particle Size Distribution and the Perten SKCS 4100 Hardness Index. Grain inspectors have observed that in the U.S. Pacific Northwest region, discriminating soft white wheat from hard white wheat has become increasingly difficult. This poses problems for assigning a proper grade to wheat loads being exported to international customers. Additionally, wheat loads with mixed hard white and soft white wheat may have different baking qualities, and may reduce the desirability of U.S. grown wheat, especially for international customers. The primary instrument for distinguishing hard and soft classes of wheat is called the Single Kernel Characterization System (SKCS). Our research found that, through simple data processing software changes to the SKCS, classification errors between hard white and soft white wheat were reduced by about 50% over the current configuration of the SKCS. This should help those using the SKCS to determine wheat class purity, such as wheat inspectors. Also, this should help wheat millers and international customers better understand the quality and properties of incoming wheat loads. (Thomas Pearson, telephone: 785-776-2729; email: thomas.pearson@gmprc.ksu.edu)

Arcelins from an Indian Wild Bean and Insecticidal Activity Against Storage Pests. Arcelins are insecticidal proteins in beans with activity against some beetle pests. Arcelins from a wild Indian bean (*Lablab purpureus*) were isolated and characterized. Biochemical assays determined that this wild bean arcelin is very similar to its relative in other beans. Bioassays of 2% arcelin with several storage pests resulted in delayed larval development, and 5% doses resulted in complete mortality. Arcelins have the potential to control storage pests through the development of transgenic cereals containing arcelin genes. (Brenda Oppert, telephone: 785-776-2780; email: brenda.oppert@gmprc.ksu.edu)

Automatic Aeration for Insect Pest Management for Rice Stored in East Texas. Although many farm storage bins are equipped with aeration fans to cool the stored grains, in many cases the fans are simply activated manually and operated for variable time periods. We conducted a field test on rough rice stored in eastern Texas, a warm humid climate, and compared temperatures and insect development in bins with manual aeration versus aeration operated through an automatic controller. In the bins with automatic aeration, the temperature of the stored rice was immediately reduced compared to bins in which manual aeration was used. This temperature reduction led to lower numbers of the lesser grain borer and the rice weevil, two common insect pests of stored rough rice. Results show the benefits of using automatic aeration to manage stored rough rice. (Frank Arthur, telephone: 785-776-2783; email: frank.arthur@gmprc.ksu.edu)

Rapid Assessment of Insect Fragments in Flour Milled from Wheat Infested with Known Densities of the Rice Weevil *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). The process of milling wheat infested with low densities of internal feeding insects can result in flour containing insect fragments. We milled small lots of wheat infested with known densities and life stages of the rice weevil to determine how many fragments would be produced; additionally, we tested near-infrared spectroscopy as a novel method to rapidly estimate the number of fragments in a sample. Immature insects produced 0.4 to 1.5 fragments per insect, but adults produced an average of 27 fragments per insect. Spectroscopy was successfully used to categorize samples containing fragments of immature insects but not fragments resulting from adult insects. These data will enable millers to better predict how many fragments may result in a lot of flour, and rapidly test a finished flour sample to determine if it contains violative numbers of insect fragments. (James Throne, telephone: 785-776-2796; email: james.throne@gmprc.ksu.edu)

Hessian Fly (*Mayetiola destructor*) Attack Causes Dramatic Shift in Carbon/Nitrogen Metabolism in Wheat. The Hessian fly is one of the most destructive insect pests of wheat. The insect is currently controlled almost exclusively by host plant resistance. The challenge for the host plant resistance strategy is that resistance conferred by R-genes is short lived, lasting for about six to eight years. New strategies with greater durability are needed. To develop new strategies, we need to understand how the insect attacks wheat. We found that Hessian fly larvae can manipulate wheat to produce nutrition necessary for the insect growth and development in susceptible plants. Specifically, more sugars are converted into amino acids to provide a balanced nutrition for the insect. In resistant plants, this conversion process is inhibited, resulting in larval death of the insect. (Ming-Shun Chen, telephone: 785-532-4719; email: ming-shun.chen@gmprc.ksu.edu)

Hull Characteristics and Susceptibility of Different Rough Rice Varieties to *Rhyzopertha dominica* (F.), the Lesser Grain Borer (Coleoptera: Bostrichidae). The hull of rough rice may offer some protection from the lesser grain borer, a major internal pest of stored grains, because this insect lays an egg on the kernel, and the

young larvae must hatch and enter the hull to feed on the kernel. We exposed young larvae of the lesser grain borer on 28 different rice varieties, determined the percentage of solid versus split and cracked hulls, and thickness of the hull. More progeny were produced on rice varieties with higher percentages of cracked hulls and on those varieties with thinner versus thick hulls. Specific varieties were identified as susceptible or tolerant based on the hull characteristics. (Frank Arthur, telephone: 785-776-2783; email: frank.arthur@gmprc.ksu.edu)

