GMPRC
GRAIN MARKETING AND PRODUCTION RESEARCH CENTER

Research Kernels

Our Latest Research Results • November 2008

Predicting stored grain insect population densities using an electronic probe trap

Manual sampling of insects in stored grain is a laborious and time consuming process. Automation of grain sampling should help to increase the adoption of stored-grain integrated pest management. We field-tested a new commercial electronic grain probe trap (Insector™) in two bins, each containing 32.6 tonnes of wheat, over a two-year period. We developed statistical models to convert trap catch into insects per kilogram of wheat. An expert system, Stored Grain Advisor Pro, was modified to automatically obtain data from Insector™ and to estimate the numbers of insects in the grain for three different species. Management decisions using Insector™ trap-catch estimates for rusty grain beetle, lesser grain borer and red flour beetle numbers were similar to those made using grain sample estimates for most sampling dates. However, because of the similarity in size of the lesser grain borer and red flour beetle, the software was unable to tell the difference between these two species. In the central and southern portions of the US, where both species frequently occur, it may be necessary to determine the proportion of each species present in the grain by manual inspection of trap catch. The combination of SGA Pro with the OPI Insector™ system should prove to be a useful tool for automatic monitoring of insect pests in stored grain.

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Occurrence of *Nosema oryzaephili* in Cryptolestes ferrugineus and transfer to the genus Paranosema

Beneficial pathogenic microbes are important components of the natural enemy complexes that help to keep pest populations in check. Difficulty in understanding how these organisms work is due in part to confusion about their taxonomy and host ranges. Microsporidia are primitive fungi that are common pathogens of insects. A microsporidium was found in rusty grain beetles for the first time, and its identity and pathology were unknown. Bioassays were conducted that suggested that it was a species that had been reported only from the sawtoothed grain beetle. Gene sequencing resulted in its placement in a recently created genus that includes a pathogen of the red flour beetle. This work is necessary for development of an understanding of the impact of these natural enemies on pest beetles.

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Short-term reducing conditions decreases soil aggregation

Upland soils in the midwestern US often undergo reducing conditions when soils are temporally flooded during the spring and remain water saturated for days, weeks, or even months. Effects of the prolonged saturation on chemical, biological, and physical properties of these soils are still not well understood and should vary according to the soil type and environmental conditions. The temporary reducing condition influences soil chemical and physico-chemical condition. Thus reducing condition may also affect nutrient status and aggregate stability of the soils, which are important issues regarding to plant growth and water quality. The objective of this study was to determine how redox changes during periods of saturation of upland soils will impact nutrients cycling and soil aggregate stability. We assumed that soil aggregate stability would decrease under reducing conditions. The hypothesis was tested on three cultivated and three forest soil using biogeochemical reactor designed to continuous measurements of redox potential (Eh), pH, and CO_2 during anaerobic incubation (from 1h to 14 day). After each incubation period the soil solution analyzed for metals and dissolved organic carbon. Aggregate stability of samples was determined using high energy moisture characteristic methods, where the destructive force used to break down aggregates was controlled wetting rate. In general, redox potential and aggregate stability decreased with increasing incubation time for all six soils. There was significantly change in pH, electrolyte concentration (EC), metal concentrations (Fe, Mn, Na, K, Ca, Mg), and DOC due to the reducing condition. Cultivated soils were less stable than uncultivated soils for the same incubation period. Soils under stronger reducing conditions were less stable. All observed changes depended on the

initial stability of the soil after the incubation treatments and the soil organic matter content. This study showed that under reducing conditions, changes in concentrations of redox sensitive metals, organic matter decomposition, and EC of the soil can affect soil structural or aggregate stability and should be considered in chemical transport processes and water quality studies.
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Particle size distribution of eroded material from interrill areas as affected by rate of wetting and rain depth

Soil erosion is an undesirable phenomenon from both agricultural and environmental points of view. Of the various size classes of the eroded material, the small soil particles or clay size fraction is the major contributor to off-site contamination by soil material containing pesticides, nutrients, etc. Soil surface sealing, runoff generation, detachment and transport of soil particles (sediment) depended on soil permanent properties such as texture and time dependent condition such as wetting rate by rainfall. Slow wetted soil due to reduced aggregate slaking are more stable than fast wetted soil. The objective of this study was to determine whether the particle size distribution (PSD) of the eroded material changes with rain depth and whether these changes in the PSD are affected by soil texture and the rate of wetting. We used a laboratory drip-type rainfall simulator to obtain runoff and soil loss from three erosion-prone soils varying in clay content (sandy loam, silty clay and clay). Soils were wetted at a slow or a fast rate and were exposed to 60 mm of simulated rainfall. Runoff samples, containing sediments were collected with fixed interval. Eroded material was analyzed for PSD using a laser particle size analyzer. Generally soil loss from fast wetted soils was higher than from slow wetted samples. Clay content in the eroded sediment at the initial stages of the rainstorm was higher in loam, but no clear trend was noted for clay soils. Cumulative clay enrichment was significantly higher (up to 30%) than that of the parent material or soil. However, with rainfall duration, clay content in runoff sediment decreased. The magnitude of this decrease and/or clay enrichment depended on both wetting rate and soil texture. The information gathered in the current study may assist in the development of models aimed at predicting the environmental impacts of soil erosion.
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Wheat moisture measurement with a fringing field capacitive sensor

A new low-cost moisture sensor has been developed for measuring the moisture content (MC) and temperature of agricultural commodities. The sensor, which can be supported on cables in grain storage bins, was tested in the laboratory to determine the accuracy using HRW wheat samples from three states (Kansas, Oklahoma, and South Dakota) over two crop years. The accuracy was ±1% MC compared to the air-oven in these test. This accuracy was slightly lower than the best laboratory instruments, but this accuracy is appropriate for a low-cost in-bin grain moisture monitoring sensor.
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Microarray analysis reveals adaptive strategies of *Tribolium castaneum* larvae to compensate for cereal protease inhibitors

Previously, our studies determined that flour beetle larvae respond to dietary inhibitors by shifting from one class of proteases to another. This response is problematic if cereal inhibitors are to be incorporated into IPM strategies for storage pest control. To study this at the gene level, whole-genome microarrays were used to evaluate the inhibitor response. The data demonstrated that the response by beetle larvae to dietary inhibitors involves a complicated adjustment of gene expression. However, the study also provided clues as to how to better utilize inhibitors for beetle pest control. Therefore, effective control of beetles may soon be possible with a strategy that can anticipate beetle responses to inhibitors.
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