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Center for Grain & Animal Health Research

Research Kernels

Our Latest Research Results - March 2013

Automated Detection of Insect-Damaged Sunflower Seeds by X-Ray Imaging

Authors: T.C. Pearson, J.R. Prasifka, D.L. Brabec, R.P. Haff, B.S. Hulke
Submitted to: Applied Engineering in Agriculture
Breeding efforts to develop insect-resistant sunflowers is hindered by the lack of a quick and effective method for scoring samples in terms of insect damage. The current method for scoring insect damage is tedious and inconsistent as it involves manual inspection of seeds for holes bored into the shell. In this study, a method was developed to quickly place sunflower seeds in a closely packed grid where the seeds were consistently oriented. Subsequently, the grid of seeds was digitally x-ray imaged. A computer program was developed to analyze the images and classify each seed as damaged or undamaged. This computer program uses a simple but novel method for detecting seeds having asymmetrical morphology due to insect feeding. An overall classification accuracy for damaged and undamaged seeds was 95% and 99%, respectively. The method, including placing the seeds into the grid, imaging, and analyzing takes approximately 3 minutes per sample, and should be consistent over time. The method should aid in scoring sunflower seed varieties for insect resistance and could also be applied to other applications, such as detecting broken seeds.
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Influence of Flour Residue on *Tribolium castaneum* (Herbst) Response to Traps Baited With Pheromone and Kairomone

Author: J.F. Campbell
Submitted to: Journal of Stored Products Research
The red flour beetle is a major pest of flour mills and is typically monitored using traps that capture walking individuals, but the accumulation of flour on surfaces has the potential to influence beetle movement and response to traps. Different landscape patterns of a thin layer of flour residue were created that represented different patterns of surface coverage, and the response of individual beetles to traps baited with attractants (aggregation pheromone and food oil) or traps with no attractants was evaluated. There were no differences in number of beetles finding traps with attractants versus those without attractants on any of the landscapes alone or when all the landscapes were combined. However, on the combined fragmented landscapes, those with the flour divided into multiple small cells, greater numbers of beetles found traps with attractants (78%) than traps without (50%). When the flour was distributed into fewer and large groupings (clumped) there was no difference in beetles finding traps with and without attractants. The mechanism for this is not clear at this point since analysis of beetle movement did not reveal corresponding differences. The results suggest that the pattern of thin layers of flour residue can influence beetle captures in traps, with fragmented patterns in flour accumulation potentially increasing beetle response to traps, and this could impact the interpretation of pheromone monitoring programs.
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How Varying Pest and Trap Densities Affect *Tribolium castaneum* (Coleoptera: Tenebrionidae) Capture in Pheromone Traps

Authors: K.A. Buckman, J.F. Campbell
Submitted to: Entomologia Experimentalis et Applicata
The red flour beetle is an important insect pest of facilities which process and store grain. Integrated pest management frequently includes monitoring populations using traps that capture walking individuals. However, fundamental questions remain about the most effective way to implement monitoring programs and interpret monitoring data to estimate beetle density. Using experiments conducted in room-sized chambers where beetle density and number of traps could be controlled, we found that the number of individuals captured in traps increased as density of beetles increased, but the percentage of individuals captured remained constant. Applying a mathematical equation to estimate beetle density based on captures in traps, we found that a trap density of 4 traps per chamber (1 trap per 80 square feet) yielded the most accurate estimate of beetle density. The more traps placed in the chamber the greater the captures of beetles, but when trap density increased beyond 3 traps per chamber (1 trap per 108 square feet) the increases in beetle captures with each additional trap diminished to the point where there was little justification for the increased costs. This is the first scientific information available to guide the number of traps needed to monitor red flour beetles effectively and to estimate beetle density based on captures in traps.
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Methodology for Determining Susceptibility of Rough Rice to *Rhyzopertha dominica* (L.) and *Sitotroga cerealella* (Olivier)

Authors: F.H. Arthur, L. Starkus, C.M. Smith, T.W. Phillips
Submitted to: Journal of Pest Science
There are few recent tests that evaluate susceptibility of stored rice to stored-product insects. We evaluated different long grain rice varieties for susceptibility to two major insect pests, the lesser grain borer and the Angoumois grain moth, using different methods. Adult lesser grain borers were first exposed on the rice varieties, then removed. Adult feeding caused the varieties to become more susceptible to larval feeding, which in turn increased progeny production. Some varieties were more susceptible than others to the lesser grain borer. Since adult Angoumois grain moths do not feed, we exposed mating pairs of adults to produce larvae that would infest the rice. All varieties were susceptible to damage caused by larval Angoumois grain moth, including those that did not support lesser grain borer growth and development. Results show that varietal susceptibility to stored-product insects may differ with insect species.
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Early Stage Phytohormone and Fatty Acid Profiles of Plants Associated with Host and Non-Host Resistance to Hessian Fly (Diptera: Cecidomyiidae) Infestation

Authors: L. Zhu, M.S. Chen, X. Lui
Submitted to: Journal of Economic Entomology
Hessian fly is an important insect pest of wheat that causes damage to seedlings as well as lodging of adult plants. The purpose of this study was to compare the induction of plant hormones and fatty acids in resistant wheat cultivar 'Molly' and a non-host rice cultivar called 'Nipponbare'. In general, chemical changes were more rapid in the wheat plants than the rice plants. Salicylic acid and 12-oxo-phytodienoic acid were increased in both wheat and rice and may be important components of the defense response. This report provides a foundation for future work on the role of phytohormones and fatty acids in the defense response against Hessian fly.
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Quantitative Trait Loci for Fusarium Head Blight Resistance in U.S. Hard Winter Wheat Cultivar Heyne

Authors: X. Zhang, G. Bai, W.W. Bockus, X. Ji, H. Pan
Submitted to: Crop Science
Fusarium head blight (FHB) is a destructive disease that can significantly reduce grain yield and quality. Hard winter wheat (HWW) cultivars growing in US Great Plains are mostly susceptible. Genetic factors, also called quantitative trait loci (QTL) controlling FHB resistance have not been reported in HWW to date although they have been identified in many Chinese cultivars and other sources. 'Heyne' is a moderately FHB-resistant HWW from Kansas. We found three QTL are responsible for resistance in 'Heyne' after analyzing a recombinant inbred population from the cross 'Trego'/'Heyne' using molecular markers. The three QTL were mapped on chromosomes 3AS, 4DL, and 4AL and reside in 'Heyne'. These QTL can be used for improving FHB resistance in U.S. hard winter wheat by pyramiding them with Fhb1 or other major resistance QTL from Asian sources.
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Rapid Mobilization of Membrane Lipids in Wheat Leaf-Sheathes During Incompatible Interactions with Hessian Fly

Authors: L. Zhu, X. Liu, H. Wang, C. Khajuria, J.C. Reese, J.R. Whitworth, R. Welti, M.S. Chen
Submitted to: Plant Journal
Host plant resistance is the most effective way to control Hessian fly (HF), an important pest of wheat. However, resistance in current wheat cultivars is short-lived, usually lasting for only 6-8 years. To develop more durable resistant wheat varieties, we need a better understanding of the resistance mechanisms at the molecular level. In this study, we discovered that there was rapid mobilization of membrane lipids in resistant plants following HF attack. The mobilized membrane lipids were likely converted into defense-related products such as polyunsaturated free fatty acids, oxylipins, and components of cuticle wax. Our results suggest that rapid mobilization of membrane lipids may constitute an important step in wheat defense against HF attack. This research provides a foundation for future research on the role of lipids in wheat resistance to HF, which may lead to practical application in resistant wheat breeding.
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