Characterization of Polymeric Proteins from Vitreous and Floury Sorghum Endosperm. Grain hardness is an important end-use quality trait in sorghum. Grain hardness is important not only in milling and food quality, but also in insect and weathering resistance. The exact mechanism controlling grain hardness in sorghum is not fully understood. This project examined the differences in protein cross-linking between different parts of the sorghum grain which is thought to play an important role in sorghum grain hardness. We found that proteins extracted from hard endosperm appeared to be more cross-linked than proteins extracted from floury (soft) endosperm. By understanding the factors controlling grain hardness in sorghum it may be possible to manipulate these factors to produce sorghum with improved quality traits, benefiting sorghum producers, the grain industry, the cereal food industry, and the animal feed industry. (Scott Bean, telephone: 785-776-2725; email: scott.bean@gmprc.ksu.edu)

Simulated and Measured Crop Residue Cover in North Dakota. The Wind Erosion Prediction System (WEPS) includes a model for the decomposition of crop residue, because residue cover is very important for controlling soil erosion by wind. WEPS will be implemented throughout the USA, but most of the data used to develop the decomposition model were collected in the southern USA. We compared the WEPS simulated residue cover with that measured in south-central North Dakota for 50 two-year cropping sequences for nine crops that were grown under no-tillage conditions. Simulated residue cover underestimated measured cover for 33 out of the 50 simulated cropping sequences and overestimated measured cover for five cropping sequences. This study will help improve the WEPS residue decomposition model and the capability of WEPS to evaluate the effect of management alternatives on wind erosion, a problem that costs the US economy over $20 billion per year. (Edward Skidmore, telephone: 785-537-5530; email: edward.skidmore@gmprc.ksu.edu)

Differentiating Tobacco Budworm and Corn Earworm Using Near-Infrared Spectroscopy. Tobacco budworm and corn earworm are major pests of several crops, including cotton. Their larvae often are found feeding inside plant structures, and these immature stages are visually indistinguishable yet vary significantly in their susceptibility to some insecticides. It is important that the pest be correctly identified so that proper control measures can be implemented. We used near-infrared spectroscopy to determine the species of the larvae and eggs with up to 95% accuracy. This technology will help farmers more efficiently control this major crop pest. (Floyd Dowell, telephone: 785-776-2753; email: floyd.dowell@gmprc.ksu.edu)

Correlation Between Head Stability of Thylakoid Membranes and Loss of Chlorophyll in Winter Wheat Under Heat Stress. Determining the mechanisms associated with heat tolerance and identifying screening methods is crucial for improving heat tolerance in crop plants. New, inexpensive and easy-to-use methods must be developed for high throughput screening for heat tolerance in wheat and other crops. We investigated the relationship between heat tolerance and loss of chlorophyll in winter wheat under heat stress conditions, and tested the possibility of using chlorophyll loss, as determined by SPAD chlorophyll meter, as an indicator of heat tolerance in wheat. A strong negative linear correlation between heat tolerance and chlorophyll content was observed. Loss of chlorophyll under heat stress, as determined with a SPAD chlorophyll meter, could be used as a

reliable and high throughput method for screening for heat tolerance in wheat. The results of this study could aid in screening and producing new wheat cultivars with improved tolerance to heat stress. (Zoran Ristic, telephone: 785-532-7746; email: zoran.ristic@gmprc.ksu.edu)

Gluten-Free Sorghum Bread Improved by Sourdough Fermentation: Biochemical, Rheological and Microstructural Background. Celiac disease is a serious illness that requires life-long avoidance of the gluten-containing cereals wheat, rye, and barley. Though a rare disorder in the past, its prevalence in the U.S. and worldwide is now estimated at 0.9% and 0.4% of the population, respectively. Therefore, a growing market for gluten-free bread in the U.S. and worldwide is expected. Sorghum grain is safe for celiacs and its use for gluten-free bread would help the celiac community to enrich their diet, as well as U.S. farmers to gain a new market for high quality, food grade sorghum. However, the quality of gluten-free sorghum bread and gluten-free bread in general is not satisfactory, and knowledge of how to improve it is lacking. We have developed a new formulation and procedure for significantly improved sorghum bread, using sourdough fermentation, and also developed information for a basic scientific understanding of the gluten-free systems to further improve these breads in the future. (Scott Bean, telephone: 785-776-2725; email: scott.bean@gmprc.ksu.edu)

Domain Organization and Phylogenetic Analysis of the Chitinase Family of Proteins in Three Insect Species. Chitin is the main component of insect exoskeleton, conferring both rigidity and flexibility, and protecting the insect from injury, predation, infection, and desiccation. Chitin is also the major component of a membrane that coats the lining of the midgut, protecting it from abrasion and self-digestion. Until recently, very little was known about the enzymes needed for digestion and reutilization of the old exoskeleton during the insect molting cycle. We examined the genome sequences of three insects, the fruit fly, the malaria mosquito, and the red flour beetle, and identified all the chitinase and chitinase-like genes in these species. We found an unexpected level of complexity and functional specialization, and discovered the existence of five distinct classes of chitinase enzymes in each of the three insects. This evidence suggests that the various chitinases are needed in different tissues, and that some of the chitinase-like proteins have evolved new functions not directly related to chitin digestion, such as chitin binding and growth regulation. Each of these newly-discovered genes can become a target in screening assays for new biopesticides that disrupt molting and related physiological processes. (Richard Beeman, telephone: 785-776-2710; email: richard.beeman@gmprc.ksu.edu)

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