



Research Kernels

Our Latest Research Results • November 2007

Utilization of chip-based capillary electrophoresis for avidin determination in transgenic tobacco and its advantages over standard gel electrophoresis and voltammetry

Analytical biosensors can be used to detect and quantify biologically important proteins in samples such as transgenic plants. Together with colleagues in the Czech Republic and New Zealand, we developed a microchip-based biosensor that measures the mobility of a charged protein in an electric field and utilized this sensor to measure levels of the biopesticide avidin in transgenic tobacco. This biosensor is more sensitive, rapid and reproducible than other analytical methods. It can be used by researchers to selectively monitor a range of biologically important compounds in different types of research and environmental samples.

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Fringing field capacitance sensor for measuring the moisture content of agricultural commodities

A low-cost moisture sensor was designed for measuring moisture content and temperature of agricultural commodities. The capacitive sensor was mounted on the end of hand-held probes and in 1.5 liter canisters and tested in wheat and corn over a range of moisture contents from approximately 1% to 20%. The sensor response was a consistent and sensitive function of the moisture content of grain for these applications. The sensor offers a promising means to determine the moisture content of grain during storage or transportation in cargo holds. The sensor is water-tight and constructed with corrosion resistant materials which allow moisture content and temperature measurements to also be made of industrial materials, chemicals, and fuels. The sensor may also be supported on cables in grain storage bins to acquire continuous, in situ data for stored grain management and the control of aeration and low-temperature drying systems.

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Localization of two post-proline cleaving peptidases in the midgut of *Tenebrio molitor* larvae

Storage pests digest foods that contain high levels of the amino acid proline, which require a special enzyme for complete digestion. We isolated several such enzymes from the gut of the yellow mealworm, and we demonstrated that one of the enzymes is involved in digestion. This information can be used to identify new inhibitors to disrupt pest digestion of food.

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The maternal-effect, selfish genetic element *Medea* in *Tribolium* is a Tc1 transposon

Selfish genetic elements are naturally occurring agents that can impose limits on insect population growth and viability. We discovered a new type of selfish gene in flour beetles that causes the death of hatchlings, and depends both on the susceptibility of progeny larvae and on the selective lethal influence of the mother. We have now determined the molecular basis for this unusual larvicidal mechanism, namely the insertion of a large segment of DNA next to a beetle gene required for nervous system function. The inserted segment of DNA contains another gene normally found only in bacteria. A better understanding of how insect populations are regulated in nature could suggest new ways to control pest populations in mills and warehouses.

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Molecular characterization of Atlas 66 derived wheat near-isogenic lines contrasting in Aluminum tolerance

Aluminum (Al) toxicity is the major limiting factor for wheat production in acidic soils. Use of Al resistant cultivars is the most cost-effective solution to solve the problem. DNA markers linked to the gene that controls Al resistance in wheat can make selection of Al-resistance genes more accurate and efficient. To identify DNA markers linked to Al-tolerance genes in wheat, two type of DNA marker called Amplified fragment length polymorphism (AFLP) and simple sequence repeat (SSR) were used to tag the Al resistance gene in Al-resistant cultivar Atlas 66. Near isogenic lines (NILs) differing in Al resistance were developed by transferring Al-resistance genes from Atlas 66 into two sensitive cultivars, Century and Chisholm. We found that nine markers were linked to Al tolerance in the Chisholm-derived NILs, and seven were associated with Al tolerance in the Century-derived NILs. Three markers associated with Al tolerance were located on wheat chromosome 4D. These common markers across two backgrounds may be the major DNA markers for Al tolerance in Atlas 66 and could be used for marker-assisted breeding for Al tolerance in wheat. The result also suggested that Atlas 66 may carry more than one gene for Al tolerance.

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Near-infrared spectroscopy detects honey bee queen insemination

The widespread honey bee colony mortality may be related to queen fertility and pathogens. A rapid, non-invasive method for assessing bee fertility and health would be useful in studies of affected bee colonies. We investigated the application of near-infrared spectroscopy to determining queen fertility and the presence of pathogens. The abdomens of honey bee queens, the heads of worker bees, and the ventriculi of worker bees were analyzed by visible and near-infrared spectroscopy. Mated honey bee queens could be distinguished from virgin queens by their spectra with 100% accuracy. Also, the heads of worker bees taken from the brood nest of a hive had reflectance spectra that differed from those of flying workers taken from the hive entrance. These spectra could be used to predict whether bees were from the brood nest or were collected as flying bees with about 85% accuracy. However, we were not able to determine the severity of *Nosema apis* infection in worker ventriculi. This technology can be a useful to rapidly and non-destructively determine the honey bee characteristics as we attempt to understand the Colony Collapse Disorder phenomenon.

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Effects of intra- and interpatch host density on egg parasitism by three species of *Trichogramma*

The Indianmeal moth is a serious pest of raw and finished stored products and attacks both packaged and bulk commodities as well as spillage. Three species of *Trichogramma* wasp parasitoids were tested to find the best one for biological control of the Indianmeal moth. We studied the effects of different intra- and interpatch Indianmeal moth egg densities on the host-foraging success of three different *Trichogramma* species. All three species parasitized the most eggs when they were arranged in a six by six patch array of four eggs per patch, and the least in the three by three patch grid of single eggs. *Trichogramma deion* parasitized significantly more eggs than *T. pretiosum* on the three by three grid of four-egg patches. *Trichogramma deion* may be the best candidate for augmentative biological control because it parasitized more eggs than the other two species in all four treatments. *Trichogramma* could provide a new tool for the retail organic food industry to manage insect pests. Harmless and practically invisible, *Trichogramma* wasps are an environmentally-friendly way to keep food pests in check.

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